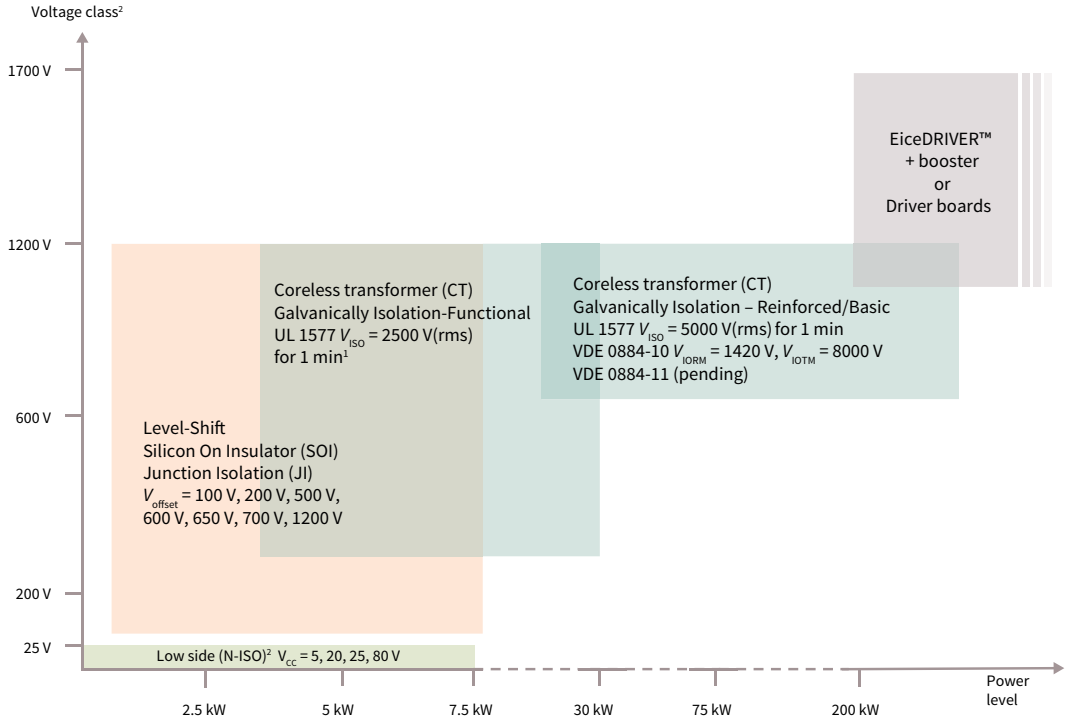
Infineon EiceDRIVER™ gate driver IC

Overview

Gate driver ICs serve as the interface between control signals (digital or analog controllers) and power switches (IGBTs, MOSFETs, SiC MOSFETs, and GaN HEMTs). The integrated gate-driver solutions reduce your design complexity, development time, bill of materials (BOM), and board space while improving reliability over discretely-implemented gate-drive solutions.

Every switch needs a driver, and every driver needs a switch. Infineon offers a comprehensive portfolio of driver ICs with a variety of configurations, voltage classes, isolation levels, protection features, and package options. These flexible gate driver ICs are complementary to Infineon IGBT discretes and modules, silicon (CoolMOS™, OptiMOS™ and StrongIRFET™) and silicon carbide MOSFETs (CoolSiC™), gallium nitride HEMTs (CoolGaN™), or as part of integrated power modules (CIPOS™ IPM and iMOTION™ smart IPM).



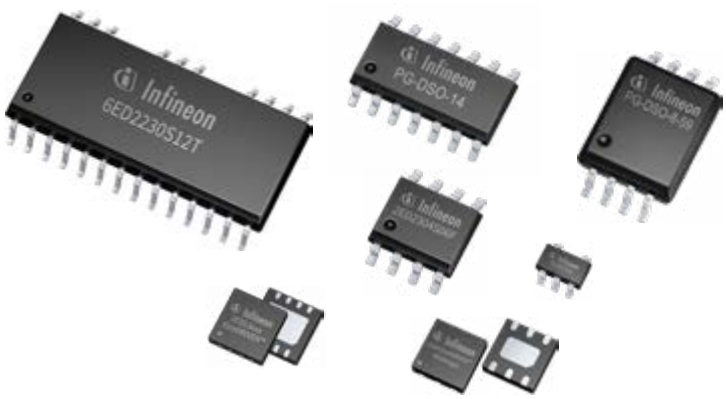
Note 1: 1EDC Compact only
Note 2: Voltage class is defined based on different driver configurations.
1. For single high-side, high- and low-side, half bridge and three phase gate drivers, voltage class is defined as switch break down voltage in applications.
2. For low side drivers, voltage class is defined as maximum operating range supply voltage.
3. For special cases as 1EDNx550 (1EDN-TDI), common mode rejection (CMR) voltage range up to 80 V.

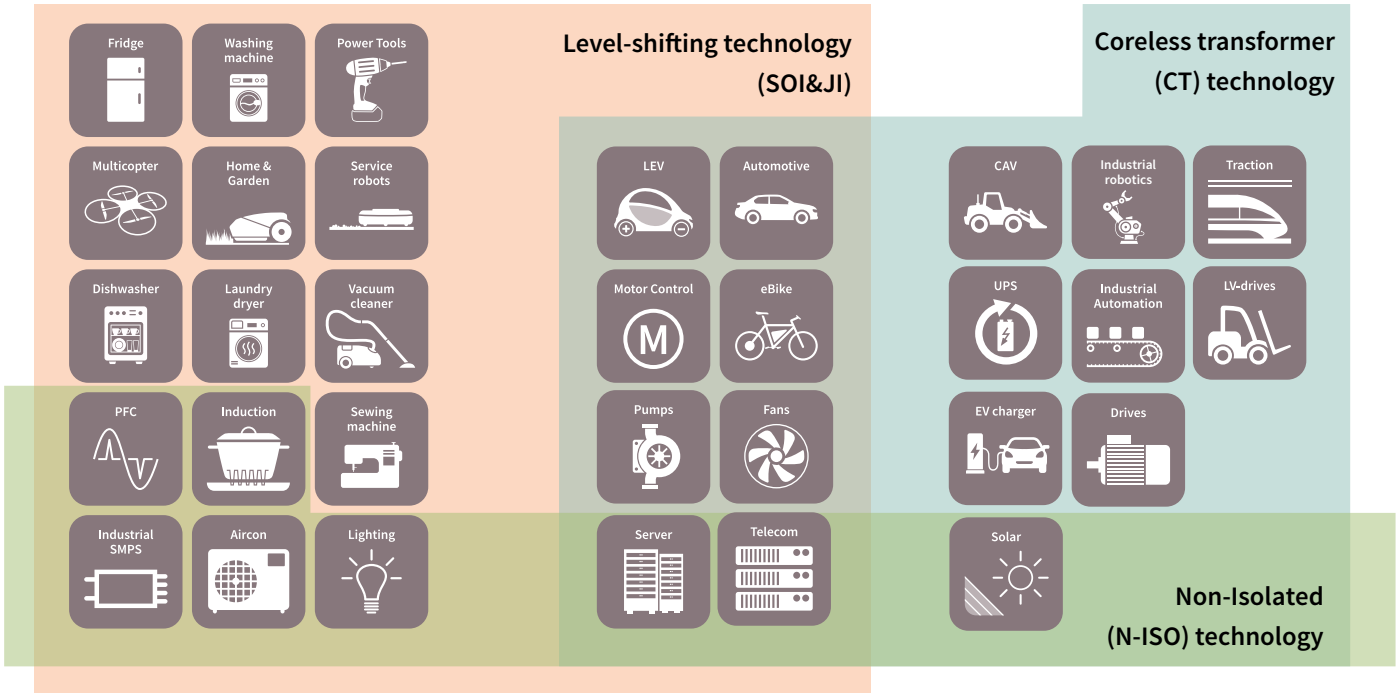
Gate driver configuration			5 V	25 V	100 V	200 V	500 V	600 V	650 V	1200 V
Gate drivers	1-Channel	High-side			●	●	●	●	●	●
		Low-side	●	●						
	2-Channel	High-side							●	●
		Low-side		●						
		High- and low-side				●	●	● ●	●	●
		Half-bridge			●	●		● ●	● ●	● ●
	4-Channel	Full-bridge			●					
	6-Channel	Three-phase				●		● ●		● ●
System building blocks		Current sense						●		●
		Start-up					●			

● Non-isolated (N-ISO) ● Junction isolation (JI) ● Silicon on insulator (SOI) ● Coreless transformer (CT)

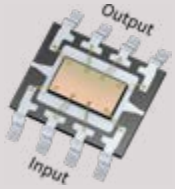
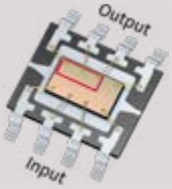
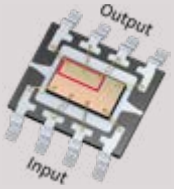
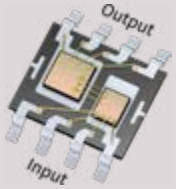
Infineon gate driver IC applications

Leveraging the application expertise and advanced technologies of Infineon and International rectifier, our gate driver ICs are well-suited for many applications such as industrial motor drives, major home appliances, solar inverters, automotive applications, EV charging, UPS, switch-mode power supplies (SMPS), high-voltage lighting, battery-powered applications, and small home appliances.





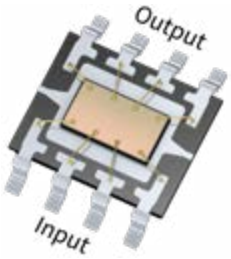
Infineon gate driver IC technologies

Low-side only	Level-shift		Galvanic isolation
Non-isolated	Junction isolation	Silicon on insulator	Coreless transformer
			
› **Comprehensive families** of single- and dual-low-side drivers with flexible output current, logic configurations, and UVLOs › **Rugged technology** of the high-voltage gate drivers, and the state-of-the-art 130-nm process	› **20 years proven technology** › **Largest portfolio** of 200 V, 600 V, 700 V and 1200 V industry standard gate drivers using rugged proprietary HVIC process	› **Infineon SOI technology** for high-voltage applications with inherent integrated bootstrap diode capability and lower level-shift losses › Industry **best-in-class robustness** against negative transient voltage spikes on VS pin	› **Magnetically-coupled isolation technology** provides galvanic isolation (functional, basic and reinforced) › **Strongest gate-drive output currents** (up to 10 A) reducing need for external booster circuits

Infineon non-isolated (N-ISO) technology

Non-isolated (N-ISO) technology refers to gate driver ICs utilizing low-voltage circuitry with the robust technology of high-voltage gate drivers, and the state-of-the-art 0.13-µm process. Infineon's world-class fabrication techniques enable high-current gate drivers for high-power-density applications in industry-standard DSO-8 and small form-factor SOT23 and WSON packages. Infineon offers comprehensive families of single-low-side and dual-low-side gate driver ICs with flexible options for output current, logic configurations, packages, and protection features such as under-voltage lockout (UVLO), integrated overcurrent protection (OCP), and truly differential inputs (TDI).

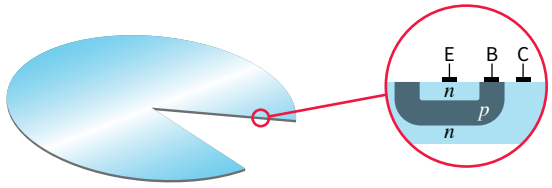
Truly differential inputs (TDI)



- The input signal levels of conventional low-side gate driver ICs are referenced to the ground potential of the gate driver IC. If in the application the ground potential of the gate driver IC shifts excessively, false triggering of the gate driver IC can occur.
- The 1EDN7550/1EDN8550 gate driver ICs have truly differential inputs. Their control signal inputs are largely independent from the ground potential. Only the voltage difference between its input contacts is relevant.
- This prevents false triggering of power MOSFETs.

Infineon junction-isolation (JI) technology

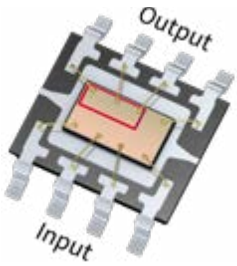
Infineon p-n junction-isolation (JI) technology is a mature, proven industry-standard MOS/CMOS fabrication technique. Infineon's proprietary HVIC and latch-immune CMOS technologies enable rugged monolithic construction. The advanced process allows monolithic high-voltage and low-voltage circuitry construction with the best price per performance for specific motor-control and switch-mode power applications.



Main benefits of Infineon JI technology:

- High current capability (4 A)
- Precision analog circuitry (tight timing/propagation delay)
- Most comprehensive portfolio with industry-standard gate driver ICs
- Voltage classes: 1200 V, 600 V, 500 V, 200 V, and 100 V
- Configurations: three phase, half bridge, single channel, and more
- Driver ICs tailored towards the best price-performance ratio

Pioneered by International Rectifier (IR) since 1989 with the introduction of the first monolithic product, the high-voltage integrated circuit (HVIC) technology uses patented and proprietary monolithic structures integrating bipolar, CMOS, and lateral DMOS devices with breakdown voltages above 700 V and 1400 V for operating offset voltages of 600 V and 1200 V.



Using this mixed-signal HVIC technology, both high-voltage level-shifting circuits and low-voltage analog and digital circuits can be implemented. With the ability to place high-voltage circuitry (in a 'well' formed by polysilicon rings) , that can 'float' 600 V or 1200 V, on the same silicon away from the rest of the low-voltage circuitry, high-side power MOSFETs or IGBTs exist in many popular off-line circuit topologies such as buck, synchronous boost, half-bridge, full-bridge and three-phase.

These HVIC gate drivers with floating switches are well-suited for topologies requiring high-side, half-bridge, and three-phase configurations.

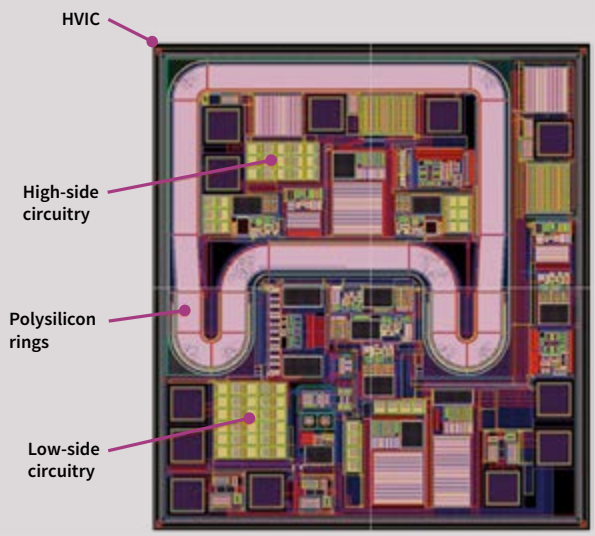


Figure 1: Top down view of JI gate driver IC

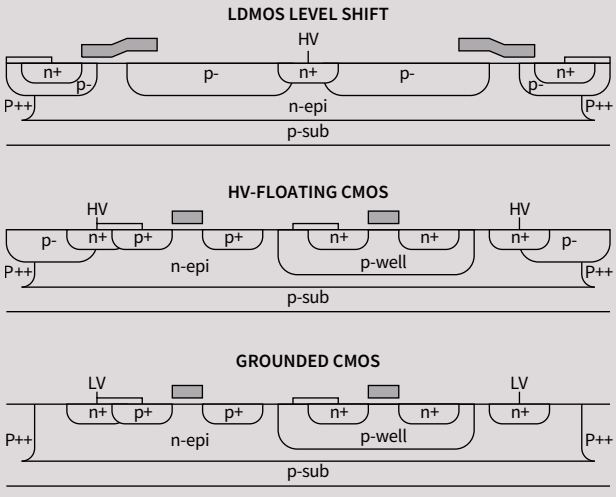
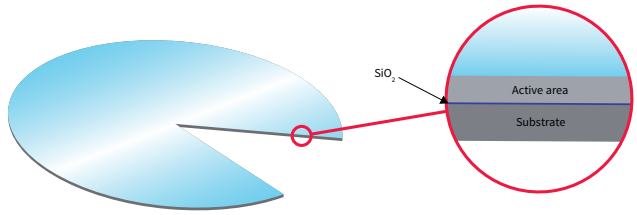


Figure 2: Device cross section of the high-voltage integrated circuit

Infineon silicon-on-insulator (SOI) technology

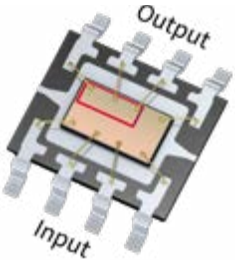
Infineon silicon-on-insulator (SOI) technology is a high-voltage, level-shift technology providing unique, measurable and best-in-class advantages, including integrated bootstrap-diode (BSD) and industry-best-in-class robustness to protect against negative transient voltage spikes. Each transistor is isolated by buried silicon dioxide, which eliminates the parasitic bipolar transistors that causing latch-up. This technology can also lower the level-shift power losses to minimize device-switching power dissipation. The advanced process allows monolithic high-voltage and low-voltage circuitry construction with technology-enhanced benefits.



Main benefits of Infineon SOI technology:

- Best-in-class immunity to negative transient voltage prevents erratic operation and latch-up while improving reliability
- Low ohmic integrated bootstrap diodes (BSD) have the lowest reverse recovery and forward losses resulting in increased efficiency, faster switching, lower temperature, and increased reliability
- Minimum level-shift losses improve driver efficiency and allow flexible housing designs
- Integrated input filters enhance noise immunity
- 200 V, 600 V, 650 V and 1200 V withstand voltages for each voltage design class providing operating margin

Operation robustness of negative transient voltage at the VS pin (-VS)



Today's high-power switching inverters and drives carry a large load current. The voltage swing on VS pin does not stop at the level of the negative DC bus. It swings below the level of the negative DC bus due to the parasitic inductances in the power circuit and from the die bonding to the PCB tracks. This undershoot voltage is called "negative transient voltage".

EiceDRIVER™ high-voltage level-shift gate driver IC products using Infineon SOI technology have the best-in-the-industry operational robustness. In Figure 4, the safe operating line of 6ED2230S12T is shown at V_{BS} = 15 V for pulse widths up to 1000 ns. In the green area, the products do not show unwanted functional anomalies or permanent damage to the IC.

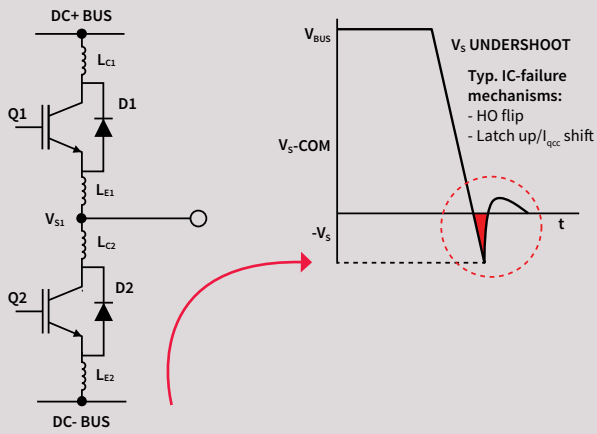


Figure 3:
Parasitic elements of a half-bridge configuration

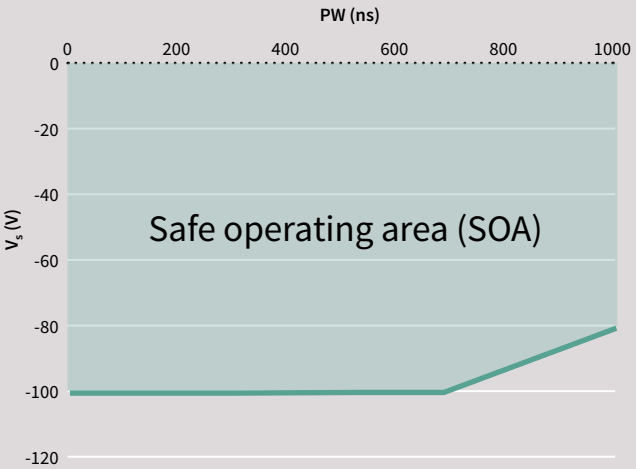


Figure 4:
Negative VS transient SOA characterization @ V_{BS}=15 V of 6ED2230S12T

Infineon silicon-on-insulator (SOI) technology

Integrated bootstrap diode (BSD)

The bootstrap power supply is one of the most common techniques for suppling power to the high-side driver circuitry due to its simplicity and low cost. As shown in Figure 5, the bootstrap power supply consists of a bootstrap diode and capacitor. The floating channel of level-shift gate drivers is typically designed for bootstrap operation. Infineon SOI drivers feature excellent integrated ultra-fast bootstrap diodes. The low diode resistance of $R_{BS} \leq 40\ \Omega$ enables a wide operating range.

The Infineon SOI drivers with this feature can drive larger IGBTs without the risk of self-heating, minimize BOM count, and reduce system cost.

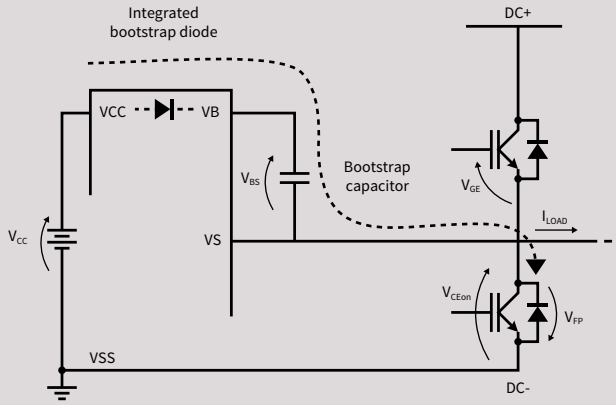


Figure 5:
Typical connection diagram with integrated bootstrap diode (BSD)

Low level-shift losses

Level-shift losses cannot be ignored easily when the operating frequency increases. A level-shift circuit is used to transmit the switching information from the low-side to the high-side. The necessary charge of the transmission determines the level-shift losses.

EiceDRIVER™ high-voltage level-shift gate driver IC products using the Infineon SOI technology require a very low charge to transmit the information. Minimizing level-shifting power consumption allows the design flexibility of higher frequency operations, as well as longer lifetime, improved system efficiency and application reliability.

In Figure 6, the thermal diagrams on the same PCB board show a temperature difference of 55.6°C lower in the power dissipation of the Infineon SOI-based products (2ED2106S06F).

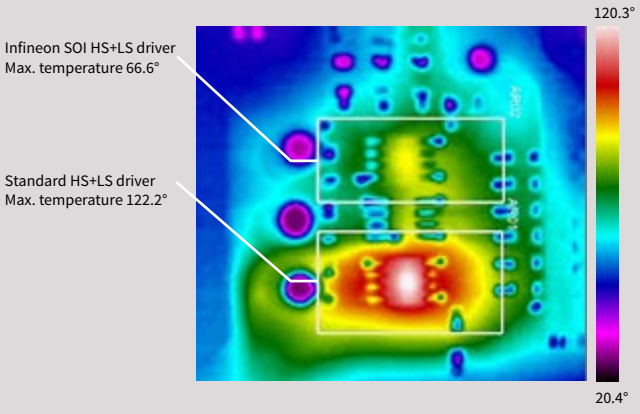
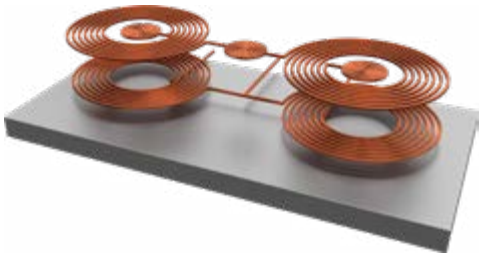


Figure 6:
DC Bus voltage = 300 V; With CoolMOS™ P7 in D-Pak; 300 kHz switching frequency

Infineon galvanically isolated coreless transformer (CT) technology

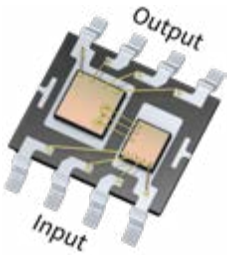
Infineon coreless transformer (CT) technology is a magnetically coupled, galvanically isolated technology which uses semiconductor manufacturing processes to integrate an on-chip transformer consisting of metal spirals and silicon oxide insulation. The on-chip coreless transformers are used for transmitting switching information between the input chip and output chip(s) and other signals. The technology provides short propagation delays, excellent delay matching, and strong robustness for driving SiC MOSFETs and state-of-the-art IGBTs.



Main benefits of Infineon CT technology:

- Galvanic isolation (functional, basic, reinforced)
- Allows very large voltage swings of ±1200 V or larger
- Immunity against negative and positive transients
- Increases reliability of the end product
- Low power losses for switching frequencies into MHz range
- Flexible configurations and options such as
  - Output current (up to 10 A)
  - DESAT protection
  - Active Miller clamp
  - Short-circuit clamp
  - Isolation rating and certification
  - 150 mil and 300 mil packages

Robustness



- Extremely robust signal transfer independent of common mode noise
- Common mode transit immunity (CMTI) up to 100 V/ns
- Tight propagation-delay matching: tolerance improves application robustness without variations due to aging, current, and temperature

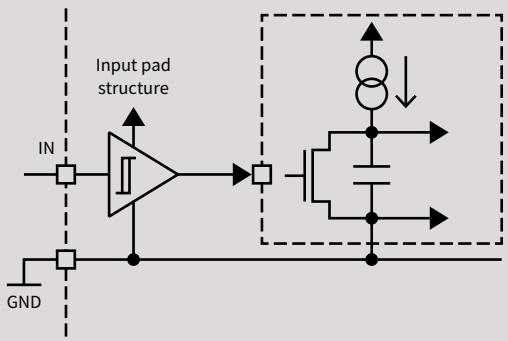
Design flexibility

- Wide range of gate voltages up to 40 V, including negative gate voltage
- CT technology is ready for use with silicon carbide (SiC) MOSFETs
- Closed-loop gate current control option

Precise timing control

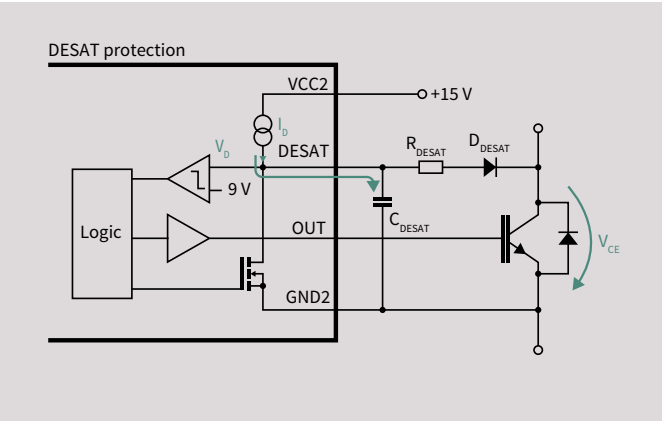
- Precise, integrated filters reduce propagation-delay variation over a wide range of operating conditions
- Integrated filters reduce the need of external filters
- Tight propagation delay allows minimum deadtime improving system efficiency and decreasing harmonic distortion

Integrated ramp-based filter



Protection

- Reliable short-circuit detection via accurate desaturation (DESAT) detection circuits (current source and comparator) protects the power switches from damage during short-circuit condition
- Two-level turn-off (TLTO) for short-circuit current protection to lower collector-emitter voltage overshoot
- Active Miller clamping option protects against parasitic turn-on due to high dV/dt
- Built in short-circuit clamping limits the gate voltage during short circuit



Safety certification

- Safety certification available for VDE 0884 and UL 1577

For SiC MOSFET switching

- Ideal for ultra-fast switching 1200 V and 650 V silicon carbide power transistors such as CoolSiC™ MOSFETs
- The drivers incorporate most important key features and parameters for SiC driving:
  - DESAT for short circuit protection
  - Active Miller clamp
  - Tight propagation delay matching
  - Precise input filters
  - Wide output side supply range
  - Negative gate voltage capability
  - Extended common mode transient immunity (CMTI) capability

Definitions of the various isolation types

Galvanic isolation

Basic isolation
Certified isolation applied to live parts to provide basic protection against electric shock

Supplementary isolation
Additional isolation to basic isolation as a fallback solution in case basic isolation fails

Double galvanic isolation
Certified isolation consisting of both basic isolation and supplementary isolation

Functional isolation
Isolation between conductive parts only for the purpose of correct equipment operation

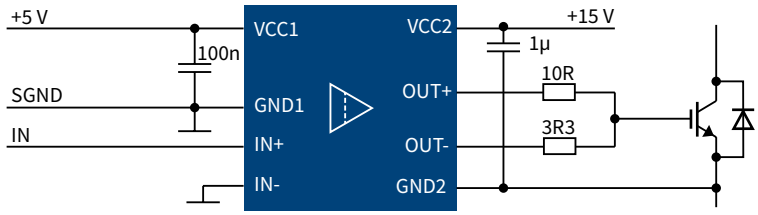
Reinforced isolation
Single certified isolation applied to live parts to protect against electric shock

Sources: IEC60747-5-5, VDE 0884-5/-10, UL 1577

Galvanically isolated gate driver ICs

Galvanically isolated gate driver ICs

Typical connection



Configuration	Voltage class [V]	Isolation type	Isolation rating	I_{O+}/I_{O-} typ. [mA]
Single high-side	1200	Functional isolation	V_{ISO} = ± 1200 V	1300/900
Single high-side	1200	Functional isolation	V_{ISO} = ± 1200 V	2200/2300
Single high-side	1200	Functional isolation	V_{ISO} = ± 1200 V	4000/3500
Single high-side	1200	Functional isolation	V_{ISO} = ± 1200 V	4000/3500
Single high-side	1200	Functional isolation	V_{ISO} = ± 1200 V	4000/3500
Single high-side	1200	Functional isolation	V_{ISO} = ± 1200 V	4400/4100
Single high-side	1200	Functional isolation	V_{ISO} = ± 1200 V	5900/6200
Single high-side	1200	Functional isolation	V_{ISO} = ± 1200 V	7500/6800
Single high-side	1200	Functional isolation	V_{ISO} = ± 1200 V	10000/9400
Single high-side	1200	Functional isolation	V_{ISO} = ± 1200 V	10000/9400
Single high-side	1200	Functional isolation	V_{ISO} = ± 1200 V	10000/9400
Single high-side	1200	Functional isolation	V_{ISO} = ± 1200 V	2000/2000
Single high-side	1200	Functional isolation	V_{ISO} = ± 1200 V	2000/2000
Single high-side	1200	Functional isolation	V_{ISO} = ± 1200 V	SRC/2000
Single high-side	1200	Functional isolation	V_{ISO} = 2500 V(rms) for 1 min	1300/900
Single high-side	1200	Functional isolation	V_{ISO} = 2500 V(rms) for 1 min	2200/2300
Single high-side	1200	Functional isolation	V_{ISO} = 2500 V(rms) for 1 min	4000/3500
Single high-side	1200	Functional isolation	V_{ISO} = 2500 V(rms) for 1 min	4000/3500
Single high-side	1200	Functional isolation	V_{ISO} = 2500 V(rms) for 1 min	4400/4100
Single high-side	1200	Functional isolation	V_{ISO} = 2500 V(rms) for 1 min	5900/6200
Single high-side	1200	Functional isolation	V_{ISO} = 2500 V(rms) for 1 min	7500/6800
Single high-side	1200	Functional isolation	V_{ISO} = 2500 V(rms) for 1 min	10000/9400
Single high-side	1200	Functional isolation	V_{ISO} = 2500 V(rms) for 1 min	10000/9400
Single high-side	1200	Functional isolation	V_{ISO} = 5000 V(rms) for 1 min	SRC/2000
Single high-side	1200	Basic isolation	V_{IORM} = 1420 V; V_{IOTM} = 6000 V; V_{ISO} = 3750 V(rms) for 1 min	2000/2000
Single high-side	1200	Basic isolation	V_{IORM} = 1420 V; V_{IOTM} = 6000 V; V_{ISO} = 3750 V(rms) for 1 min	2000/2000
Single high-side	1200	Basic isolation	V_{IORM} = 1420 V; V_{IOTM} = 6000 V; V_{ISO} = 3750 V(rms) for 1 min	2000/2000
Single high-side	1200	Basic isolation	V_{IORM} = 1420 V; V_{IOTM} = 6000 V; V_{ISO} = 3750 V(rms) for 1 min	2100/2100
Single high-side	1200	Basic isolation	V_{IORM} = 1420 V; V_{IOTM} = 6000 V; V_{ISO} = 3750 V(rms) for 1 min	2000/2000
Single high-side	1200	Basic isolation	V_{IORM} = 1420 V; V_{IOTM} = 6000 V; V_{ISO} = 3750 V(rms) for 1 min	2000/2000
Single high-side	1200	Basic isolation	V_{IORM} = 1420 V; V_{IOTM} = 6000 V; V_{ISO} = 3750 V(rms) for 1 min	2000/2000
Single high-side	1200	Reinforced isolation	V_{IORM} = 1420 V; V_{IOTM} = 8000 V; V_{ISO} = 5000 V(rms) for 1 min	SRC/2000
Single high-side	650	Reinforced isolation	V_{IORM} = 1000 V(rms); V_{IOTM} = 8000 V; V_{ISO} = 5700 V(rms) for 1 min	4000/8000
Single high-side	650	Functional isolation	V_{IORM} = 510 V(rms); V_{ISO} = 1500 V(rms) for 10 ms	4000/8000
Single high-side	250	Functional isolation	V_{IORM} = 460 V(rms); V_{ISO} = 1500 V(rms) for 10 ms	4000/8000
Half-bridge	1200	Functional isolation on high-side	V_{ISO} = ± 1200 V	1500/2500
Half-bridge	650	Functional isolation on high-side	V_{ISO} = ± 650 V	1500/2500
Dual high-side/half-bridge	1200	Functional isolation	V_{ISO} = ± 1200 V	2000/2000
Dual high-side/half-bridge	1200	Basic isolation	V_{IORM} = 1420 V; V_{IOTM} = 6000 V; V_{ISO} = 3750 V(rms) for 1 min	2000/2000
Dual high-side/half-bridge	650	Reinforced isolation	V_{IOWM} = 1000 V(rms); V_{IOTM} = 8000 V; V_{ISO} = 5700 V(rms) for 1 min	4000/8000
Dual high-side/half-bridge	650	Reinforced isolation	V_{IOWM} = 1000 V(rms); V_{IOTM} = 8000 V; V_{ISO} = 5700 V(rms) for 1 min	1000/2000
Dual high-side/half-bridge	650	Functional isolation	V_{IOWM} = 510 V(rms); V_{ISO} = 1500 V(rms) for 10 ms	4000/8000
Dual high-side/half-bridge	650	Functional isolation	V_{IOWM} = 510 V(rms); V_{ISO} = 1500 V(rms) for 10 ms	1000/2000
Dual high-side/half-bridge	250	Functional isolation	V_{IOWM} = 460 V(rms); V_{ISO} = 1500 V(rms) for 10 ms	4000/8000
Dual high-side/half-bridge	250	Functional isolation	V_{IOWM} = 460 V(rms); V_{ISO} = 1500 V(rms) for 10 ms	4000/8000

SRC=Turn on slew rate control

UVLO on/off typ. [V]	Prop delay off/on typ. [ns]	Base PN	Technology	Active Miller clamp	Automotive qualified	Comparator	Desaturation protection	Enable	Fault reporting	Fault reset	Operational amplifier	Over-current protection	Separate pin for logic ground	Separate sink/source outputs	Shoot-through protection	Shutdown	Soft over-current shutdown	Two-level turn-off	UL 1577	VDE 0884-10	DSO-8	DSO-8 300mil	DSO-16	DSO-16 WB	DSO-18	DSO-20	DSO-36	TFLGA-13
				Features (see page 58)																	Package (see page 59)							
12/11.1	300/300	1EDI05I12A	CT										✓	✓							✓	✓						
12/11.1	300/300	1EDI10I12M	CT	✓									✓								✓	✓						
9.1/8.5	120/115	1EDI20N12A	CT										✓	✓							✓							
12/11.1	125/120	1EDI20H12A	CT										✓	✓								✓						
12/11.1	300/300	1EDI20I12A	CT										✓	✓							✓	✓						
12/11.1	300/300	1EDI20I12M	CT	✓									✓								✓	✓						
12/11.1	300/300	1EDI30I12M	CT	✓									✓								✓	✓						
12/11.1	300/300	1EDI40I12A	CT										✓	✓							✓	✓						
12/11.1	125/120	1EDI60H12A	CT										✓	✓								✓						
12/11.1	300/300	1EDI60I12A	CT										✓	✓							✓	✓						
9.1/8.5	125/120	1EDI60N12A	CT										✓	✓							✓							
12/11	165/170	1ED020I12-F2	CT	✓			✓		✓	✓			✓											✓				
12/11	1750/1750	1ED020I12-FT	CT	✓			✓		✓	✓			✓					✓						✓				
11.9/11	460/460	1EDI20I12SV NEW	CT				✓	✓	✓			✓	✓				✓	✓									✓	
12/11.1	300/300	1EDC05I12A NEW	CT										✓	✓					✓			✓						
12/11.1	300/300	1EDC10I12M NEW	CT	✓									✓						✓			✓						
12/11.1	125/120	1EDC20H12A NEW	CT										✓	✓					✓			✓						
12/11.1	300/300	1EDC20I12A NEW	CT										✓	✓					✓			✓						
12/11.1	300/300	1EDC20I12M NEW	CT	✓									✓						✓			✓						
12/11.1	300/300	1EDC30I12M NEW	CT	✓									✓						✓			✓						
12/11.1	300/300	1EDC40I12A NEW	CT										✓	✓					✓			✓						
12/11.1	125/120	1EDC60H12A NEW	CT										✓						✓			✓						
12/11.1	300/300	1EDC60I12A NEW	CT										✓						✓			✓						
11.9/11	460/460	1EDU20I12SV NEW	CT				✓	✓	✓			✓	✓				✓	✓	✓								✓	
12.5/11.7	215/215	1EDI2001AS	CT		✓		✓	✓	✓			✓	✓					✓	✓	✓								✓	
12.5/11.7	215/215	1EDI2002AS	CT		✓		✓	✓	✓			✓	✓					✓	✓	✓								✓	
12.5/11.7	215/215	1EDI2010AS	CT		✓		✓	✓	✓			✓	✓					✓	✓	✓								✓	
12/11	165/170	1ED020I12FA2	CT		✓		✓		✓				✓						✓	✓							✓		
12/11	1900/1750	1ED020I12FTA	CT		✓		✓		✓				✓					✓	✓	✓							✓		
12/11	165/170	1ED020I12-B2	CT	✓			✓		✓	✓			✓						✓	✓				✓					
12/11	1750/1750	1ED020I12-BT	CT	✓			✓		✓	✓			✓					✓	✓	✓				✓					
11.9/11	460/460	1EDS20I12SV NEW	CT				✓	✓	✓			✓	✓				✓	✓	✓	✓							✓	
5.8/5.2	37/37	1EDS5663H NEW	CT					✓						✓				✓	✓	✓				✓				
5.8/5.2	37/37	1EDF5673F NEW	CT					✓						✓				✓					✓					
5.8/5.2	37/37	1EDF5673K NEW	CT					✓						✓				✓										✓
12.2/11.2	85/85	2ED020I12-FI	CT			✓					✓		✓		✓	✓									✓			
13.5/0	85/85	2ED020I06-FI	CT										✓		✓	✓									✓			
12/11	165/170	2ED020I12-F2	CT	✓			✓		✓	✓			✓															
12/11	165/170	2ED020I12FA	CT		✓		✓		✓						✓				✓	✓							✓	
8/7	37/37	2EDS8265H NEW	CT					✓											✓	✓				✓				
8/7	37/37	2EDS8165H NEW	CT					✓											✓	✓				✓				
4.2/3.9	37/37	2EDF7275F NEW	CT					✓															✓					
4.2/3.9	37/37	2EDF7175F NEW	CT					✓															✓					
4.2/3.9	37/37	2EDF7275K NEW	CT					✓																				✓
4.2/3.9	37/37	2EDF7235K NEW	CT					✓																				✓