

Introduction – Solid-State Relays

TI Precision Labs – Solid-State Relay (SSR) Portfolio

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Agenda

- What is a solid state relay?
- Galvanic isolation
- How solid state relays work
- Existing relay technologies
- TI's isolation technologies
- Types of solid state relays
- Solid state relay portfolio
- Applications

What is a solid state relay?

Function

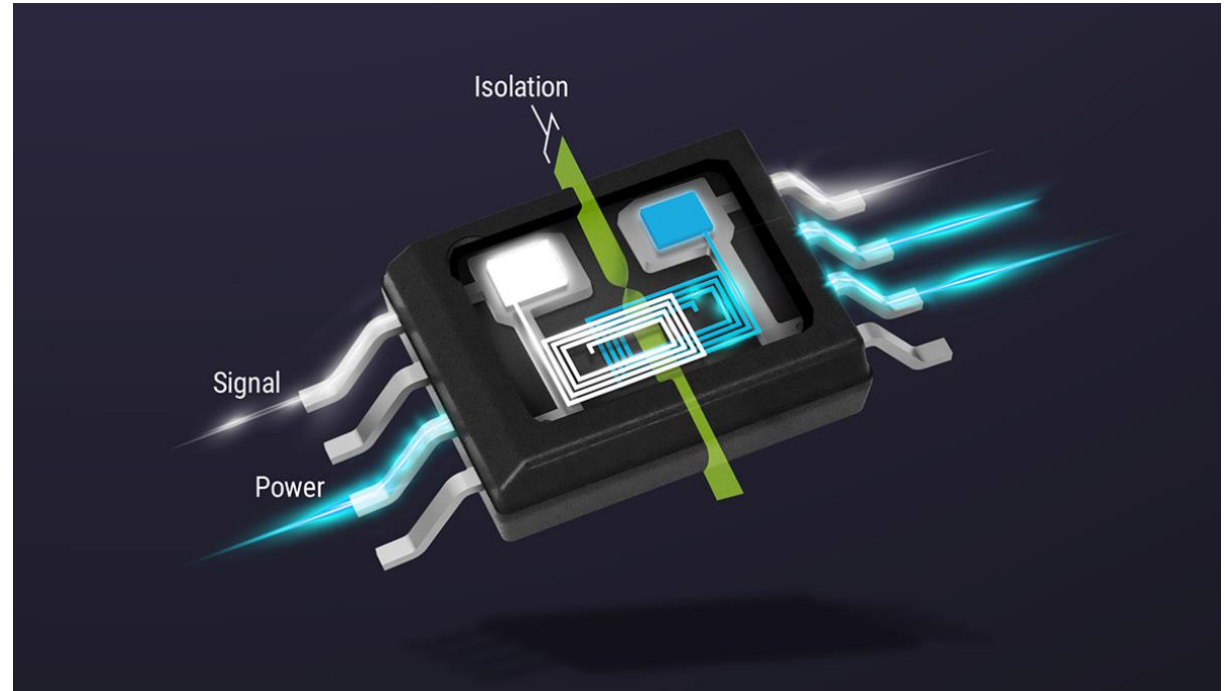
- A SSR is a device that turns another switch on or off to control a load

Features

- “Solid-state” means no moving parts
- Isolation barrier separates the low voltage system from the high voltage system for user safety

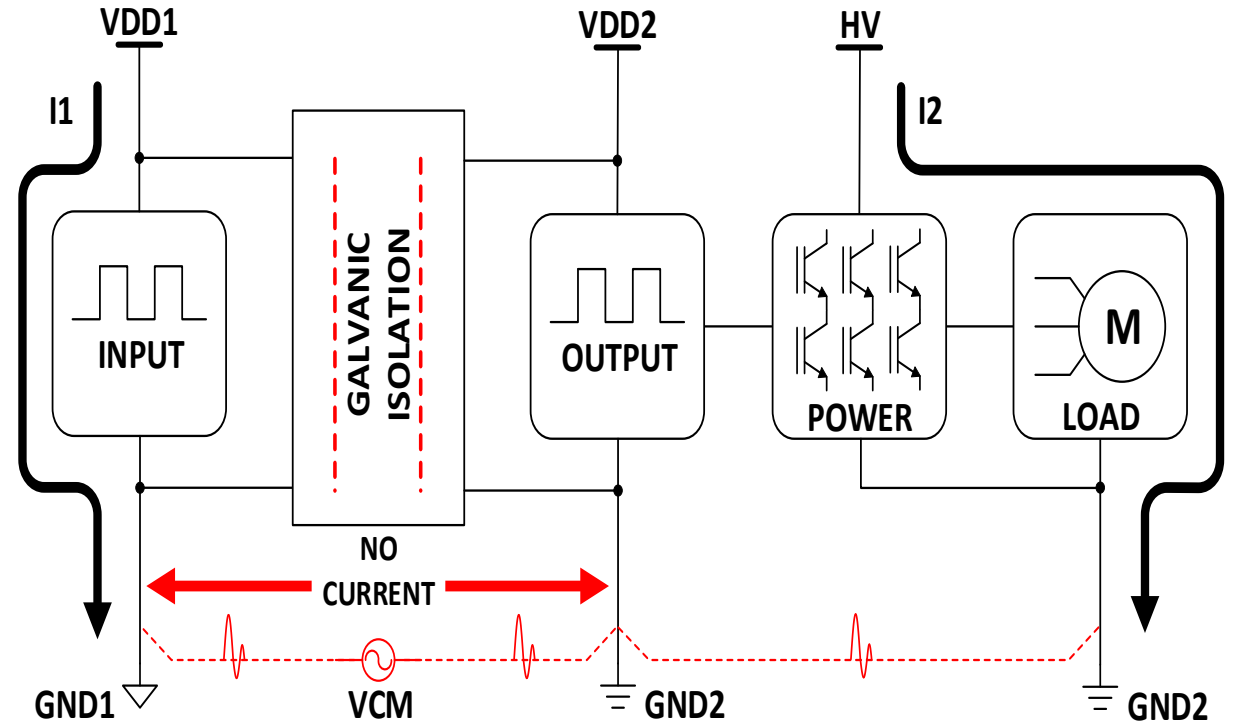
Significance

- Decreases the probability of high voltage injuries from a device failure or short circuit



Galvanic isolation

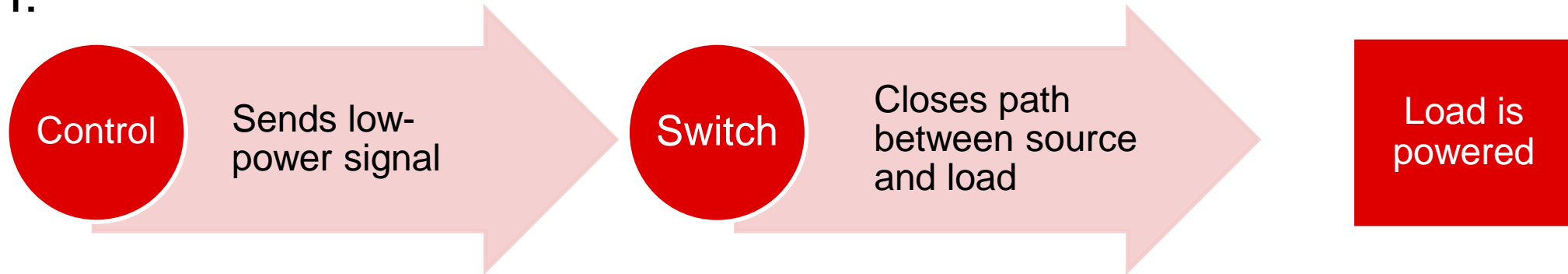
- Isolation barrier
 - Electrical divide between two circuit domains
 - Prevents direct current (DC) and unwanted alternating current (AC) flow between two systems
- Increased operator protection
- Better reliability for signal sensing and communication
- Satisfies isolation standards
 - UL-Underwriters Laboratories-1577
 - VDE-Verband Deutscher Elektrotechniker-0884-17



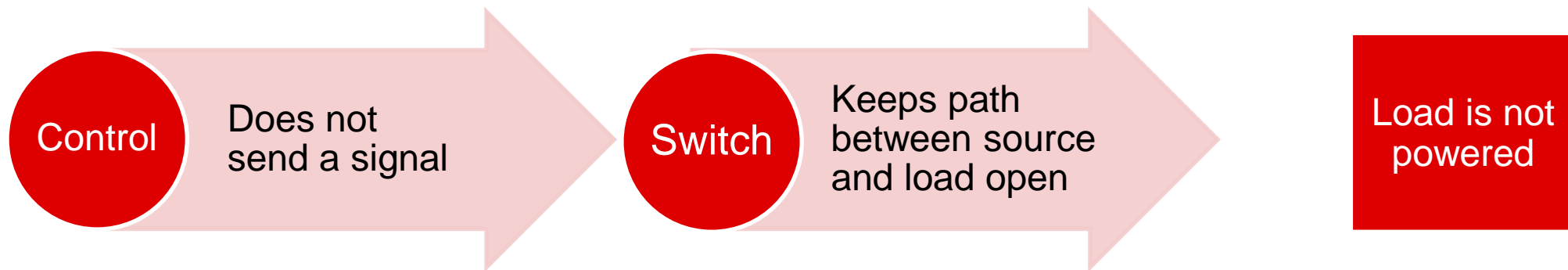
How solid state relays work

- A SSR is typically made of 2 components: a controller and a switch/FET (field effect transistor)
- A controller's low voltage signal switches on and off a load

Case 1:

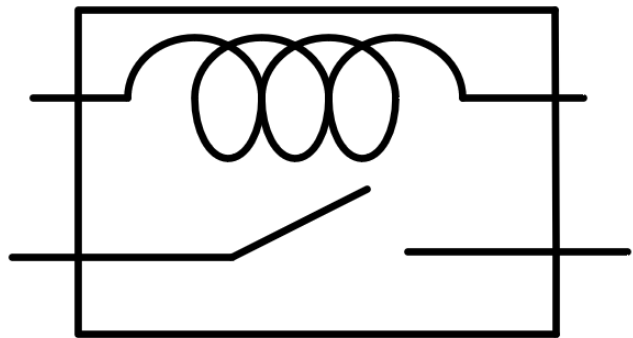


Case 2:

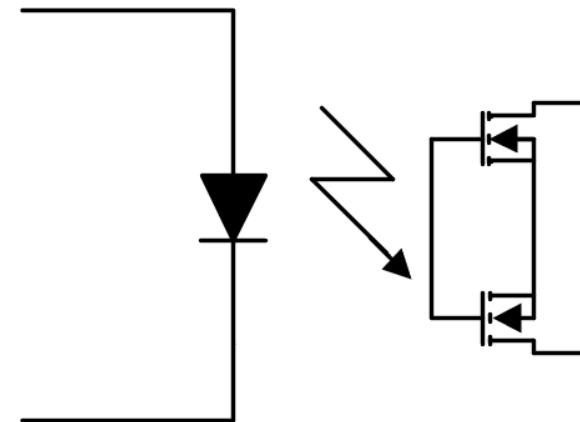
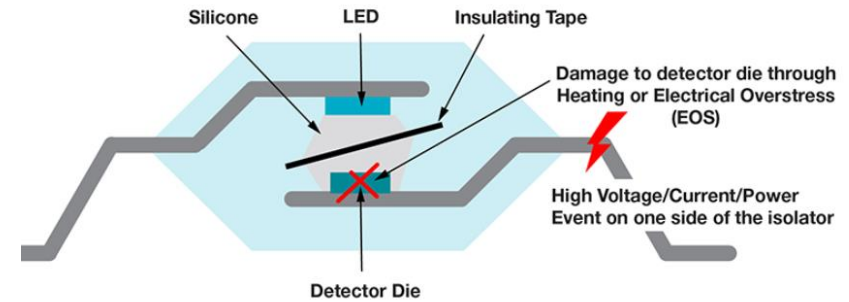


Existing relay technology

Mechanical relays/contactors

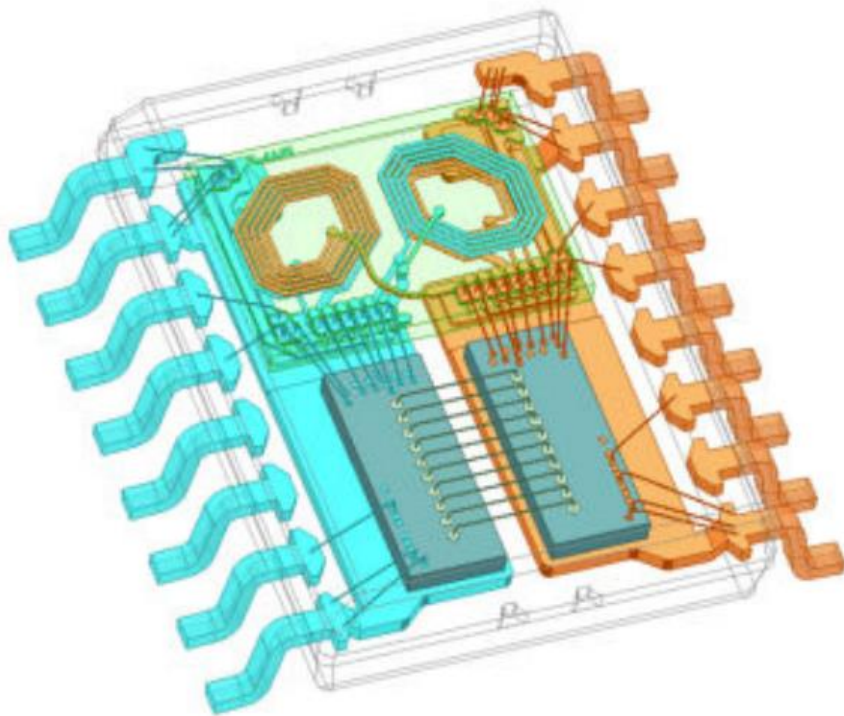


Photo/optical relays

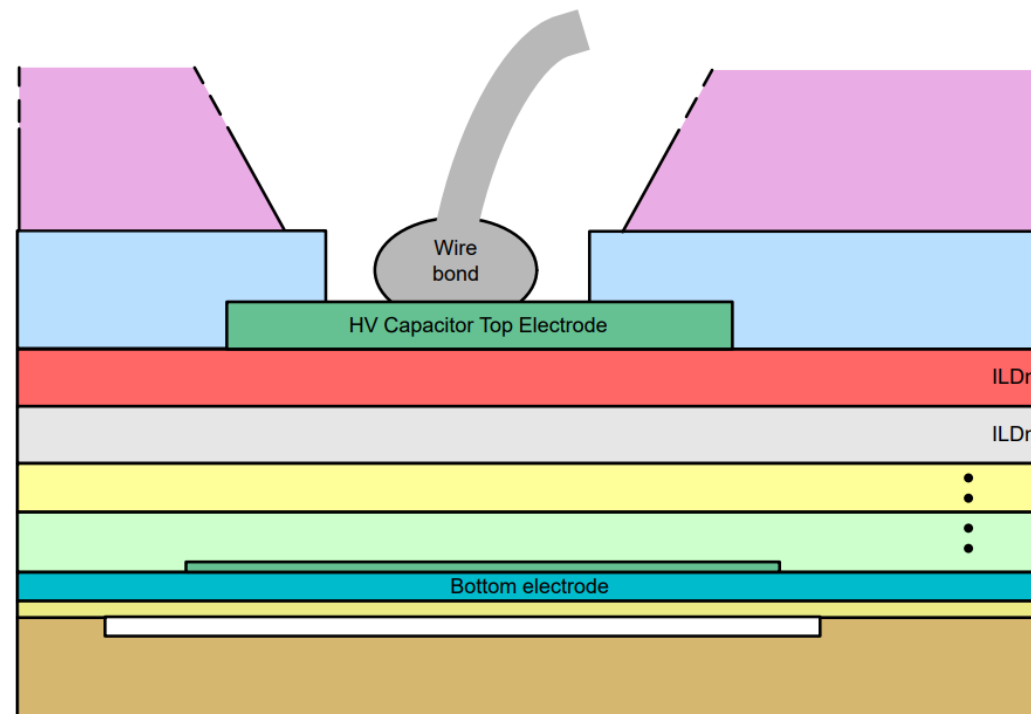


TI's isolation technology

Magnetic transformers



Capacitive isolation



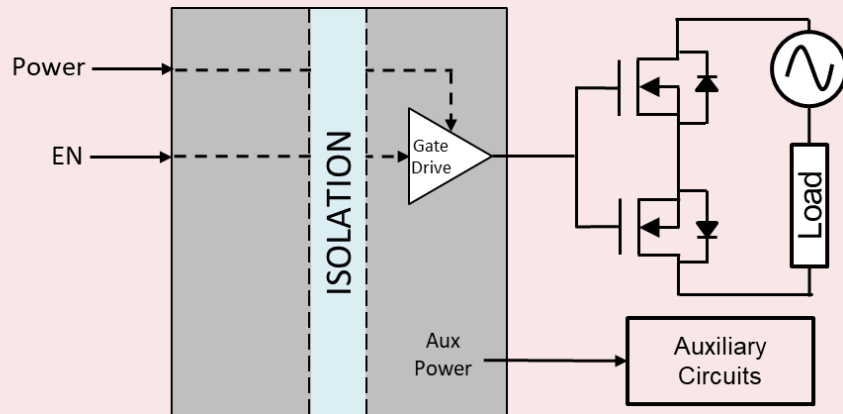
Existing technology vs. TI's isolation technology

	Electromechanical relay	Photo / Optical	TI's magnetic transformer	TI's capacitive isolation
Insulation material	Air, gas, or Epoxy	Epoxy or Polyimide	Laminate or Polyimide	Silicon dioxide (SiO ₂)
Dielectric strength (1sec)	~1 V _{RMS} / μm ~20 V _{RMS} / μm	~20 V _{RMS} / μm ~300 V _{RMS} / μm	~300 V _{RMS} / μm	~500 V _{RMS} / μm
Advantages	Low resistance High power transfer	Low-EMI emissions	High speed (μs) High power transfer	High speed (μs) Low power consumed
Disadvantages	Slow speed (ms) Mechanical wear, vibration/magnetic immunity	Photodegradation and partial discharge (PD) Limited power transfer	IC design to limit EMI	IC design to limit EMI Limited power transfer
Operating ambient temp.	-40C to 85C	-40C to 85C	-40 C to 125 C	-40 C to 125 C

Types of solid state relays

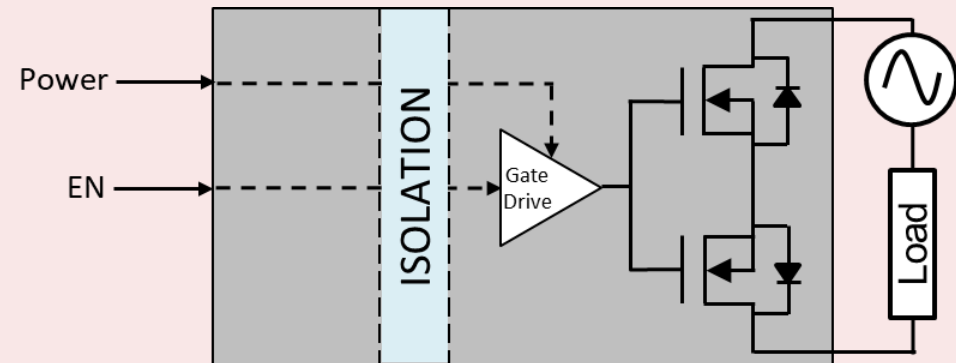
Isolated switch drivers

- Controls an external power FET:
 - MOSFET-metal oxide semiconductor FET
 - IGBT-insulated-gate bipolar transistor
 - SiC MOSFET-silicon carbide MOSFET
 - SCR-silicon control rectifier
- Generates its own secondary bias supply
 - Able to power external circuitry
- Suited for high power solutions

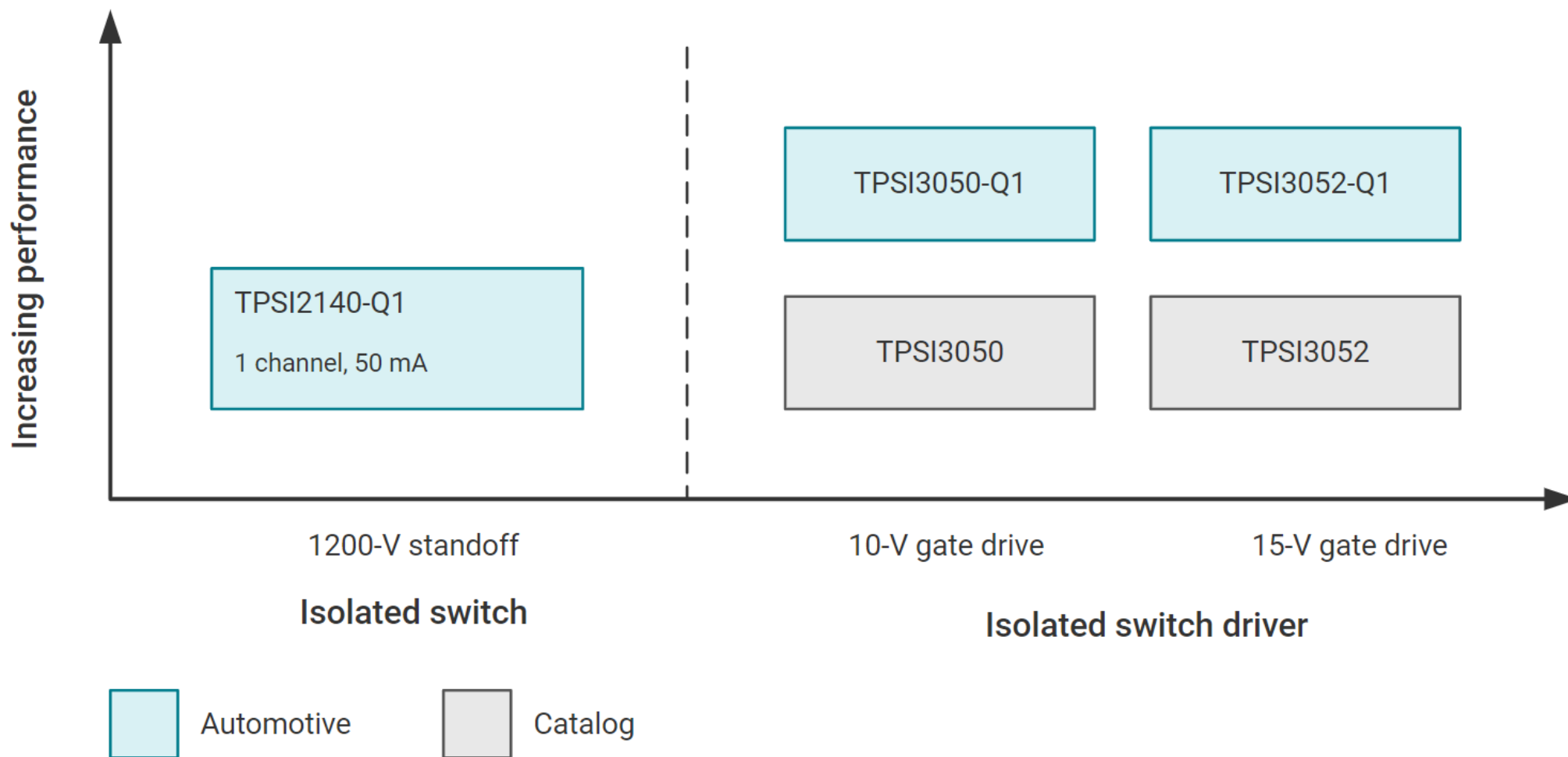


Isolated switches

- Single chip SSR solution
 - Integrated FET and driver
- Robust isolation technology
- Superior avalanche performance
- Small overall solution size



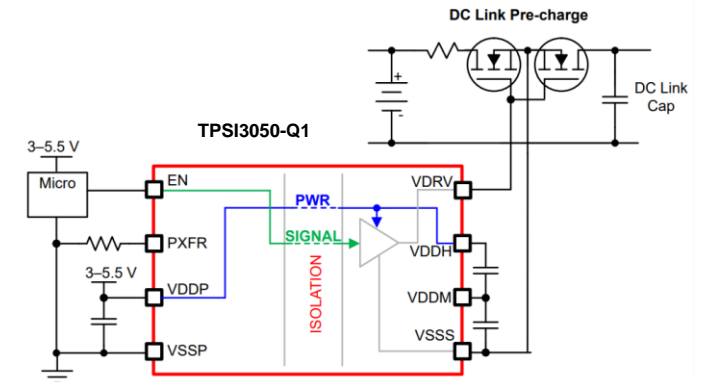
Solid state relay portfolio



TPSI305x-Q1 and TPSI2140-Q1

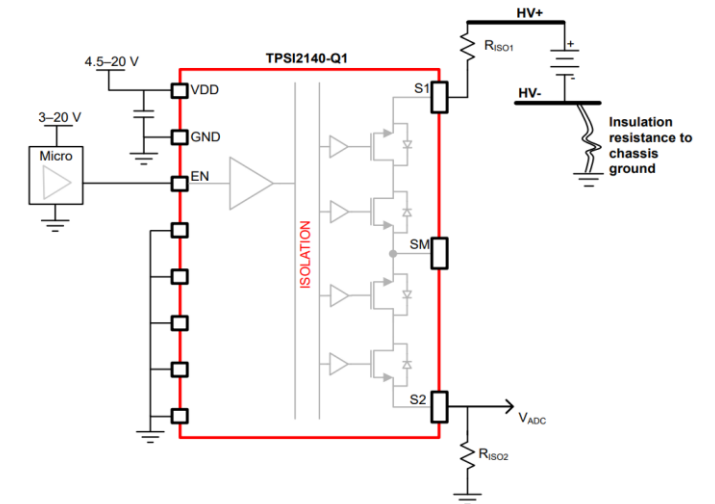
TPSI305x-Q1

- When TPSI305x-Q1 is powered, capacitors on the secondary side charge up to 10 V (TPSI3050-Q1) or 15V (TPSI3052-Q1)
- When the MCU sends a high enable signal, VDRV drives the load up to 10 V or 15 V
- Isolated power supply from VDDH/VDDM pins for external circuitry



TPSI2140-Q1

- When TPSI2140-Q1 is powered & the MCU sends a high enable signal, the FET switches close, allowing a path between the source & load
- Includes avalanche rated MOSFETs that endure high potential screening & sustain 2 mA of current during avalanche condition



Automotive & industrial applications



HEV/EV

- Onboard chargers
- Traction inverters
- DC link capacitors
- DC/DC converters



Grid infrastructures

- Energy storage systems
- Solar inverters

- SSRs are used for insulation monitoring & high voltage monitoring
 - Helps ensure high voltage battery terminals are insulated from protective earth to provide safer environments for users
 - Maintain system components in a sufficient working condition
- Pre-charging capacitors
 - Allows current to slowly charge up DC link capacitor

To find more solid state relay technical resources and search products, visit [ti.com/SSR](https://www.ti.com/SSR).