

EiceDRIVER™ 1ED020I12-B2 Enhanced

Single channel isolated gate driver IC with DESAT, and Miller Clamp

Features

- Single channel coreless transformer isolated gate driver IC
- For 600 V/1200 V IGBTs and SiC MOSFETs
- 2 A typical rail-to-rail output current
- Integrated protection features, e.g.
 - V_{CEsat} -detection (DESAT)
 - Short circuit clamping
 - Active shut-down
 - Active Miller clamp
- 28 V absolute maximum output supply voltage
- 195/190 ns maximum propagation delay
- 100 kV/ μ s common mode transient immunity (CMTI)
- 12/11 V output undervoltage lockout (UVLO)
- Suitable for operation at high ambient temperature
- Certified according to UL 1577 with $V_{ISO} = 3750$ V (rms) for 1 min
- Basic insulation tested

Potential applications

- AC and brushless DC motor drives
- High voltage DC/DC-converter
- UPS-systems
- Solar inverter
- EV charging
- Commercial, construction and agricultural vehicles (CAV)
- Commercial air conditioner (CAC)
- Industrial power supply



PG-DSO-16-15

Product validation

Qualified for applications listed above based on the test conditions in the relevant tests of JEDEC20/22.

Device information

| Product type | Typical output current | Certification(File E311313) | Package | Evaluation board |
|------------------------------|------------------------|-----------------------------|--------------|-----------------------------------|
| 1ED020I12-B2 | ± 2 A | UL 1577 | PG-DSO-16-15 | EVAL-1ED020I12-B2 |

Table 1 Similar products

| Product type | Typical output current | Certification(File E311313) | Package | Evaluation board |
|------------------------------|------------------------|-----------------------------|--------------|------------------------------|
| 1ED020I12-F2 | ± 2 A | – | PG-DSO-16-15 | 2ED100E12-F2 |

Description

Table 1 Similar products (continued)

| Product type | Typical output current | Certification(File E311313) | Package | Evaluation board |
|------------------------------|------------------------|-----------------------------|--------------|-----------------------------------|
| 1ED020I12-BT | ± 2 A | UL 1577 | PG-DSO-16-15 | EVAL-1ED020I12-BT |
| 1ED020I12-FT | ± 2 A | – | PG-DSO-16-15 | – |
| 2ED020I12-F2 | ± 2 A | – | PG-DSO-36-58 | EVAL-2ED020I12-F2 |

Description

The 1ED020I12-B2 is a galvanic isolated single channel driver in a PG-DSO-16-15 300 mil wide body package that provides an output current capability of typically 2 A.

All logic pins are 5 V CMOS compatible and could be directly connected to a microcontroller.

The data transfer across galvanic isolation is realized by the integrated coreless transformer technology.

The 1ED020I12-B2 provides several protection features like IGBT desaturation protection, active Miller clamping and active shut down.

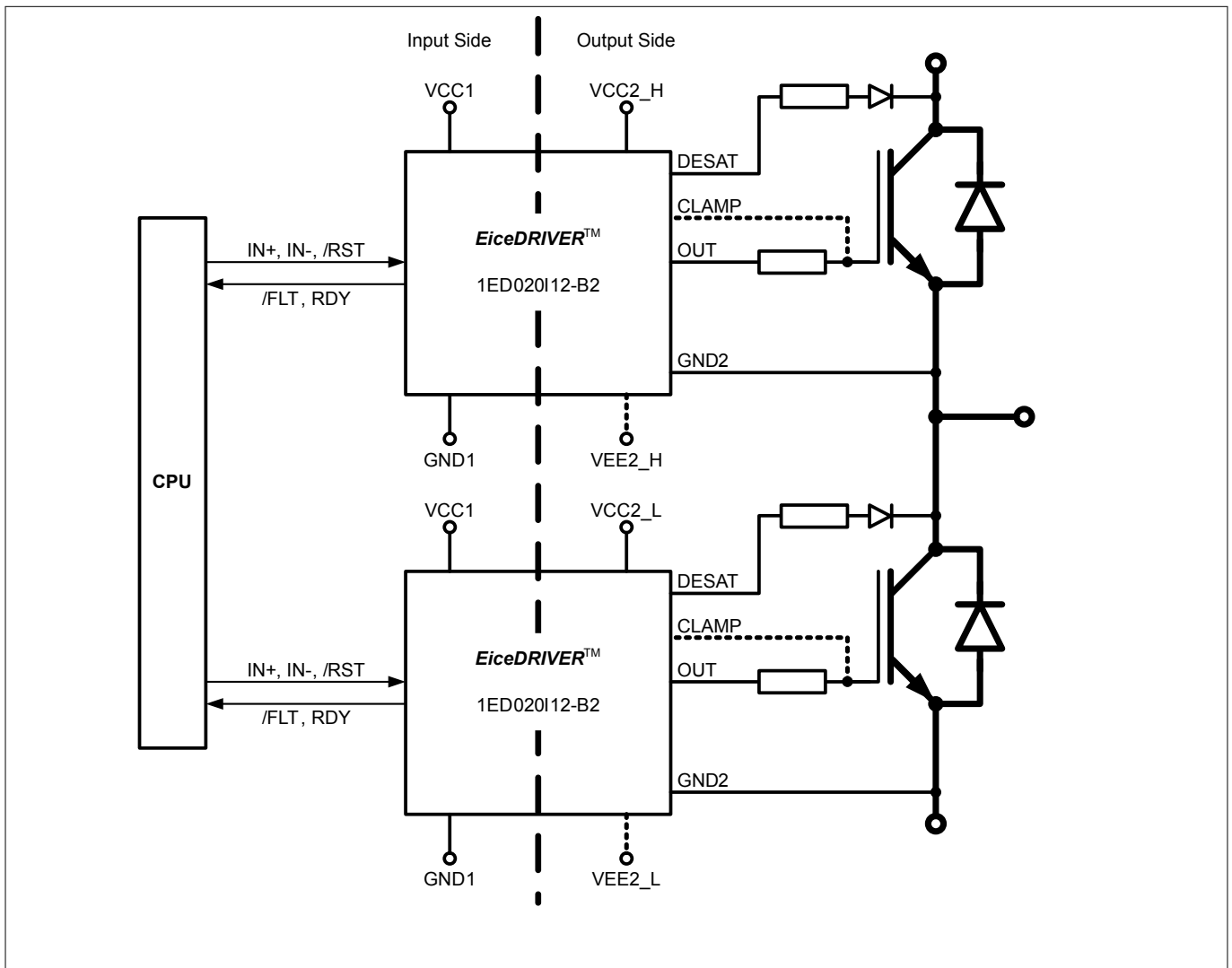


Figure 1 Typical application

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1 Block diagram

1 Block diagram

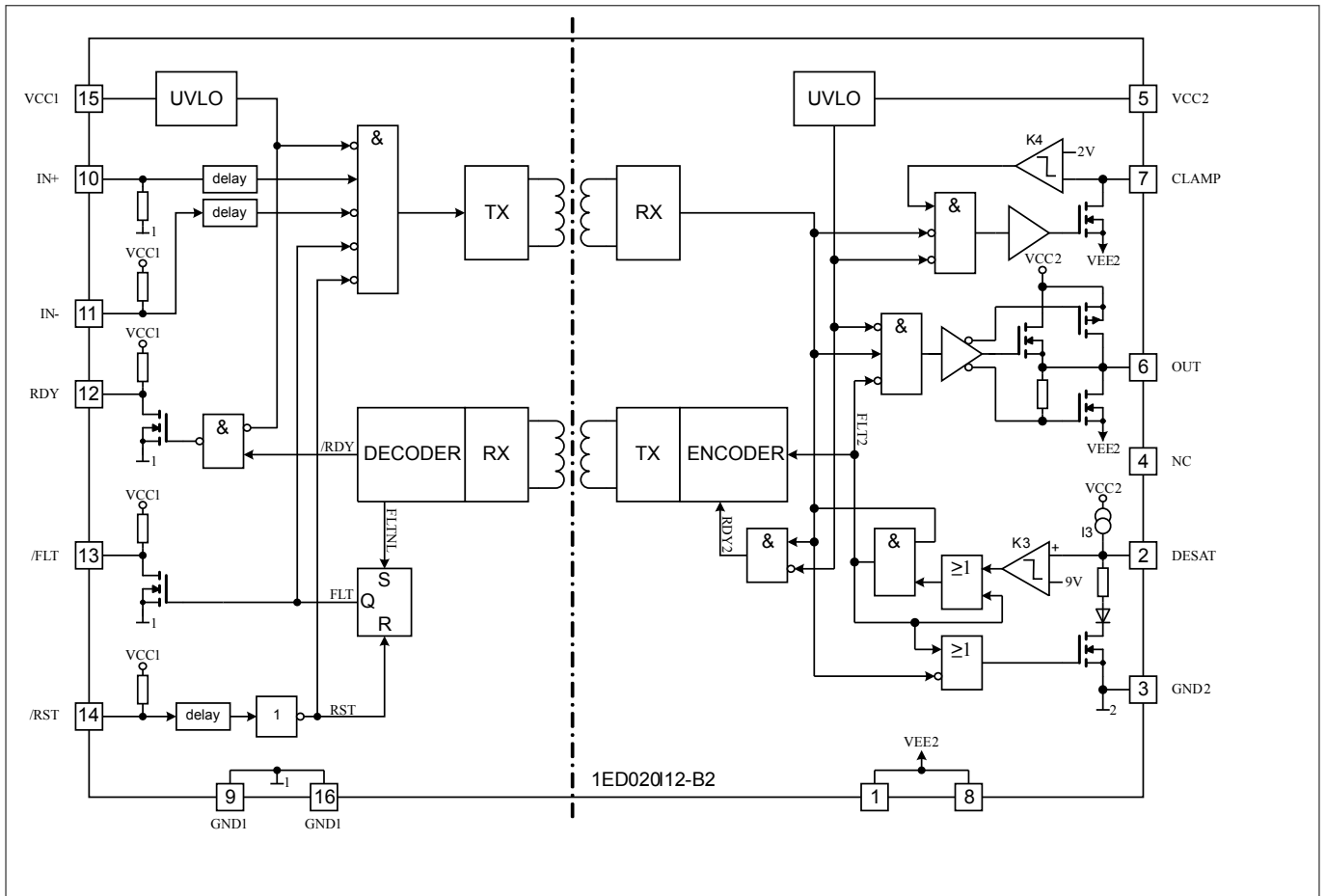


Figure 2 Block diagram 1ED020I12-B2

2 Pin configuration and functionality

2.1 Pin configuration

Table 2 Pin configuration

| Pin No. | Name | Function |
|---------|-------|-----------------------------------|
| 1 | VEE2 | Negative power supply output side |
| 2 | DESAT | Desaturation protection |
| 3 | GND2 | Signal ground output side |
| 4 | NC | Not connected |
| 5 | VCC2 | Positive power supply output side |
| 6 | OUT | Driver output |
| 7 | CLAMP | Miller clamping |
| 8 | VEE2 | Negative power supply output side |
| 9 | GND1 | Ground input side |

2 Pin configuration and functionality

Table 2 Pin configuration (continued)

| Pin No. | Name | Function |
|---------|-------------|----------------------------------|
| 10 | <i>IN+</i> | Non inverted driver input |
| 11 | <i>IN-</i> | Inverted driver input |
| 12 | <i>RDY</i> | Ready output |
| 13 | <i>/FLT</i> | Fault output, low active |
| 14 | <i>/RST</i> | Reset input, low active |
| 15 | <i>VCC1</i> | Positive power supply input side |
| 16 | <i>GND1</i> | Ground input side |

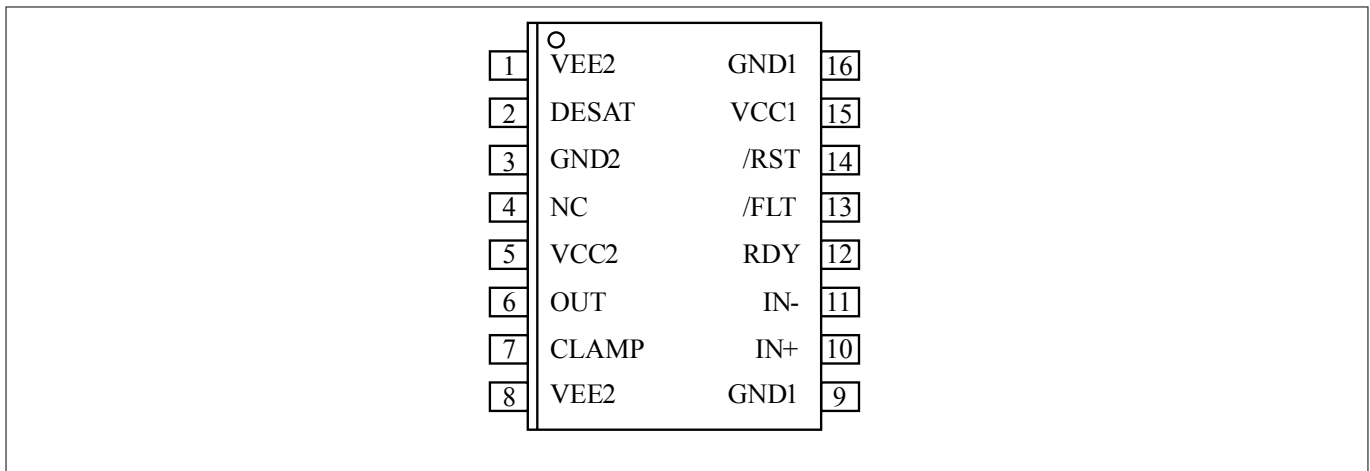


Figure 3 1ED020I12-B2 (top view)

2.2 Pin functionality

GND1

Ground connection of the input side.

***IN+* non-inverting gate driver input**

IN+ control signal for the driver output if *IN-* is set to low. (The IGBT is on if *IN+* = high and *IN-* = low)

A minimum pulse width is defined to make the IC robust against glitches at *IN+*. An internal pull-down resistor ensures IGBT off-state.

***IN-* inverting gate driver input**

IN- control signal for driver output if *IN+* is set to high. (IGBT is on if *IN-* = low and *IN+* = high)

A minimum pulse width is defined to make the IC robust against glitches at *IN-*. An internal pull-up resistor ensures IGBT off-state.

***/RST* reset input**

Function 1: Enable/shutdown of the input chip. (The IGBT is off if */RST* = low). A minimum pulse width is defined to make the IC robust against glitches at */RST*.

Function 2: Resets the DESAT fault-state of the chip if */RST* is low for a time t_{RST} . An internal pull-up resistor is used to ensure */FLT* status output.

3 Functional description

/FLT fault output

Open-drain output to report a desaturation error of the IGBT (/FLT is low if desaturation occurs)

RDY ready status

Open-drain output to report the correct operation of the device (RDY = high if both chips are above the UVLO level and the internal chip transmission is faultless).

VCC1

5 V power supply of the input chip

VEE2

Negative power supply pins of the output chip. If no negative supply voltage is available, all VEE2 pins have to be connected to GND2.

DESAT desaturation detection input

Monitoring of the IGBT saturation voltage (V_{CE}) to detect desaturation caused by short circuits. If OUT is high, V_{CE} is above a defined value and a certain blanking time has expired, the desaturation protection is activated and the IGBT is switched off. The blanking time is adjustable by an external capacitor.

CLAMP Miller clamping

Ties the gate voltage to ground after the IGBT has been switched off at a defined voltage to avoid a parasitic switch-on of the IGBT. During turn-off, the gate voltage is monitored and the clamp output is activated when the gate voltage goes below 2 V (related to VEE2). The clamp is designed for a Miller current up to 2 A.

GND2 reference ground

Reference ground of the output chip.

OUT driver output

Output pin to drive an IGBT. The voltage is switched between VEE2 and VCC2. In normal operating mode V_{OUT} is controlled by IN+, IN- and /RST. During error mode (UVLO, internal error or DESAT) V_{OUT} is set to VEE2 independent of the input control signals.

VCC2

Positive power supply pin of the output side.

3 Functional description

The 1ED020I12-B2 is an advanced IGBT gate driver that can be also used for driving power MOS devices. Control and protection functions are included to enable the design of high reliability systems.

The device consists of two galvanic separated parts. The input chip can be directly connected to a standard 5 V DSP or microcontroller with CMOS in/output and the output chip is connected to the high voltage side.

The rail-to-rail driver output enables the user to provide easy clamping of the IGBTs gate voltage during short circuit of the IGBT. So an increase of short circuit current due to the feedback via the Miller capacitance can be avoided. Further, a rail-to-rail output reduces power dissipation on a system-level.

The device also includes IGBT desaturation protection with /FLT status output.

The RDY status output reports if the device is supplied and operates correctly.

3 Functional description

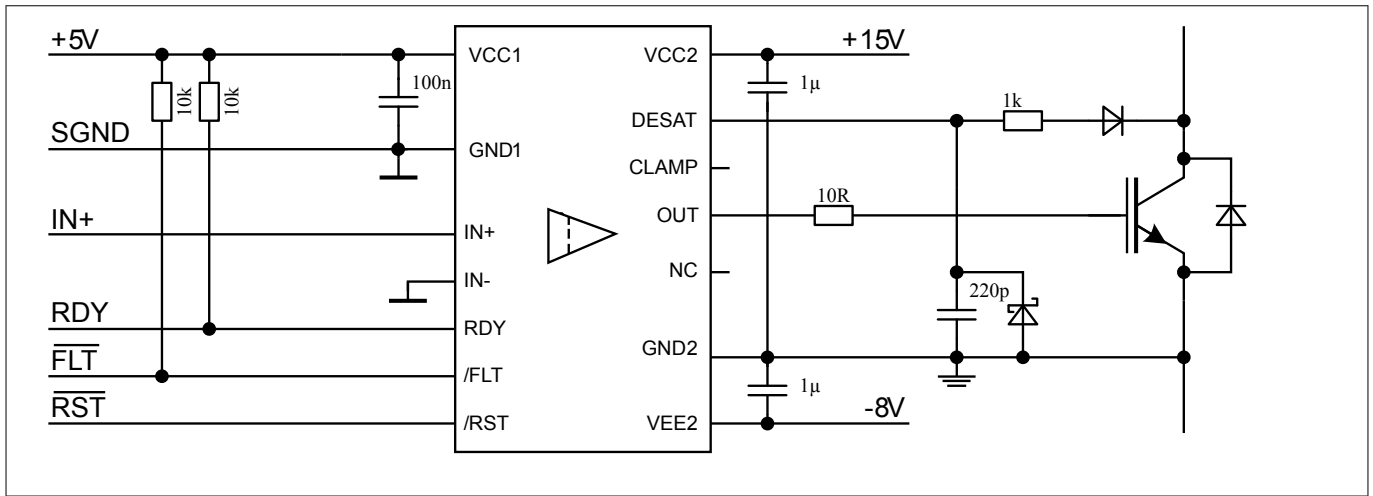


Figure 4 Application example bipolar supply

3.1 Supply

The driver 1ED020I12-B2 is designed to support two different supply configurations, bipolar supply and unipolar supply.

In bipolar supply the driver is typically supplied with a positive voltage of 15 V at VCC2 and a negative voltage of -8 V at VEE2. Negative supply prevents a dynamic turn on due to the additional charge which is generated from IGBT input capacitance times negative supply voltage. If an appropriate negative supply voltage is used, connecting CLAMP to IGBT gate is redundant and therefore typically not necessary.

For unipolar supply configuration the driver is typically supplied with a positive voltage of 15 V at VCC2. Erratically dynamic turn on of the IGBT could be prevented with active Miller clamp function, so CLAMP output is directly connected to IGBT gate.

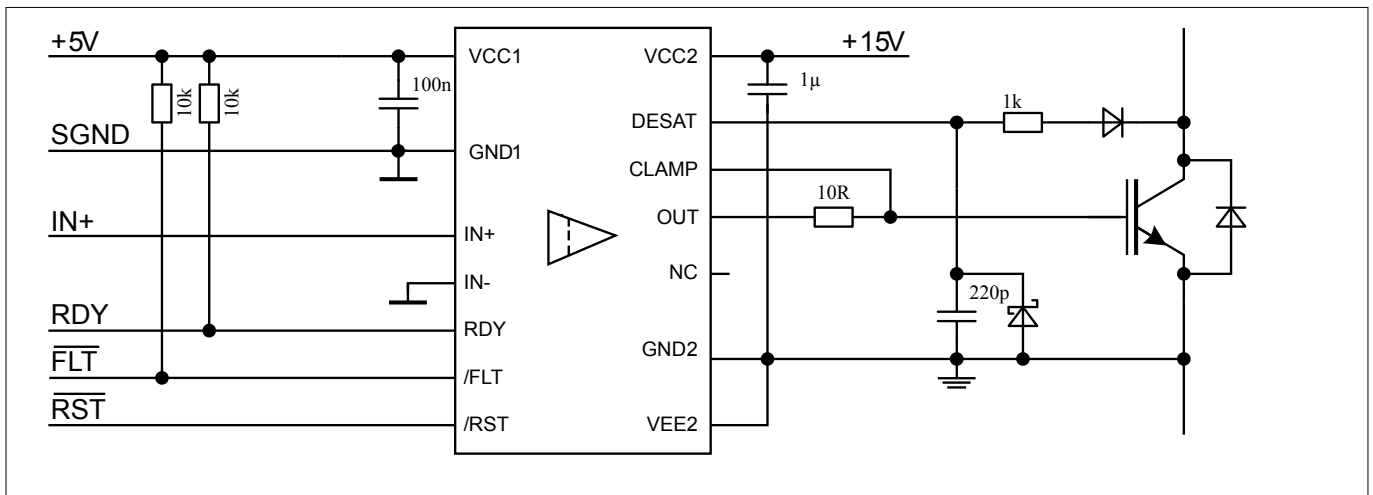


Figure 5 Application example unipolar supply

3.2 Internal protection features

3.2.1 Undervoltage lockout (UVLO)

To ensure correct switching of IGBTs the device is equipped with an undervoltage lockout for both chips, refer to [Figure 9](#).

3 Functional description

If the power supply voltage V_{VCC1} of the input chip drops below V_{UVLOL1} a turn-off signal is sent to the output chip before power-down. The IGBT is switched off and the signals at $IN+$ and $IN-$ are ignored as long as V_{VCC1} reaches the power-up voltage V_{UVLOH1} .

If the power supply voltage V_{VCC2} of the output chip goes down below V_{UVLOL2} the IGBT is switched off and signals from the input chip are ignored as long as V_{VCC2} reaches the power-up voltage V_{UVLOH2} . $VEE2$ is not monitored, otherwise negative supply voltage range from 0 V to -12 V would not be possible.

3.2.2 **RDY ready status output**

The *RDY* output shows the status of three internal protection features.

- UVLO of the input chip
- UVLO of the output chip after a short delay
- Internal signal transmission after a short delay

It is not necessary to reset the *RDY* signal since its state only depends on the status of the former mentioned protection signals.

3.2.3 **Watchdog timer**

During normal operation the internal signal transmission is monitored by a watchdog timer. If the transmission fails for a given time, the IGBT is switched off and the *RDY* ready output reports an internal error.

3.2.4 **Active shut-down**

The active shut-down feature ensures a safe IGBT off-state if the output chip is not connected to the power supply, IGBT gate is clamped at *OUT* to $VEE2$.

3.3 **Non-inverting and inverting inputs**

There are two possible input modes to control the IGBT. At non-inverting mode $IN+$ controls the driver output while $IN-$ is set to low. At inverting mode $IN-$ controls the driver output while $IN+$ is set to high, please see [Figure 7](#). A minimum input pulse width is defined to filter occasional glitches.

3.4 **Driver output**

The output driver sections uses only MOSFETs to provide a rail-to-rail output. This feature permits that tight control of gate voltage during on-state and short circuit can be maintained as long as the drivers supply is stable.

Due to the low internal voltage drop, switching behavior of the IGBT is predominantly governed by the gate resistor. Furthermore, it reduces the power to be dissipated by the driver.

3.5 **External protection features**

3.5.1 **Desaturation protection**

A desaturation protection ensures the protection of the IGBT at short circuit.

When the DESAT voltage goes up and reaches 9 V, the output is driven low. Further, the */FLT* output is activated after DESAT to fault-off delay, please refer to [Figure 8](#). An off command at IN during DESAT to fault-off delay is erasing the fault status. A programmable blanking time is used to allow enough time for IGBT saturation. Blanking time is provided by a highly precise internal current source and an external capacitor.

4 Electrical parameters

3.5.2 Active Miller clamp

In a half bridge configuration the switched off IGBT tends to dynamically turn on during turn on phase of the opposite IGBT. A Miller clamp allows sinking the Miller current across a low impedance path in this high dV/dt situation. Therefore in many applications, the use of a negative supply voltage can be avoided. During turn-off, the gate voltage is monitored and the clamp output is activated when the gate voltage goes below typical 2 V (related to V_{EE2}). The clamp is designed for a Miller current up to 2 A.

3.5.3 Short circuit clamping

During short circuit the IGBTs gate voltage tends to rise because of the feedback via the Miller capacitance. An additional protection circuit connected to OUT and $CLAMP$ limits this voltage to a value slightly higher than the supply voltage. A current of maximum 500 mA for 10 μs may be fed back to the supply through one of this paths. If higher currents are expected or a tighter clamping is desired external Schottky diodes may be added.

3.6 /RST reset

The reset input has two functions.

- /RST is in charge of setting back the /FLT output. If /RST is low longer than a given time, /FLT will be cleared at the rising edge of /RST, refer to [Figure 8](#); otherwise, it will remain unchanged
- /RST works as enable/shutdown of the input logic, refer to [Figure 7](#)

4 Electrical parameters

4.1 Absolute maximum ratings

Note: Absolute maximum ratings are defined as ratings, which when being exceeded may lead to destruction of the integrated circuit. Unless otherwise noted all parameters refer to GND1.

Table 3 Absolute maximum ratings

| Parameter | Symbol | Values | | Unit | Note / Test condition |
|--------------------------------------------------------------------|------------|----------------|----------------|---------|----------------------------------|
| | | Min. | Max. | | |
| Positive power supply output side | V_{VCC2} | -0.3 | 20 | V | ¹⁾ |
| Negative power supply output side | V_{VEE2} | -12 | 0.3 | V | ¹⁾ |
| Maximum power supply voltage output side ($V_{VCC2} - V_{VEE2}$) | V_{max2} | - | 28 | V | - |
| Gate driver output | V_{OUT} | $V_{VEE2}-0.3$ | $V_{VCC2}+0.3$ | V | - |
| Gate driver high output maximum current | I_{OUT} | - | 2.4 | A | $t = 2 \mu s$ |
| Gate & clamp driver low output maximum current | I_{OUT} | - | 2.4 | A | $t = 2 \mu s$ |
| Maximum short circuit clamping time | t_{CLP} | - | 10 | μs | $I_{CLAMP/OUT} = 500 \text{ mA}$ |
| Positive power supply input side | V_{VCC1} | -0.3 | 6.5 | V | - |

¹ With respect to GND2.

4 Electrical parameters

Table 3 Absolute maximum ratings (continued)

| Parameter | Symbol | Values | | Unit | Note / Test condition |
|------------------------------------------------|-----------------|--------|--------------------------------|------|------------------------------------------|
| | | Min. | Max. | | |
| Logic input voltages ($IN+$, $IN-$, RST) | $V_{LogicIN}$ | -0.3 | 6.5 | V | – |
| Opendrain Logic output voltage ($/FLT$) | $V_{/FLT}$ | -0.3 | 6.5 | V | – |
| Opendrain Logic output voltage (RDY) | V_{RDY} | -0.3 | 6.5 | V | – |
| Opendrain Logic output current ($/FLT$) | $I_{/FLT}$ | – | 10 | mA | – |
| Opendrain Logic output current (RDY) | I_{RDY} | – | 10 | mA | – |
| Pin $DESAT$ voltage | V_{DESAT} | -0.3 | $V_{VCC2} + 0.3$ | V | ¹⁾ |
| Pin $CLAMP$ voltage | V_{CLAMP} | -0.3 | $V_{VCC2} + 0.3$ ²⁾ | V | ³⁾ |
| Input to output isolation voltage ($GND2$) | V_{offset} | -1200 | 1200 | V | |
| Junction temperature | T_J | -40 | 150 | °C | – |
| Storage temperature | T_S | -55 | 150 | °C | – |
| Power dissipation, per input part | $P_{D, IN}$ | – | 100 | mW | ⁴⁾ @ $T_A = 25^\circ\text{C}$ |
| Power dissipation, at output side | $P_{D, OUT}$ | – | 700 | mW | ⁴⁾ @ $T_A = 25^\circ\text{C}$ |
| Thermal resistance (input side) | $R_{thJA, IN}$ | – | 160 | K/W | ⁴⁾ @ $T_A = 25^\circ\text{C}$ |
| Thermal resistance (output side) | $R_{thJA, OUT}$ | – | 125 | K/W | ⁴⁾ @ $T_A = 25^\circ\text{C}$ |
| ESD capability | $V_{ESD, HBM}$ | – | 1 | kV | Human Body Model ⁵⁾ |

4.2 Operating parameters

Note: Within the operating range the IC operates as described in the functional description. Unless otherwise noted all parameters refer to $GND1$.

Table 4 Operating parameters

| Parameter | Symbol | Values | | Unit | Note / Test condition |
|-----------------------------------|------------|--------|------|------|-----------------------|
| | | Min. | Max. | | |
| Positive power supply output side | V_{VCC2} | 13 | 20 | V | ⁶⁾ |
| Negative power supply output side | V_{VEE2} | -12 | 0 | V | ⁶⁾ |

¹⁾ With respect to $GND2$.

²⁾ May be exceeded during short circuit clamping.

³⁾ With respect to $VEE2$.

⁴⁾ Output IC power dissipation is derated linearly at 10 mW/°C above 62°C. Input IC power dissipation does not require derating. See **Figure 11** for reference layouts for these thermal data. Thermal performance may change significantly with layout and heat dissipation of components in close proximity.

⁵⁾ According to EIA/JESD22-A114-B (discharging a 100 pF capacitor through a 1.5 kΩ series resistor).

⁶⁾ With respect to $GND2$.

4 Electrical parameters

Table 4 Operating parameters (continued)

| Parameter | Symbol | Values | | Unit | Note / Test condition |
|--------------------------------------------------------------------|-----------------|----------------|--------------------------|-------------|-----------------------|
| | | Min. | Max. | | |
| Maximum power supply voltage output side ($V_{VCC2} - V_{VEE2}$) | V_{max2} | – | 28 | V | – |
| Positive power supply input side | V_{VCC1} | 4.5 | 5.5 | V | – |
| Logic input voltages ($IN+$, $IN-$, RST) | $V_{LogicIN}$ | -0.3 | 5.5 | V | – |
| Pin <i>CLAMP</i> voltage | V_{CLAMP} | $V_{VEE2}-0.3$ | V_{VCC2} ⁷⁾ | V | – |
| Pin <i>DESAT</i> voltage | V_{DESAT} | -0.3 | V_{VCC2} | V | ⁶⁾ |
| Ambient temperature | T_A | -40 | 105 | °C | – |
| Common mode transient immunity ⁸⁾ | $ dV_{ISO}/dt $ | – | 100 | kV/ μ s | @ 1200 V |

4.3 Recommended operating parameters

Note: Unless otherwise noted all parameters refer to *GND1*.

Table 5 Recommended operating parameters

| Parameter | Symbol | Value | Unit | Note / Test condition |
|-----------------------------------|------------|-------|------|-----------------------|
| Positive power supply output side | V_{VCC2} | 15 | V | ⁹⁾ |
| Negative power supply output side | V_{VEE2} | -8 | V | ⁹⁾ |
| Positive power supply input side | V_{VCC1} | 5 | V | – |

⁷ May be exceeded during short circuit clamping.

⁶ With respect to *GND2*.

⁸ The parameter is not subject to production test - verified by design/characterization

⁹ With respect to *GND2*.

4 Electrical parameters

4.4 Electrical characteristics

Note: The electrical characteristics include the spread of values in supply voltages, load and junction temperatures given below. Typical values represent the median values at $T_A = 25^\circ\text{C}$. Unless otherwise noted all voltages are given with respect to their respective GND (GND1 for pins 9 to 16, GND2 for pins 1 to 8).

4.4.1 Voltage supply

Table 6 Voltage supply

| Parameter | Symbol | Values | | | Unit | Note / Test condition |
|-----------------------------------------------------------|--------------|--------|------|------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | Min. | Typ. | Max. | | |
| UVLO threshold input chip | V_{UVLOH1} | – | 4.1 | 4.3 | V | – |
| | V_{UVLOL1} | 3.5 | 3.8 | – | V | – |
| UVLO hysteresis input chip ($V_{UVLOH1} - V_{UVLOL1}$) | V_{HYS1} | 0.15 | – | – | V | – |
| UVLO threshold output chip | V_{UVLOH2} | – | 12.0 | 12.6 | V | – |
| | V_{UVLOL2} | 10.4 | 11.0 | – | V | – |
| UVLO hysteresis output chip ($V_{UVLOH2} - V_{UVLOL2}$) | V_{HYS2} | 0.7 | 0.9 | – | V | – |
| Quiescent current input chip | I_{Q1} | – | 7 | 9 | mA | $V_{CC1} = 5\text{ V}$ $IN+ = \text{High}$, $IN- = \text{Low}$ $\Rightarrow OUT = \text{High}$, $RDY = \text{High}$, $/FLT = \text{High}$ |
| Quiescent current output chip | I_{Q2} | – | 4 | 6 | mA | $V_{CC2} = 15\text{ V}$ $V_{VEE2} = -8\text{ V}$ $IN+ = \text{High}$, $IN- = \text{Low}$ $\Rightarrow OUT = \text{High}$, $RDY = \text{High}$, $/FLT = \text{High}$ |

4 Electrical parameters

4.4.2 Logic input and output

Table 7 Logic input and output

| Parameter | Symbol | Values | | | Unit | Note / Test condition |
|----------------------------------------------------------|---------------------------------------------|--------|------|------|------|---------------------------------------|
| | | Min. | Typ. | Max. | | |
| <i>IN+</i> , <i>IN-</i> , <i>/RST</i> low input voltage | $V_{IN+,L}$, $V_{IN-,L}$, $V_{/RST,L}$ | – | – | 1.5 | V | – |
| <i>IN+</i> , <i>IN-</i> , <i>/RST</i> high input voltage | $V_{IN+,H}$, $V_{IN-,H}$, $V_{/RST,H}$ | 3.5 | – | – | V | – |
| <i>IN-</i> , <i>/RST</i> input current | I_{IN-} , $I_{/RST}$ | -400 | -100 | – | μA | $V_{IN-} = GND1$ $V_{/RST} = GND1$ |
| <i>IN+</i> input current | I_{IN+} | – | 100 | 400 | μA | $V_{IN+} = VCC1$ |
| <i>RDY</i> , <i>/FLT</i> pull-up current | $I_{P,RDY}$, $I_{P,/FLT}$ | -400 | -100 | – | μA | $V_{RDY} = GND1$ $V_{/FLT} = GND1$ |
| Input pulse suppression <i>IN+</i> , <i>IN-</i> | t_{MININ+} , t_{MININ-} | 30 | 40 | – | ns | – |
| Input pulse suppression <i>/RST</i> for enable/shutdown | t_{MINRST} | 30 | 40 | – | ns | – |
| Pulse width <i>/RST</i> for resetting <i>/FLT</i> | $t_{/RST}$ | 800 | – | – | ns | – |
| <i>/FLT</i> low voltage | $V_{/FLT,L}$ | – | – | 300 | mV | $I_{SINK,/FLT} = 5 \text{ mA}$ |
| <i>RDY</i> low voltage | $V_{RDY,L}$ | – | – | 300 | mV | $I_{SINK,RDY} = 5 \text{ mA}$ |

4 Electrical parameters

4.4.3 Gate driver

Table 8 Gate driver

| Parameter | Symbol | Values | | | Unit | Note / Test condition |
|--------------------------------|--------------------|------------------------|--------------------------|--------------------------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | Min. | Typ. | Max. | | |
| High level output voltage | V_{OUTH1} | $V_{\text{CC2}} - 1.2$ | $V_{\text{CC2}} - 0.8$ | – | V | $I_{\text{OUTH}} = -20 \text{ mA}$ |
| | V_{OUTH2} | $V_{\text{CC2}} - 2.5$ | $V_{\text{CC2}} - 2.0$ | – | V | $I_{\text{OUTH}} = -200 \text{ mA}$ |
| | V_{OUTH3} | $V_{\text{CC2}} - 9$ | $V_{\text{CC2}} - 5$ | – | V | $I_{\text{OUTH}} = -1 \text{ A}$ |
| | V_{OUTH4} | | $V_{\text{CC2}} - 10$ | – | V | $I_{\text{OUTH}} = -2 \text{ A}$ |
| High level output peak current | I_{OUTH} | -1.5 | -2.0 | – | A | $I_{\text{N+}} = \text{High}$, $I_{\text{N-}} = \text{Low}$; $\text{OUT} = \text{High}$ |
| Low level output voltage | V_{OUTL1} | – | $V_{\text{VEE2}} + 0.04$ | $V_{\text{VEE2}} + 0.09$ | V | $I_{\text{OUTL}} = 20 \text{ mA}$ |
| | V_{OUTL2} | – | $V_{\text{VEE2}} + 0.3$ | $V_{\text{VEE2}} + 0.85$ | V | $I_{\text{OUTL}} = 200 \text{ mA}$ |
| | V_{OUTL3} | – | $V_{\text{VEE2}} + 2.1$ | $V_{\text{VEE2}} + 5$ | V | $I_{\text{OUTL}} = 1 \text{ A}$ |
| | V_{OUTL4} | – | $V_{\text{VEE2}} + 7$ | – | V | $I_{\text{OUTL}} = 2 \text{ A}$ |
| Low level output peak current | I_{OUTL} | 1.5 | 2.0 | – | A | $I_{\text{N+}} = \text{Low}$, $I_{\text{N-}} = \text{Low}$; $\text{OUT} = \text{Low}$, $V_{\text{CC2}} = 15 \text{ V}$, $V_{\text{VEE2}} = -8 \text{ V}$ |

4.4.4 Active Miller clamp

Table 9 Active Miller clamp

| Parameter | Symbol | Values | | | Unit | Note / Test condition |
|-------------------------|----------------------|--------|--------------------------|--------------------------|------|------------------------------------|
| | | Min. | Typ. | Max. | | |
| Low level clamp voltage | V_{CLAMPL1} | – | $V_{\text{VEE2}} + 0.03$ | $V_{\text{VEE2}} + 0.08$ | V | $I_{\text{OUTL}} = 20 \text{ mA}$ |
| | V_{CLAMPL2} | – | $V_{\text{VEE2}} + 0.3$ | $V_{\text{VEE2}} + 0.8$ | V | $I_{\text{OUTL}} = 200 \text{ mA}$ |
| | V_{CLAMPL3} | – | $V_{\text{VEE2}} + 1.9$ | $V_{\text{VEE2}} + 4.8$ | V | $I_{\text{OUTL}} = 1 \text{ A}$ |
| Low level clamp current | I_{CLAMPL} | 2 | – | – | A | ¹⁰⁾ |
| Clamp threshold voltage | V_{CLAMP} | 1.6 | 2.1 | 2.4 | V | Related to V_{EE2} |

¹⁰⁾ The parameter is not subject to production test - verified by design/characterization

4 Electrical parameters

4.4.5 Short circuit clamping

Table 10 Short circuit clamping

| Parameter | Symbol | Values | | | Unit | Note / Test condition |
|------------------------------------------------------|----------------|--------|------|------|------|-------------------------------------------------------------------------------------------------------------------------|
| | | Min. | Typ. | Max. | | |
| Clamping voltage (OUT) ($V_{OUT} - V_{VCC2}$) | V_{CLPout} | - | 0.8 | 1.3 | V | $IN+ = High,$ $IN- = Low,$ $OUT = High$ $I_{OUT} = 500\text{ mA}$ pulse test, $t_{CLPmax} = 10\ \mu s$) |
| Clamping voltage (CLAMP) ($V_{VCLAMP} - V_{VCC2}$) | $V_{CLPclamp}$ | - | 1.3 | - | V | $IN+ = High,$ $IN- = Low,$ $OUT = High$ $I_{CLAMP} = 500\text{ mA}$ (pulse test, $t_{CLPmax} = 10\ \mu s$) |
| Clamping voltage (CLAMP) | $V_{CLPclamp}$ | - | 0.7 | 1.1 | V | $IN+ = High,$ $IN- = Low,$ $OUT = High$ $I_{CLAMP} = 20\text{ mA}$ |

4.4.6 Dynamic characteristics

Dynamic characteristics are measured with $V_{VCC1} = 5\text{ V}$, $V_{VCC2} = 15\text{ V}$ and $V_{VEE2} = -8\text{ V}$.

Table 11 Dynamic characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test condition |
|---------------------------------------------------------------------------------------|--------------|--------|------|------|------|-------------------------------------------------------------------------------------|
| | | Min. | Typ. | Max. | | |
| Input $IN+$, $IN-$ to output propagation delay ON | t_{PDON} | 145 | 170 | 195 | ns | $C_{LOAD} = 100\text{ pF}$ $V_{IN+} = 50\%$, $V_{OUT} = 50\%$ @ 25°C |
| Input $IN+$, $IN-$ to output propagation delay OFF | t_{PDOFF} | 145 | 165 | 190 | ns | |
| Input $IN+$, $IN-$ to output propagation delay distortion ($t_{PDOFF} - t_{PDON}$) | t_{PDISTO} | -35 | -5 | 25 | ns | |
| $IN+$, $IN-$ input to output propagation delay ON variation due to temp | $t_{PDON,t}$ | - | - | 25 | ns | ¹¹⁾ $C_{LOAD} = 100\text{ pF}$ $V_{IN+} = 50\%$, $V_{OUT} = 50\%$ |

¹¹ The parameter is not subject to production test - verified by design/characterization

4 Electrical parameters

Table 11 Dynamic characteristics (continued)

| Parameter | Symbol | Values | | | Unit | Note / Test condition |
|---------------------------------------------------------------------------------------------------------------------------------|-----------------------|--------|------|------|------|-----------------------------------------------------------------------------------------------------------|
| | | Min. | Typ. | Max. | | |
| I_{N+} , I_{N-} input to output propagation delay OFF variation due to temp | $t_{P\text{DOFF},t}$ | – | – | 40 | ns | ¹¹⁾ $C_{\text{LOAD}} = 100 \text{ pF}$ $V_{\text{IN}+} = 50\%$, $V_{\text{OUT}} = 50\%$ |
| I_{N+} , I_{N-} input to output propagation delay distortion variation due to temp ($t_{P\text{DOFF}} - t_{P\text{DON}}$) | $t_{P\text{DISTO},t}$ | – | – | 20 | ns | ¹¹⁾ $C_{\text{LOAD}} = 100 \text{ pF}$ $V_{\text{IN}+} = 50\%$, $V_{\text{OUT}} = 50\%$ |
| Rise time | t_{RISE} | 10 | 30 | 60 | ns | $C_{\text{LOAD}} = 1 \text{ nF}$ $V_L 10\%$, $V_H 90\%$ |
| | | 200 | 400 | 800 | ns | $C_{\text{LOAD}} = 34 \text{ nF}$ $V_L 10\%$, $V_H 90\%$ |
| Fall time | t_{FALL} | 10 | 50 | 90 | ns | $C_{\text{LOAD}} = 1 \text{ nF}$ $V_L 10\%$, $V_H 90\%$ |
| | | 200 | 350 | 600 | ns | $C_{\text{LOAD}} = 34 \text{ nF}$ $V_L 10\%$, $V_H 90\%$ |

4.4.7 Desaturation protection

Table 12 Desaturation protection

| Parameter | Symbol | Values | | | Unit | Note / Test condition |
|--------------------------------------|---------------------|--------|------|------|---------------|-----------------------------------------------------------------------------------------------------------|
| | | Min. | Typ. | Max. | | |
| Blanking capacitor charge current | I_{DESATC} | 450 | 500 | 550 | μA | $V_{\text{CC2}} = 15 \text{ V}$, $V_{\text{VEE2}} = -8 \text{ V}$ $V_{\text{DESAT}} = 2 \text{ V}$ |
| Blanking capacitor discharge current | I_{DESATD} | 9 | 14 | – | mA | $V_{\text{CC2}} = 15 \text{ V}$, $V_{\text{VEE2}} = -8 \text{ V}$ $V_{\text{DESAT}} = 6 \text{ V}$ |
| Desaturation reference level | V_{DESAT} | 8.3 | 9 | 9.5 | V | $V_{\text{CC2}} = 15 \text{ V}$ |

¹¹⁾ The parameter is not subject to production test - verified by design/characterization

4 Electrical parameters

Table 12 Desaturation protection (continued)

| Parameter | Symbol | Values | | | Unit | Note / Test condition |
|---------------------------------------------|--------------------------|--------|------|------|---------------|------------------------------------------------------------------------------------------------------------|
| | | Min. | Typ. | Max. | | |
| Desaturation filter time | $t_{\text{DESATfilter}}$ | – | 250 | – | ns | $V_{\text{VCC2}} = 15 \text{ V}$, $V_{\text{VEE2}} = -8 \text{ V}$ $V_{\text{DESAT}} = 9 \text{ V}$ |
| Desaturation sense to <i>OUT</i> low delay | t_{DESATOUT} | – | 350 | 430 | ns | $V_{\text{OUT}} = 90\%$ $C_{\text{LOAD}} = 1 \text{ nF}$ |
| Desaturation sense to <i>/FLT</i> low delay | t_{DESATFLT} | – | – | 2.25 | μs | $V_{\text{/FLT}} = 10\%$; $I_{\text{/FLT}} = 5 \text{ mA}$ |
| Desaturation low voltage | V_{DESATL} | 0.4 | 0.6 | 0.95 | V | $IN+ = \text{low}$, $IN- = \text{low}$, $OUT = \text{low}$ |
| Leading edge blanking | t_{DESATleb} | – | 400 | – | ns | Not subject of production test |

4 Electrical parameters

4.4.8 Active shut-down

Table 13 Active shut-down

| Parameter | Symbol | Values | | | Unit | Note / Test condition |
|--------------------------|-------------------|--------|------|------|------|-------------------------------------------------|
| | | Min. | Typ. | Max. | | |
| Active shut-down voltage | $V_{ACTSD}^{12)}$ | – | – | 2.0 | V | $I_{OUT} = -200\text{ mA}$, V_{VCC2} open |

¹²⁾ With reference to $VEE2$

5 Insulation characteristics

5 Insulation characteristics

Insulation characteristics are guaranteed only within the safety maximum ratings which must be ensured by protective circuits in application. Surface mount classification is class A in accordance with CECC00802.

This coupler is suitable for rated insulation only within the safety ratings. Compliance with the safety ratings shall be ensured by means of suitable protective circuits.

5.1 Tested according to VDE 0884-10 (Standard expired on Dec. 31, 2019)

Since the standard has expired on December 31, 2019, the product and its testing has not been changed.

Table 14 According to VDE 0884-10 (Standard expired on Dec. 31, 2019)

| Description | Symbol | Characteristic | Unit |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-----------------------|----------|
| Installation classification per EN 60664-1, Table 1 for rated mains voltage ≤ 150 V (rms) for rated mains voltage ≤ 300 V (rms) for rated mains voltage ≤ 600 V (rms) | | I-IV I-III I-II | – |
| Climatic classification (IEC68-1) | | 40/105/21 | – |
| Pollution degree (EN 60664-1) | | 2 | – |
| Minimum external clearance | CLR | 8.12 | mm |
| Minimum external creepage | CPG | 8.24 | mm |
| Minimum comparative tracking index | CTI | 175 | – |
| Maximum repetitive insulation voltage | V_{IORM} | 1420 | V (pk) |
| Input to output test voltage, method b ¹³⁾ $V_{IORM} * 1.875 = V_{PR}$, 100% production test with $t_m = 1$ sec, partial discharge < 5 pC | V_{PR} | 2663 | V (pk) |
| Input to output test voltage, method a ¹³⁾ $V_{IORM} * 1.6 = V_{PR}$, 100% production test with $t_m = 60$ sec, partial discharge < 5 pC | V_{PR} | 2272 | V (pk) |
| Highest allowable overvoltage | V_{IOTM} | 6000 | V (pk) |
| Maximum surge insulation voltage | V_{IOSM} | 6000 | V |
| Insulation resistance at T_S , $V_{IO} = 500$ V | R_{IO} | $> 10^9$ | Ω |

5.2 Recognized under UL 1577 (File E311313)

Table 15 Recognized under UL 1577

| Description | Symbol | Characteristic | Unit |
|--------------------------------------|----------------|----------------|---------|
| Insulation withstand voltage / 1 min | V_{ISO} | 3750 | V (rms) |
| Insulation test voltage / 1 s | $V_{ISO,test}$ | 4500 | V (rms) |

¹³ Refer to VDE 0884 for a detailed description of Method a and Method b partial discharge test profiles.

6 Timing diagrams

6 Timing diagrams

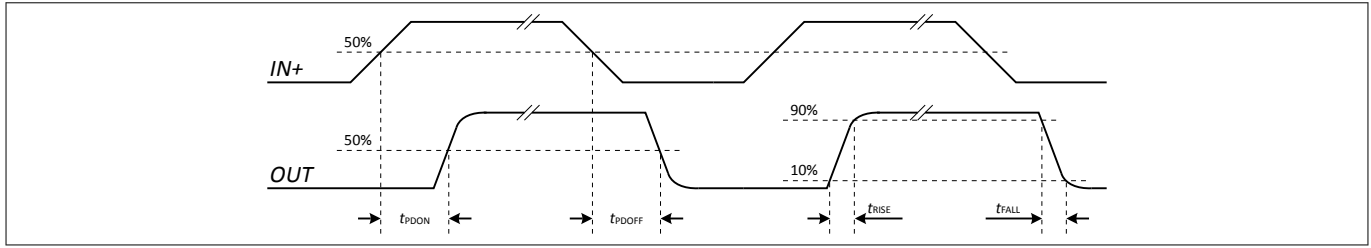


Figure 6 Propagation delay, rise and fall time

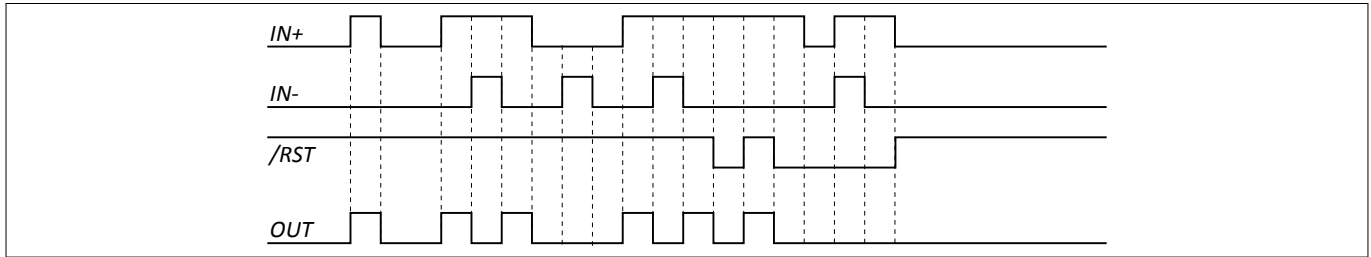


Figure 7 Typical switching behavior

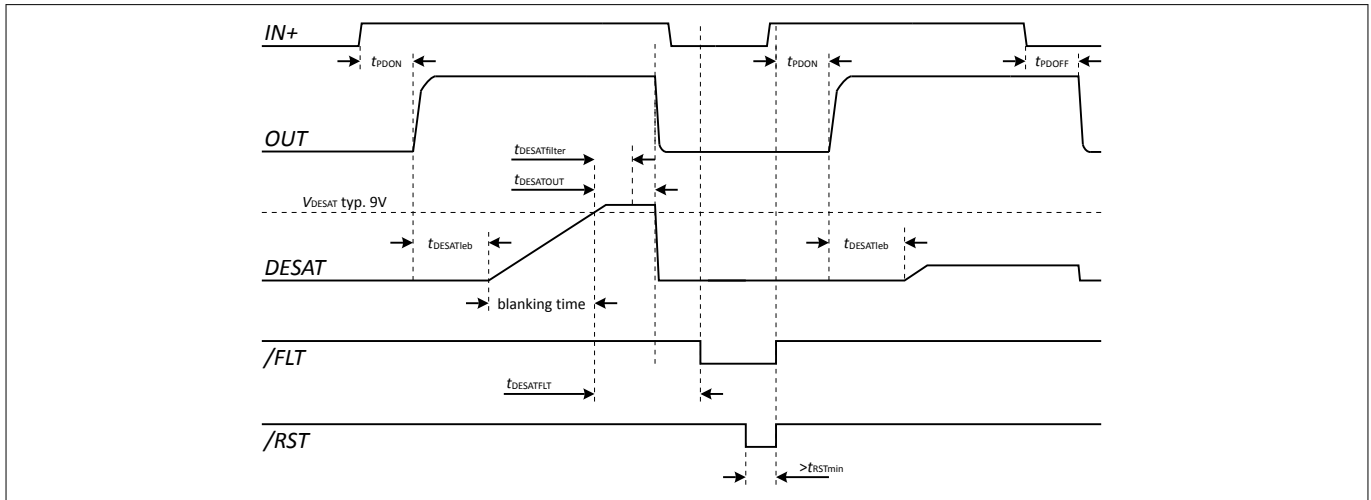


Figure 8 DESAT switch-off behavior

6 Timing diagrams

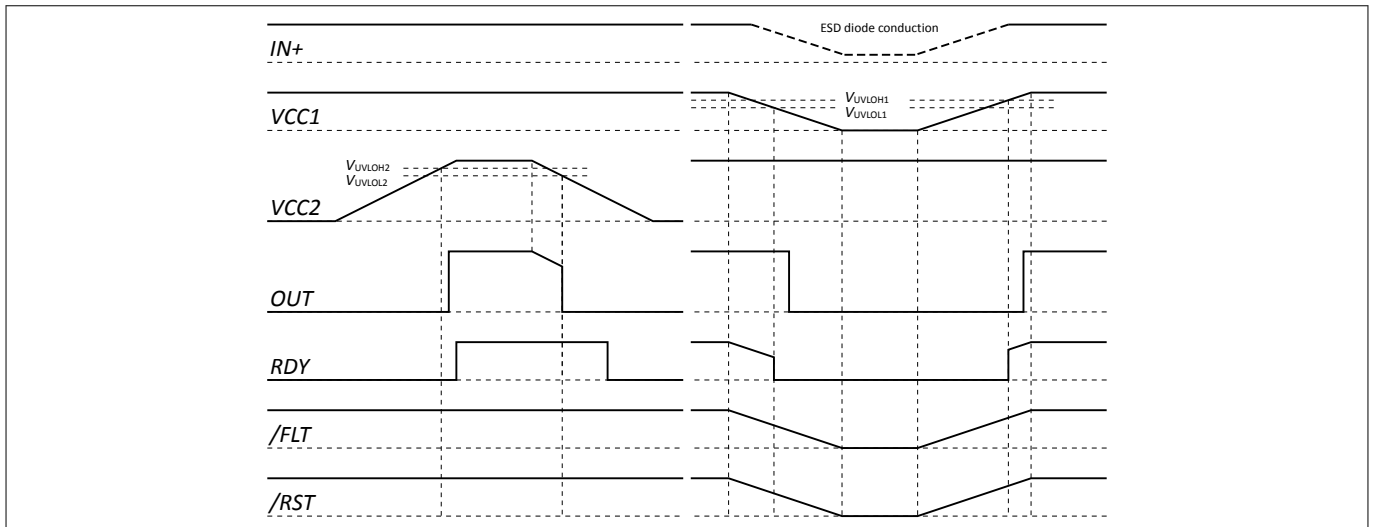


Figure 9 UVLO behavior

7 Package outline

7 Package outline

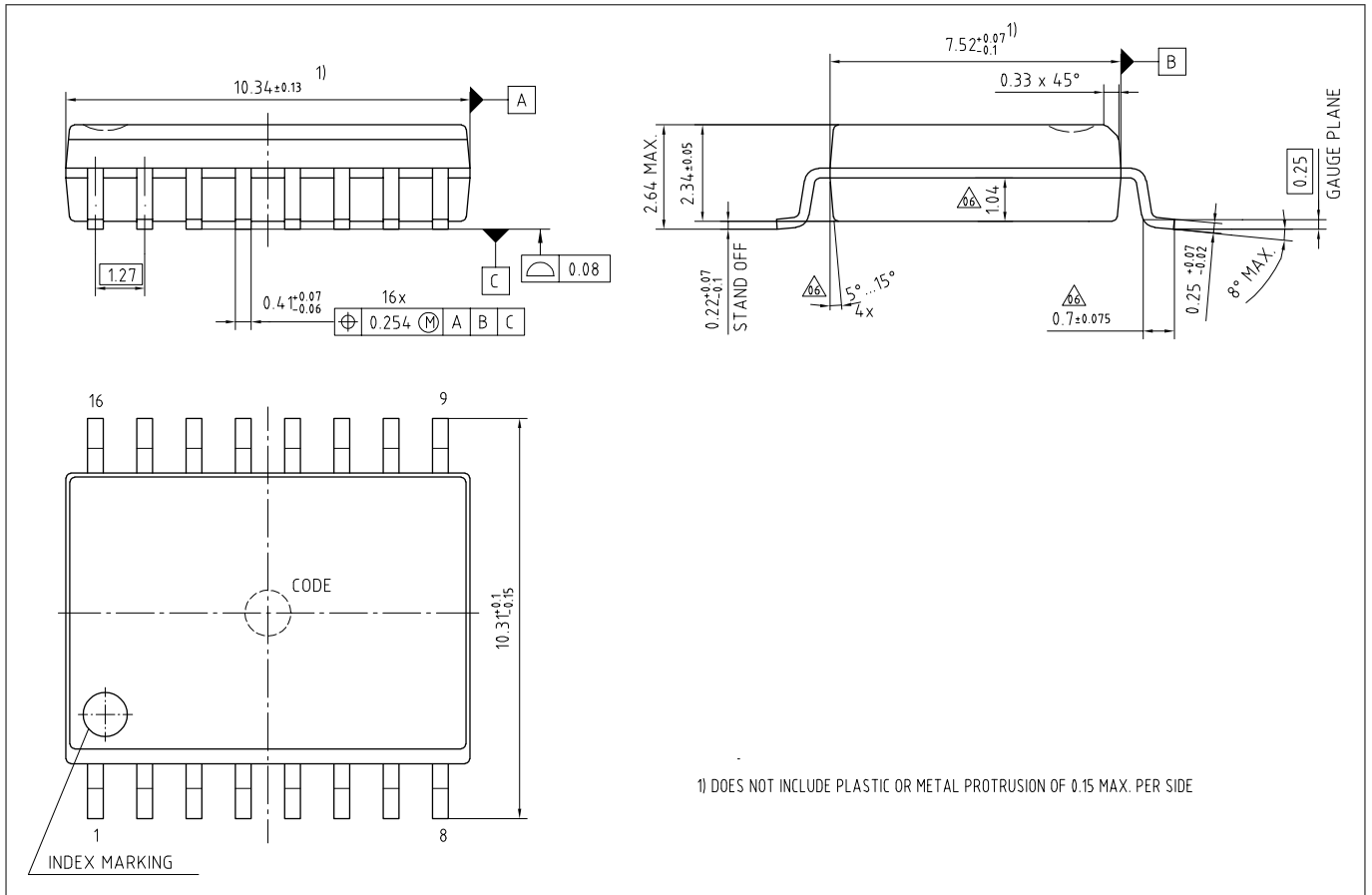


Figure 10 PG-DSO-16-15 300 mil body

8 Application notes

8.1 Reference layout for thermal data

The PCB layout shown in [Figure 11](#) represents the reference layout used for the thermal characterization. Pins 9 and 16 (*GND1*) and pins 1 and 8 (*VEE2*) require ground plane connections for achieving maximum power dissipation. The 1ED020I12-B2 is conceived to dissipate most of the heat generated through this pins.

8 Application notes

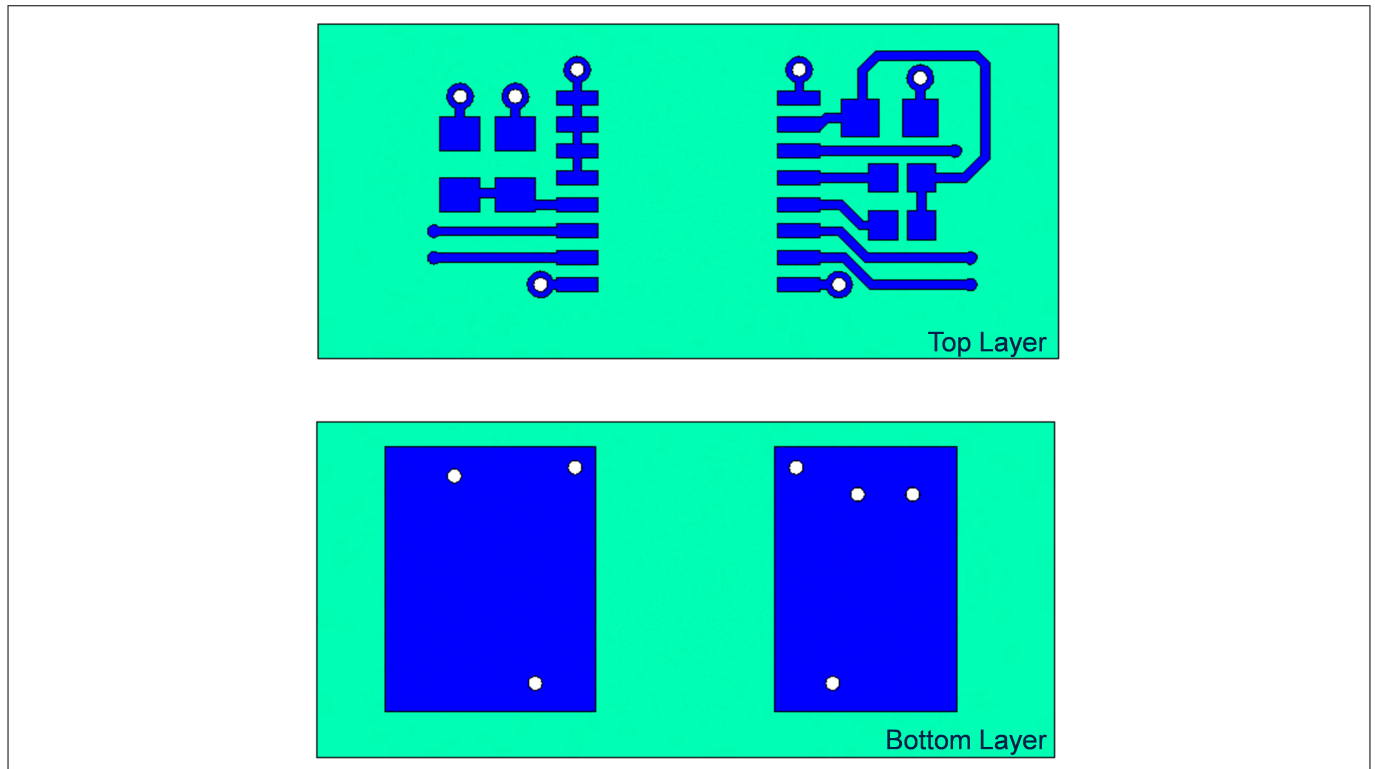


Figure 11 Reference layout for thermal data (Copper thickness 102 μm)

8.2 Printed circuit board guidelines

Following factors should be taken into account for an optimum PCB layout.

- Sufficient spacing should be kept between high voltage isolated side and low voltage side circuits.
- The same minimum distance between two adjacent high-side isolated parts of the PCB should be maintained to increase the effective isolation and reduce parasitic coupling.
- In order to ensure low supply ripple and clean switching signals, bypass capacitor trace lengths should be kept as short as possible.
- Lowest trace length for *VEE2* to *GND2* decoupling could be achieved with capacitor closed to pins 1 and 3.

9 Revision history

9 Revision history

| Document version | Date of release | Description of changes |
|-------------------------|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| v2.2 | 2020-01-01 | <ul style="list-style-type: none">• Update to new template• Editorial changes to headlines, descriptions and figures• Update to VDE 0884-10 expiration date, product and testing have not been changed |
| v2.1 | 2017-09-28 | <ul style="list-style-type: none">• Upgrade common mode transient immunity rating to 100 kV/μs, change typo DV_{ISO}/dt to dV_{ISO}/dt• Editorial changes to headlines, descriptions and figures |

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