

# EiceDRIVER™ 1ED32xxMC12H Two-level slew-rate control (2L-SRC)

Single-channel 5.7kV (rms) isolated gate driver IC with 2L-SRC

## Feature list

- Single channel isolated gate driver
- Two-level slew rate control by controlling two independent gate resistors for both turn-on and turn-off
- Enable on the fly & cycle-by-cycle gate resistor change, optimize both EMI and efficiency during different load conditions
- 110ns propagation delay with 15 ns part to part variation
- For use with 600 V/650 V/1200 V/1700 V/2300 V IGBTs, Si and SiC MOSFETs
- Up to 18.0 A typical peak output current
- 40 V absolute maximum output supply voltage
- High common-mode transient immunity CMTI > 200 kV/μs
- Active output clamping
- Active Miller Clamp options available
- Galvanically isolated coreless transformer gate driver
- 3.3 V and 5 V input supply voltage
- Suitable for operation at high ambient temperature and in fast switching applications
- Certification: VDE 0884-11 with  $V_{IORM} = 1767$  V (peak) and UL 1577 with  $V_{ISO} = 5.7$  kV (rms) for 1 min

## Potential applications

- AC and brushless DC motor drives
- High voltage DC/DC converter and DC/AC inverter
- UPS systems
- Solar inverters, e.g. for 1500 V (DC) systems



PG-DSO-8-66

## Product validation

Qualified for industrial applications according to the relevant tests of JEDEC47/20/22.

## Device information

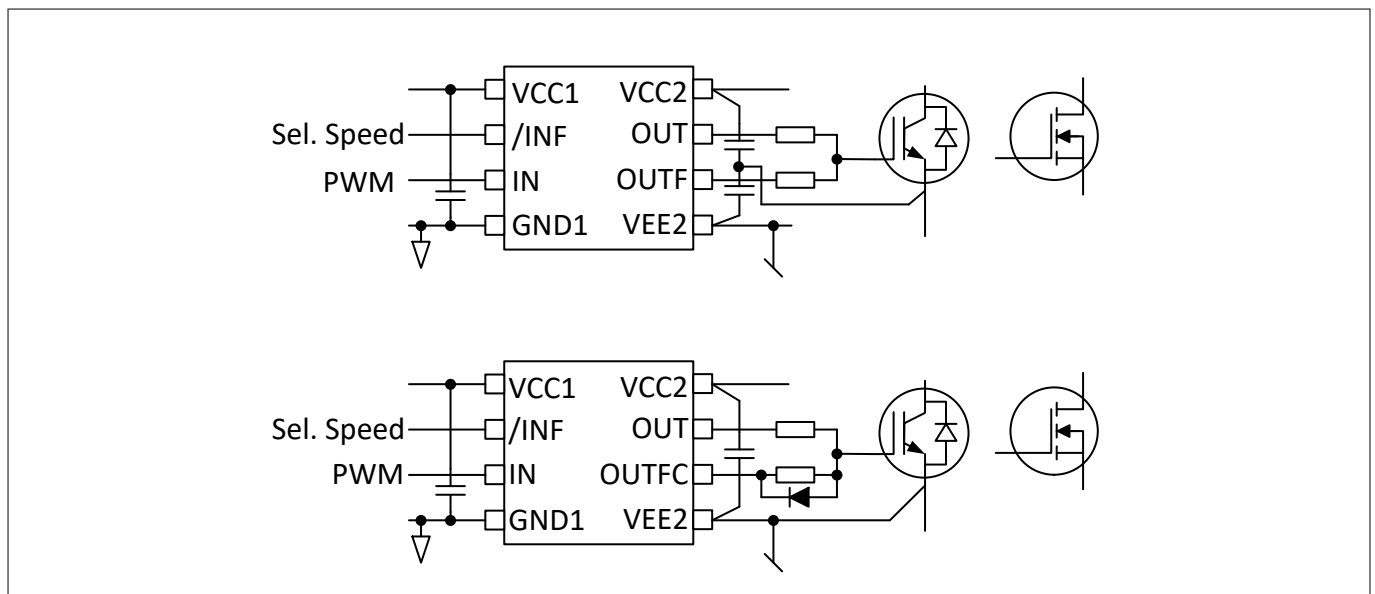
| Product type                 | Typical output current and configuration | Slew-rate control    | Certification | Marking  | Package     |
|------------------------------|--|----------------------|---------------|----------|-------------|
| <a href="#">1ED3240MC12H</a> | 10 A, standard                           | turn-on and turn-off | VDE + UL      | 1ED3240M | PG-DSO-8-66 |
| <a href="#">1ED3241MC12H</a> | 18 A, standard                           | turn-on and turn-off | VDE + UL      | 1ED3241M | PG-DSO-8-66 |
| <a href="#">1ED3250MC12H</a> | 10 A, Miller clamp                       | turn-on              | VDE + UL      | 1ED3250M | PG-DSO-8-66 |
| <a href="#">1ED3251MC12H</a> | 18 A, Miller clamp                       | turn-on              | VDE + UL      | 1ED3251M | PG-DSO-8-66 |

## Description

## Description

The 1ED32xx family is a group of galvanically isolated single-channel driver ICs in a DSO-8 300 mil package. The driver ICs provide typical peak output currents up to 18 A. The family implements two-level slew rate control (2L-SRC). This feature allows for controlling two independent gate resistors, which enables the optimization of both EMI and switching losses.

The family comprises standard output configuration and active Miller clamp output configurations with the same current rating to protect against parasitic turn-on. The input logic terminals operate safely with supply voltages of 3.3 V and 5 V. All input structures have threshold levels for support of 3.3 V microcontrollers. The driver IC family offers suitable output undervoltage lockout (UVLO) levels to operate various kinds of power transistors. The wide range of the output side supply voltage up to 40 V can be configured arbitrarily for positive and negative voltages as long as the absolute maximum of 40 V is not exceeded. All driver ICs have output sections with active shutdown.



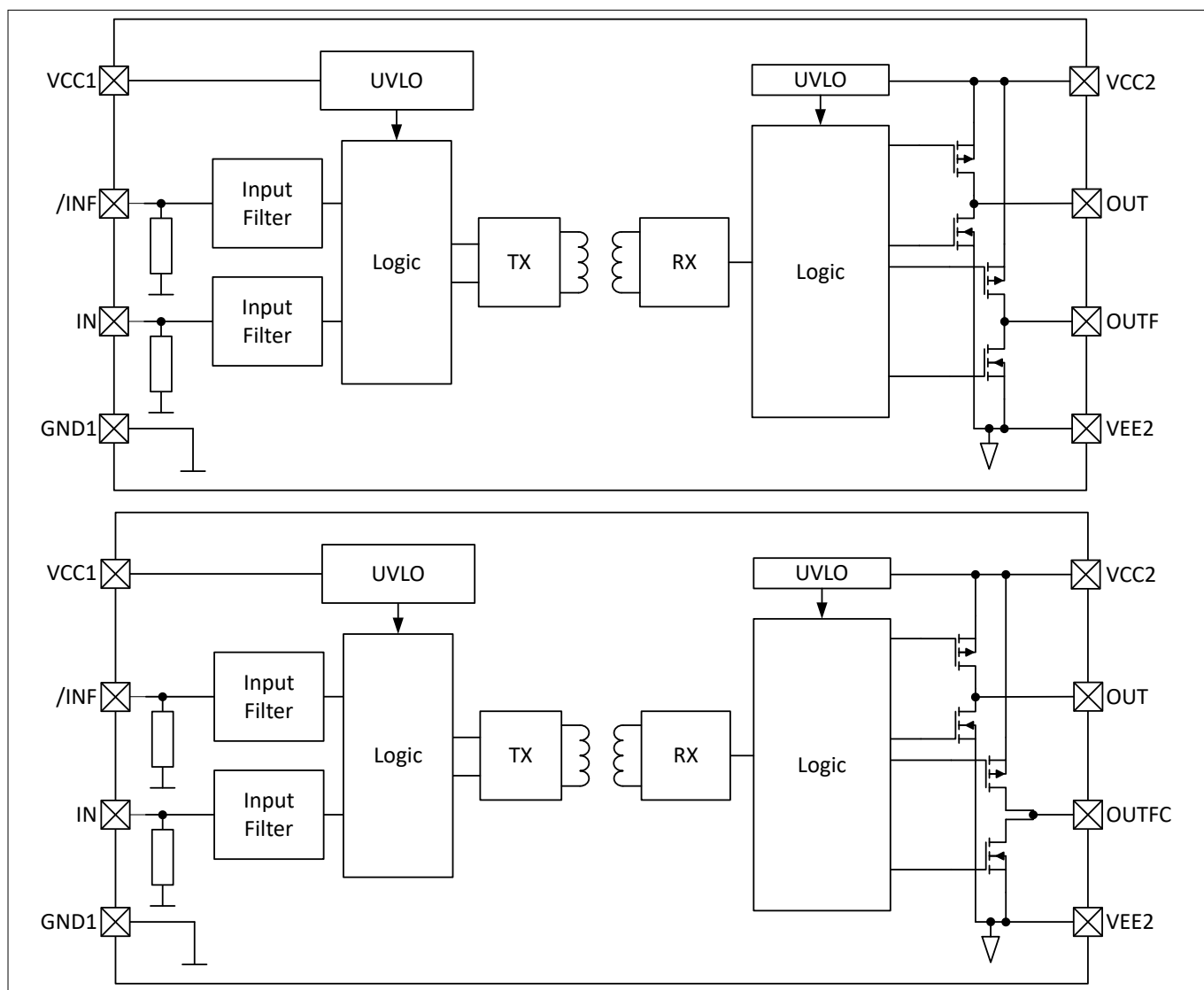
**Figure 1** Typical application for standard pinout (top) and CLAMP pinout (bottom)

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## Block diagram reference

### 1 Block diagram reference



**Figure 2** Block diagram for standard variants (top) and for CLAMP variants (bottom)

### 2 Related products to 1ED32xxMC12H

*Note:* Please consider the gate driver IC power dissipation and insulation requirements for the selected power switch and operating condition.

| Product group             | Product name                      | Description   |
|---------------------------|-----------------------------------|---|
| Evaluation boards         | <a href="#">EVAL-1ED3241MC12H</a> | Supporting 1ED3241MC12H and IKQ75N120CT2 for double pulse tests |
|                           | <a href="#">EVAL-1ED3251MC12H</a> | Supporting 1ED3251MC12H and IKQ75N120CT2 for double pulse tests |
| TRENCHSTOP™ IGBT Discrete | <a href="#">IKWH40N65WR6</a>      | 650 V, 40 A IGBT with anti-parallel diode in TO-247-3-HCC       |
|                           | <a href="#">IHW30N160R5</a>       | 1600 V, 30 A IGBT Discrete with anti-parallel diode in TO-247   |

## Pin configuration

| Product group                | Product name                       | Description  |
|------------------------------|------------------------------------|--|
|                              | <a href="#">IKW15N120CS7</a>       | 1200 V IGBT7 S7, 15 A IGBT with anti-parallel diode in TO247             |
|                              | <a href="#">IKQ75N120CS7</a>       | 1200 V IGBT7 S7, 75 A IGBT with anti-parallel diode in TO247-3           |
| CoolSiC™ SiC MOSFET Discrete | <a href="#">IMBF170R1K0M1</a>      | 1700 V, 1000 mΩ SiC MOSFET in TO-263-7 with extended creepage            |
|                              | <a href="#">IMZA120R040M1H</a>     | 1200 V, 40 mΩ SiC MOSFET in TO247-4 package                              |
|                              | <a href="#">IMZA120R014M1H</a>     | 1200 V, 14 mΩ SiC MOSFET in TO247-4 package                              |
|                              | <a href="#">IMBG120R030M1H</a>     | 1200 V, 30 mΩ SiC MOSFET in TO-263-7 package                             |
|                              | <a href="#">IMYH200R012M1H</a>     | 2000 V, 12 mΩ SiC MOSFET in TO-247-PLUS with high creepage and clearance |
|                              |                                    |  |
| CoolSiC™ SiC MOSFET Module   | <a href="#">FS33MR12W1M1H_B11</a>  | EasyPACK™ 1B 1200 V, 33 mΩ sixpack module                                |
|                              | <a href="#">FF17MR12W1M1H_B11</a>  | EasyDUAL™ 1B 1200 V, 17 mΩ half-bridge module                            |
|                              | <a href="#">FF4MR12W2M1H_B11</a>   | EasyDUAL™ 2B 1200 V, 4 mΩ half-bridge module                             |
|                              | <a href="#">F4-17MR12W1M1H_B11</a> | EasyPACK™ 1B 1200 V, 17 mΩ fourpack module                               |
| TRENCHSTOP™ IGBT Modules     | <a href="#">F4-100R17N3E4</a>      | EconoPACK™ 3 1700 V, 100 A fourpack IGBT module                          |
|                              | <a href="#">F4-200R17N3E4</a>      | EconoPACK™ 3 1700 V, 200 A fourpack IGBT module                          |
|                              | <a href="#">FP10R12W1T7_B11</a>    | EasyPIM™ 1B 1200 V, 10 A three phase input rectifier PIM IGBT module     |
|                              | <a href="#">FS100R12W2T7_B11</a>   | EasyPACK™ 2B 1200 V, 100 A sixpack IGBT module                           |
|                              | <a href="#">FP150R12KT4_B11</a>    | EconoPIM™ 3 1200V three-phase PIM IGBT module                            |
|                              | <a href="#">FS200R12KT4R_B11</a>   | EconoPACK™ 3 1200 V, 200 A sixpack IGBT module                           |

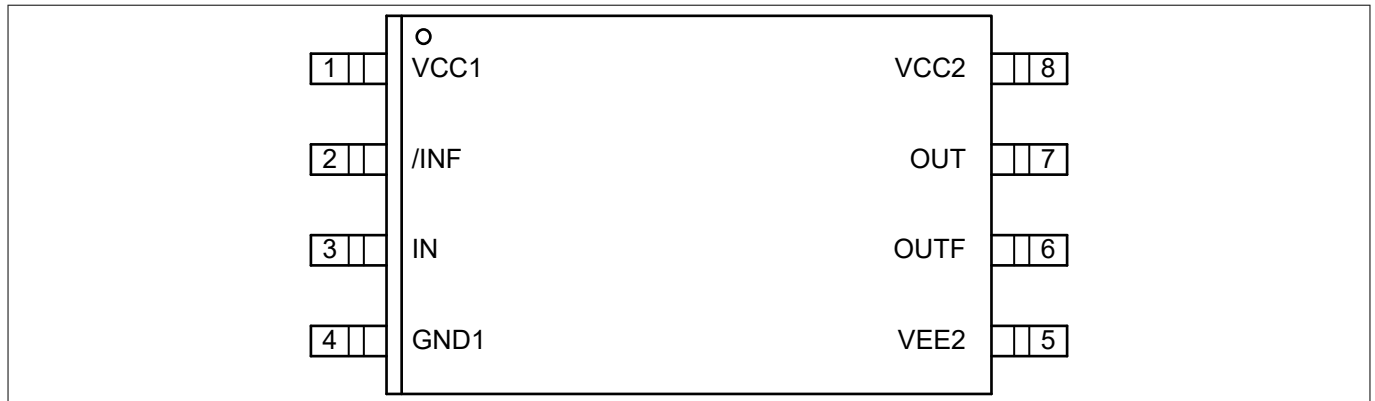
## 3 Pin configuration

### Pin configuration

**Table 1** Pin configuration

| Pin No. | Name         | Function  |
|---------|--------------|---|
| 1       | VCC1         | Positive logic supply   |
| 2       | /INF         | Driver input (active low) for operation <i>OUTF</i> or <i>OUTFC</i> |
| 3       | IN           | PWM driver input (active high)                                      |
| 4       | GND1         | Logic ground  |
| 5       | VEE2         | Power ground  |
| 6       | OUTF / OUTFC | Additional driver output  |
| 7       | OUT          | Regular driver output   |
| 8       | VCC2         | Positive power supply output side                                   |

## Pin configuration



**Figure 3 Pinout standard configuration (top view)**



**Figure 4 Pinout clamp configuration (top view)**

## Pin description

- **VCC1:** Logic input supply voltage with wide operating range from 3.3 V up to 15 V. This terminal is referenced to *GND1*
- **GND1:** Ground connection of input circuit. This is the reference point for the input side.
- **/INF:** Inverted control signal for controlling the operation of output *OUTF* or *OUTFC* respectively. An internal filter provides robustness against noise at terminal */INF*. An internal weak pull-down resistor favors a low level. This terminal is referenced to *GND1*
- **IN:** Direct control signal for driver output. An internal filter provides robustness against noise at terminal *IN*. An internal weak pull-down resistor favors off-state. This terminal is referenced to *GND1*
- **VCC2:** Positive power supply pin of output driving circuit. A proper blocking capacitor has to be placed close to this supply pin. This terminal is referenced to *VEE2*.
- **VEE2:** Reference ground of the output driving circuit. In case of a bipolar supply (positive and negative voltage referred to IGBT emitter) this pin is connected to the negative supply voltage.
- **OUT:** This driver output terminal follows the signal at terminal *IN* to turn on or off the external power transistor. During on-state the driving output is switched to *VCC2*. This output will be actively pulled down to *VEE2* in case of an UVLO event on either the input side or the output side. The active shutdown keeps the output voltage at a low level in case that the output side supply voltage collapses.
- **OUTF:** This output follows terminal *OUT* according to the signal at terminal */INF*.
- **OUTFC:** This output follows terminal *OUT* according to the signal at terminal */INF* for turn-on only.

## Functional description

## 4 Functional description

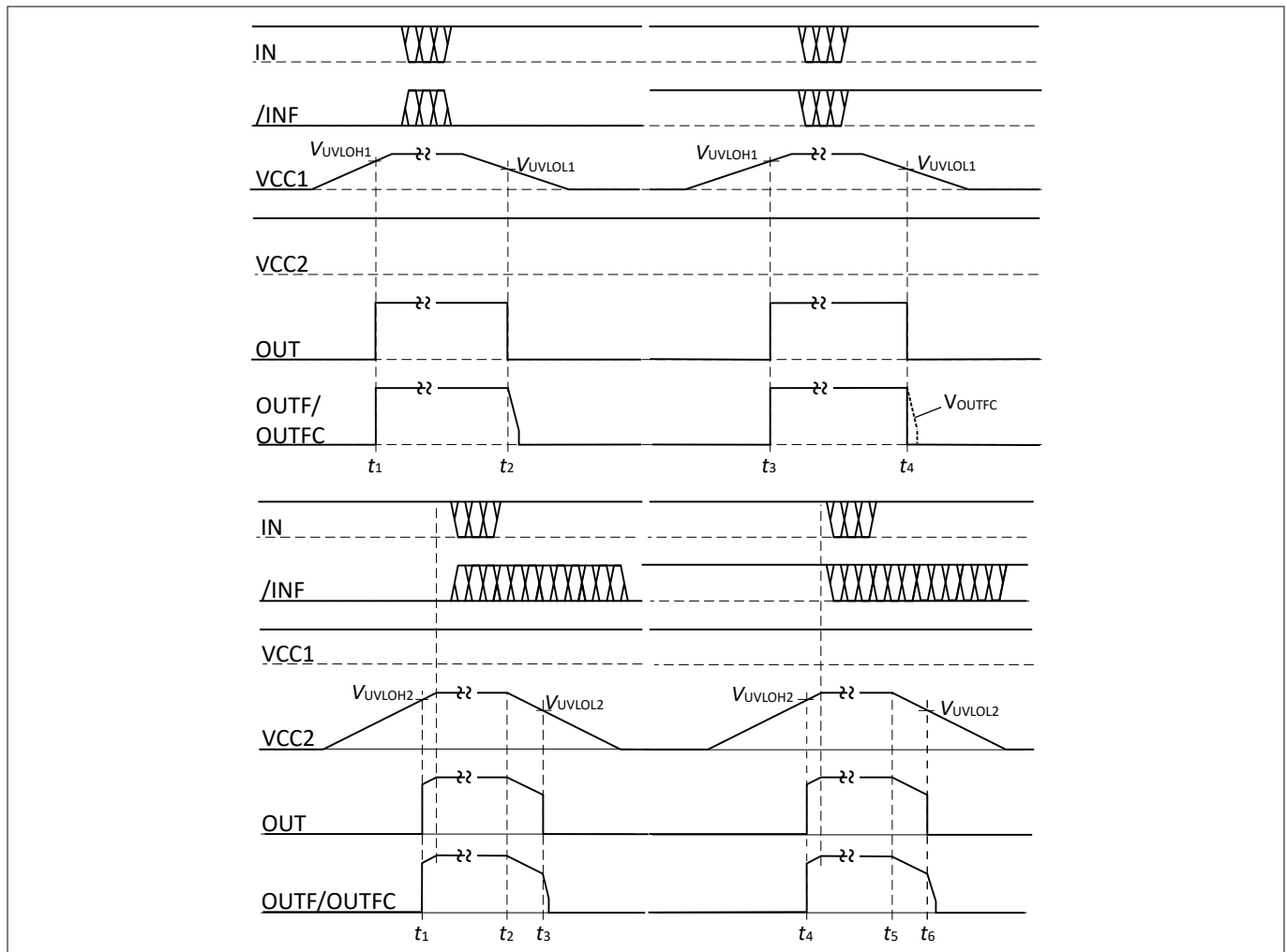
The 1ED32xxMC12H are general purpose gate drivers incorporating two-level slew-rate control functionality (2L-SRC). Based on one additional input control signal  $/INF$ , these drivers enable on-the-fly gate resistor changes.

The integrated galvanic isolation between control input logic and driving output stage grants additional safety. Its input voltage supply range supports the direct connection of various signal sources like DSPs and microcontrollers.

### 4.1 IC supply

The driver can operate over a wide supply-voltage range at both input side and output side. Both sides have an undervoltage lockout (UVLO) function which suppresses incoming control signals and prevents insufficient supply or gate voltages. The outputs are pulled down in cases of under-voltage lockout on either side.

The input-side power supply at terminal  $VCC1$  can range from typically 3.3 V up to 15 V. This allows a high safety margin with respect to voltage spikes on the supply voltage when supplying with 3.3 V or 5 V. A minimum of  $V_{UVLOH1}$  is required to start-up the input side of the driver IC.



**Figure 5** UVLO behavior regarding  $V_{CC1}$  (top) and  $V_{CC2}$  (bottom) after start up

The output side supports negative gate voltage operation, which helps to avoid a parasitic turn-on during off-state. The negative rail is connected to terminal  $VEE2$  in this case. A minimum voltage of  $V_{UVLOH2}$  at terminal  $VCC2$  is required for a safe start-up of the IC on the output side. The device is equipped with an undervoltage

## Functional description

lockout for input and output independently to ensure correct switching of power transistors. Operation starts only, if both  $V_{VCC1}$  and  $V_{VCC2}$  have increased above the respective levels  $V_{UVLOH1}$  and  $V_{UVLOH2}$ .

The input signals at terminals  $IN$  and  $/INF$  are ignored until  $V_{VCC1}$  reaches the power-up voltage  $V_{UVLOH1}$ . Terminal  $OUT$  is activated according to the instantaneous state of terminal  $IN$ . Terminal  $OUTF$  or  $OUTFC$  are activated after a UVLO condition for turn-on according to the default state at terminal  $/INF$ , which is LOW after start up. A new edge at terminal  $/INF$  is required to establish the initial user setting after a UVLO event. A new edge at terminal  $IN$  is required to replace the  $/INF$  default setting on the output side. 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. Both outputs  $OUT$  and  $OUTF$  shut down according to the last transmitted status at terminals  $IN$  and  $/INF$ .

The input signals at terminals  $IN$  and  $/INF$  are ignored until  $V_{VCC2}$  reaches the power-up voltage  $V_{UVLOH2}$ . Terminal  $OUT$  is activated according to the instantaneous state of terminal  $IN$ . Terminal  $OUTF$  or  $OUTFC$  are activated after a UVLO condition of  $V_{VCC2}$  for turn-on according to the default state at terminal  $/INF$ , which is LOW after start up. A new edge at terminal  $/INF$  is required to establish the initial user setting after a UVLO event. A new edge at terminal  $IN$  is required to replace the  $/INF$  default setting on the output side. If the power supply voltage  $V_{VCC2}$  of the output side drops below  $V_{UVLOL2}$ , output  $OUT$  pulls down independent of the last transmitted status at terminals  $IN$  and  $/INF$ . Output  $OUTF$  or  $OUTFC$  pull down in addition when their voltage is below  $V_{CLAMPL}$ .

UVLO events on the output side other than a full IC start-up result in a recovery of the output terminals  $OUTF$  and  $OUTFC$  according to the input-to-output control scheme.

*Note: The supply voltage  $V_{VCC2}$  and related protection functions is always referred to as  $VEE2$ . There is no differentiation between unipolar or bipolar supply.*

A capacitor that is placed in close proximity to the supply terminals  $VCC1$  and  $GND1$  on the input side, and  $VCC2$  and  $VEE2$  on the output side, avoids eventual triggering of under-voltage lockout events.

The IC is safe with any start-up sequence regarding its supply voltages  $V_{VCC1}$  and  $V_{VCC2}$ . However, it is good practice to have the input side supply voltage to start up first, followed by the output side supply.

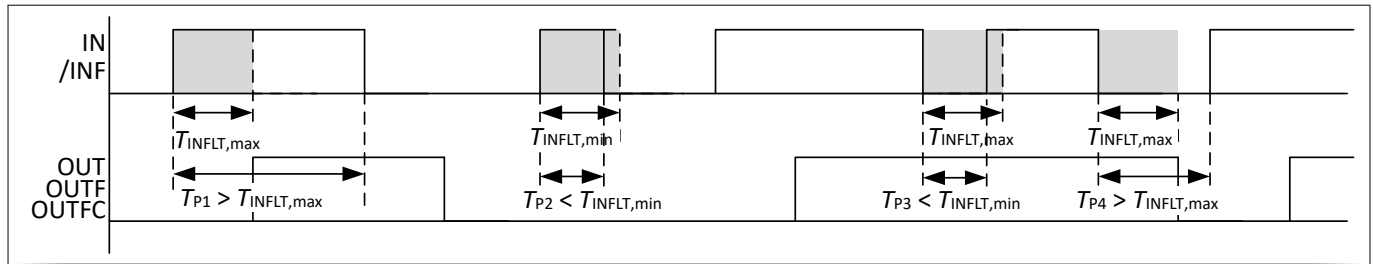
## 4.2 Input terminals $IN$ and $/INF$

The input terminals  $IN$  and  $/INF$  determine the behavior of the two output terminals  $OUT$  and  $OUTF(C)$ . While a PWM signal is connected to the  $IN$  terminal, thus determining the switching behavior of  $OUT$  and  $OUTF(C)$ , the  $/INF$  terminal controls if only  $OUT$  or both  $OUT$  and  $OUTF(C)$  follow the input terminal  $IN$ . Since both output terminals  $OUT$  and  $OUTF(C)$  are connected to gate resistors,  $/INF$  determines whether a single or both gate resistors are connected to an IGBT's gate.

Both input terminals contain a pull-down resistor to bias the IC into a safe mode in case the connection to the system control is interrupted. The non-inverting Schmitt trigger receives the input control signal and has CMOS-compatible trigger thresholds with minimum  $V_{IN,L}$  for LOW level and maximum  $V_{IN,H}$  for HIGH level. The input signal at terminal  $IN$  follows a positive logic, while the signal at terminal  $/INF$  follows an active-low logic.

There is a short-pulse suppression filter after the Schmitt trigger with a filter time  $T_{INFLT}$ . All pulses that are below  $T_{INFLT,min}$  will be suppressed, and pulses that are longer than  $T_{INFLT,max}$  will pass the filter and be transmitted to the output side. External RC-filters with time constants of more than 10 ns, for example 1 nF and 10  $\Omega$ , have to be used to further support the integrated short pulse suppression function to filter input noise.

## Functional description



**Figure 6** Timing of input signals with respect of the input filter

All changes at terminal */INF* are acknowledged, if they occur earlier than or simultaneously with a change at terminal *IN*. After a signal edge is applied at terminal *IN*, the signal at terminal */INF* has to be kept for at least  $T_{/INF,hold}$  for its status to be transmitted to the output side.

### 4.3 Output terminal *OUT*

The output terminal *OUT* changes its status according to the status of the input signal at terminal *IN*. A high signal at terminal *IN* determines a high signal at terminal *OUT*. A low signal determines a low signal.

The driver IC's output section at terminal *OUT* provides a rail-to-rail output. This feature allows the tight control of gate voltage during on-state and short circuit to be maintained as long as the driver's supply is stable. The switching behavior of the power transistor is mainly controlled by the gate resistor, due to the low internal voltage drop of the IC. In turn, the low voltage drop reduces the power to be dissipated by the driver.

The active shutdown feature of terminal *OUT* ensures a safe off-state of the power transistor in case the output side is not connected to the power supply or an undervoltage lockout is in effect. The transistor's gate is clamped at terminal *OUT* to *VEE2*.

### 4.4 Output terminal *OUTF*

Terminal *OUTF* is the second output of those gate driver ICs, which have the standard output configuration. *OUTF* changes its status according to the status of the input signals */INF* and *IN*. It turns the power transistor on and off in combination with the terminal *OUT*, so that depending on the status at terminal */INF*, a higher gate current is available, and the switching speed can be modified on the fly. Terminal *OUTF* is also set to clamping mode, if it is not activated for active gate operation. The clamping mode is activated when the gate voltage of the power transistor is below  $V_{CLAMPL}$  during off-state or above  $V_{VCC2} - V_{CLAMPH}$  during on-state. The clamping mode during on-state helps to achieve better short circuit clamping. The on-state clamping is activated after turn-on, as soon as the filter time of  $t_{dCLAMPL}$  is elapsed. A clamping filter time  $t_{dCLAMPL}$  for off-state improves the robustness of the IC's Miller clamp function.

The driver IC's output section at terminal *OUTF* provides a rail-to-rail output. This feature allows the tight control of gate voltage during on-state and short circuit to be maintained as long as the driver's supply is stable. The switching behavior of the power transistor is mainly controlled by the gate resistor, due to the low internal voltage drop of the IC. In turn, the low voltage drop reduces the power to be dissipated by the driver.

Terminal *OUTF* features the active shutdown function. This ensures a safe off-state of the power transistor in case the output side is not connected to the power supply, or the power supply of the output side collapses faster than the UVLO can react. The transistor's gate is clamped at terminal *OUTF* to *VEE2*.

The driving capability of terminal *OUTF* is the same as for terminal *OUT*. *OUTF* and *OUT* can be operated in low resistive connection (i.e. direct paralleling) only if the voltage  $V_{/INF}$  at terminal */INF* is at the corresponding level at any time.

### 4.5 Output terminal *OUTFC*

Terminal *OUTFC* is the second output of those gate driver ICs having the Miller clamp function, i.e. the two-level slew-rate control in for turn-on only. *OUTFC* changes its status according to the status of the input signal */INF*

## Functional description

and *IN*. It turns on the power transistor in combination with terminal *OUT*, so that depending on the status at terminal */INF*, a higher gate current is available and the switching speed can be modified for each PWM edge. Terminal *OUTFC* is not activated during the turn-off transient.

Terminal *OUTFC* is set to clamping mode also if it is not activated for active gate turn-on. The clamping mode is activated when the gate voltage of the power transistor is below  $V_{CLAMPL}$  during off-state or above  $V_{VCC2} - V_{CLAMPH}$  during on-state. The clamping mode during on-state helps to achieve better short circuit clamping. The on-state clamping is activated after turn-on, as soon as the filter time of  $t_{dCLAMPH}$  is elapsed. A clamping filter time  $t_{dCLAMPL}$  for off-state improves the robustness of the IC's Miller clamp function.

The clamping capability of the output *OUTFC* during off-state of the power transistor is identical to turn-off current capability terminal *OUT*.

The driver IC's output section at terminal *OUTFC* provides a rail-to-rail output. This feature allows the tight control of gate voltage during on-state and short circuit to be maintained as long as the driver's supply is stable. The switching behavior of the power transistor is mainly controlled by the gate resistor, due to the low internal voltage drop of the IC. In turn, the low voltage drop reduces the power to be dissipated by the driver.

Terminal *OUTFC* features the active shutdown function. This ensures a safe off-state of the power transistor in case the output side is not connected to the power supply, or the power supply of the output side collapses faster than the UVLO can react. The transistor's gate is clamped at terminal *OUTFC* to *VEE2*.

The driving capability of terminal *OUTFC* is the same as for terminal *OUT*. *OUTFC* and *OUT* can be operated in low resistive connection (i.e. direct paralleling) only if the voltage  $V_{/INF}$  at terminal */INF* is at the corresponding level at any time.

## 4.6 Input-to-output control scheme

The two-level slew rate control IC family can activate the additional output *OUTF* or *OUTFC* depending on the input signals at the terminals *IN* and */INF*. The relationship between input signals and output signals is defined in the table below.

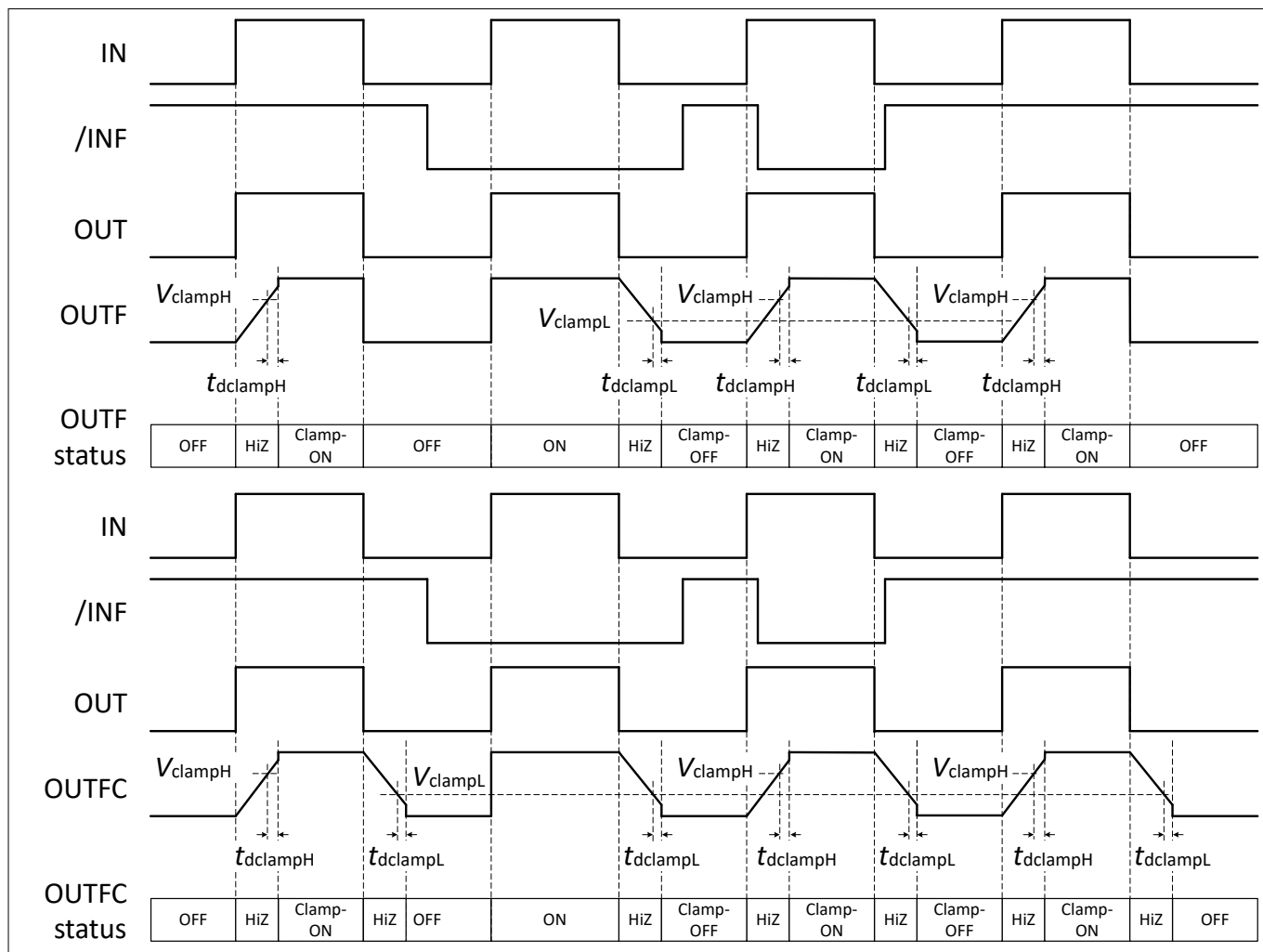
**Table 2** Input-to-output control scheme

| State        | <i>IN</i> | <i>/INF</i> | <i>OUT</i> | <i>OUTF</i><br>(1ED3240MC12H,<br>1ED3241MC12H) | <i>OUTFC</i><br>(1ED3250MC12H,<br>1ED3251MC12H) |
|--------------|-----------|-------------|------------|--|---|
| 1            | 0         | 0           | 0          | 0*   | 0*  |
| 2            | 0 → 1     | 0           | 0 → 1      | 0 → 1  | 0 → 1   |
| 3            | 0         | 0 → 1       | 0          | 0*   | 0*  |
| 4            | 1         | 0           | 1          | 1*   | 1*  |
| 5            | 1 → 0     | 0           | 1 → 0      | 1 → HiZ  | 1 → HiZ   |
| 6            | 1         | 0 → 1       | 1          | 1*   | 1*  |
| 7            | 0         | 1           | 0          | 0*   | 0*  |
| 8            | 0         | 1 → 0       | 0          | 0*   | 0*  |
| 9            | 0 → 1     | 1           | 0 → 1      | 0 → HiZ  | 0 → HiZ   |
| 10           | 1         | 1           | 1          | 1*   | 1*  |
| 11           | 1         | 1 → 0       | 1          | 1*   | 1*  |
| 12           | 1 → 0     | 1           | 1 → 0      | 1 → 0  | 1 → HiZ   |
| Input UVLO↓  | X         | X           | 0          | last <i>/INF</i>                               | last <i>/INF</i>                                |
| Output UVLO↓ | X         | X           | 0          | HiZ  | HiZ   |

## Functional description

\*) Output is activated when the voltage at terminal *OUTF* or *OUTFC* is higher than  $V_{VCC2} - V_{CLAMPH}$  during on-state, or lower than  $V_{CLAMPL}$  during off-state.

The control scheme of the gate driver IC family inherently avoids the activation of the two outputs *OUT* or *OUTF* / *OUTFC* in active opposite status. Both outputs *OUTF* and *OUTFC* can have the states 1, 0 and high impedance (HiZ) according to the table above. The status of terminal */INF* can be changed pulse-by-pulse with a short delay with respect to a potential change of status at terminal *IN* according to the timing diagrams below.



**Figure 7** Timing diagram of input and output signals for standard version (top) and clamp version (bottom)

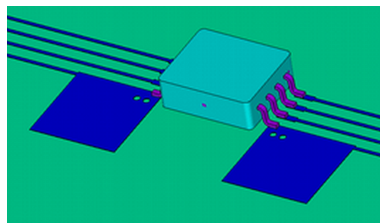
## 5 Electrical characteristics and parameters

### 5.1 Absolute maximum ratings

Absolute maximum ratings are defined as ratings, that can lead to the destruction of the integrated circuit, if exceeded. Unless otherwise noted all parameters refer to terminal *GND1*.

**Table 3 Absolute maximum ratings**

| Parameter  | Symbol                | Values                  |                         | Unit | Note or test condition   |
|--|-----------------------|-------------------------|-------------------------|------|--|
|  |                       | Min.                    | Max.                    |      |  |
| Input to output offset voltage                                 | $V_{\text{OFFSET}}$   |                         | 2300                    | V    | $V_{\text{VEE2,max}} - V_{\text{VEE2,min}}$<br>with $V_{\text{VEE2,max}} \geq V_{\text{GND1}}$<br>$\geq V_{\text{VEE2,min}}$ <sup>1)2)</sup> |
| Power supply input side  | $V_{\text{VCC1}}$     | -0.3                    | 15                      | V    |  |
| Power supply input side  | $V_{\text{VCC1,dyn}}$ | -0.3                    | 17                      | V    | $t < 1 \mu\text{s}$ <sup>3)</sup>  |
| Logic input voltages ( <i>IN</i> , <i>/INF</i> )               | $V_{\text{IN}}$       | -0.3                    | 15                      | V    |  |
| Dynamic logic input voltages ( <i>IN</i> , <i>/INF</i> )       | $V_{\text{IN,dyn}}$   | -0.3                    | 17                      | V    | $t < 1 \mu\text{s}$ <sup>3)</sup>  |
| Power supply output side                                       | $V_{\text{VCC2}}$     | -0.3                    | 40                      | V    | with respect to <i>VEE2</i>  |
| Gate driver output ( <i>OUT</i> , <i>OUTF</i> , <i>OUTFC</i> ) | $V_{\text{OUT}}$      | $V_{\text{VEE2}} - 0.3$ | $V_{\text{VCC2}} + 0.3$ | V    | with respect to <i>VEE2</i>  |
| Junction temperature   | $T_{\text{J}}$        | -40                     | 150                     | °C   |  |
| Storage temperature  | $T_{\text{stg}}$      | -55                     | 150                     | °C   |  |
| Power dissipation (input side)                                 | $P_{\text{D,IN}}$     | -                       | 100                     | mW   | $T_{\text{A}} = 85 \text{ °C}$ , 1s0p <sup>4)</sup>  |
| Power dissipation (output side)                                | $P_{\text{D,OUT}}$    | -                       | 625                     | mW   | $T_{\text{A}} = 85 \text{ °C}$ , 1s0p <sup>5)</sup>  |
| Thermal resistance (input side)                                | $R_{\text{THJA,IN}}$  | -                       | 104                     | K/W  | $T_{\text{A}} = 85 \text{ °C}$ , 1s0p  |
| Thermal resistance (output side)                               | $R_{\text{THJA,OUT}}$ | -                       | 104                     | K/W  | $T_{\text{A}} = 85 \text{ °C}$ , 1s0p  |
| ESD capability   | $V_{\text{ESD,HBM}}$  | -                       | 4                       | kV   | <sup>6)</sup>  |
|  | $\text{ESD,CDM}$      | -                       | TC 1000                 |      | <sup>7)</sup>  |



**Figure 8 Reference layout for thermal data (1s0p, 2 x 50 mm<sup>2</sup> cooling area, Copper thickness 35 μm)**

This PCB layout represents the reference layout used for the thermal characterization of the 300 mil package.

<sup>1</sup> For functional isolation only

<sup>2</sup> See also: Insulation characteristics

<sup>3</sup> Parameter is not subject of production test - verified by design/ characterization

<sup>4</sup> IC output-side power dissipation is derated linearly with 9.62 mW/°C above 139,6 °C

<sup>5</sup> IC output-side power dissipation is derated linearly with 9.62 mW/°C above 85 °C

<sup>6</sup> According to ANSI/ESDA/JEDEC-JS-001-2017

<sup>7</sup> According to ANSI/ESDA/JEDEC-JS-002-2014, TC = test condition in Volt

**Electrical characteristics and parameters**

## 5.2 Operating parameters

The IC operates as described in the functional description within the operating parameters. Unless otherwise noted all parameters refer to GND1.

**Table 4 Operating parameters**

| Parameter                             | Symbol          | Values |      | Unit              | Note or test condition              |
|---------------------------------------|-----------------|--------|------|-------------------|-------------------------------------|
|                                       |                 | Min.   | Max. |                   |                                     |
| Power supply output side              | $V_{VCC2}$      | 10     | 35   | V                 |                                     |
| Power supply input side               | $V_{VCC1}$      | 3      | 15   | V                 |                                     |
| Logic input voltages ( $IN$ , $INF$ ) | $V_{IN}$        | -0.3   | 5.5  | V                 |                                     |
| Ambient temperature                   | $T_A$           | -40    | 125  | °C                |                                     |
| Thermal coefficient, junction-top     | $\psi_{TH, JT}$ | -      | 6.8  | K/W               | $T_A = \text{tbd } ^\circ\text{C}$  |
| Common mode transient immunity (CMTI) | $ CMTI $        | -      | 200  | kV/ $\mu\text{s}$ | $V_{OFFSET, test} = 1500 \text{ V}$ |

## 5.3 Eletrical characteristics

The electrical characteristics include the spread of values in supply voltages, load and junction temperatures given below. Typical values represent the median values at  $V_{VCC1} = 5 \text{ V}$ ,  $V_{VCC2} = 15 \text{ V}$ , and  $T_A = 25^\circ\text{C}$ . Unless otherwise noted all voltages are given with respect to their respective reference  $GND1$  or  $VEE2$ .

### 5.3.1 Power supply

**Table 5 Power supply**

| Parameter                        | Symbol       | Values |      |      | Unit          | Note or test condition |
|----------------------------------|--------------|--------|------|------|---------------|------------------------|
|                                  |              | Min.   | Typ. | Max. |               |                        |
| UVLO threshold input side (on)   | $V_{UVLOH1}$ | -      | 2.85 | 3.1  | V             |                        |
| UVLO threshold input side (off)  | $V_{UVLOL1}$ | 2.5    | 2.65 | -    | V             |                        |
| UVLO hysteresis input side       | $V_{HYS1}$   | 0.1    | 0.2  | -    | V             |                        |
| UVLO threshold output side (on)  | $V_{UVLOH2}$ | -      | 11.8 | 12.5 | V             |                        |
| UVLO threshold output side (off) | $V_{UVLOL2}$ | 10.4   | 10.8 | -    | V             |                        |
| UVLO hysteresis output side      | $V_{HYS2}$   | 0.8    | -    | -    | V             |                        |
| Quiescent current input side     | $I_{Q1}$     | -      | 1.2  | 1.4  | mA            |                        |
| Quiescent current output side    | $I_{Q2}$     | -      | 1.9  | 2.3  | mA            |                        |
| Start up time <sup>8)</sup>      | $t_{START}$  | -      | 7.4  | 20   | $\mu\text{s}$ |                        |

### 5.3.2 Logic input

**Table 6 Logic input**

| Parameter                                | Symbol      | Values |      |      | Unit | Note or test condition |
|--|-------------|--------|------|------|------|------------------------|
|  |             | Min.   | Typ. | Max. |      |                        |
| $IN$ , $INF$ low-input threshold voltage | $V_{IN, L}$ | 1      | 1.2  | -    | V    |                        |

(table continues...)

<sup>8</sup> Parameter is not subject of production test - verified by design/ characterization

**Electrical characteristics and parameters**

**Table 6 (continued) Logic input**

| Parameter                                      | Symbol          | Values |      |      | Unit | Note or test condition |
|--|-----------------|--------|------|------|------|------------------------|
|  |                 | Min.   | Typ. | Max. |      |                        |
| $I_{IN}$ , $/INF$ high-input threshold voltage | $V_{IN,H}$      | -      | 2.1  | 2.3  | V    |                        |
| $I_{IN}$ , $/INF$ low/high hysteresis          | $V_{IN,HYS}$    | 0.7    | -    |      | V    |                        |
| $I_{IN}$ , $/INF$ input current                | $I_{IN}$        | -      | -    | 100  | μA   | $V_{IN} = V_{VCC1}$    |
| $I_{IN}$ , $/INF$ pull-down resistor           | $R_{IN,PD}$     | -      | 75   | -    | kΩ   |                        |
| $/INF$ hold time <sup>9)</sup>                 | $t_{/INF,hold}$ | 50     | -    | -    | ns   |                        |

### 5.3.3 Gate driver

**Table 7 Gate driver**

| Parameter  | Symbol          | Values |      |      | Unit | Note or test condition                             |
|--|-----------------|--------|------|------|------|--|
|  |                 | Min.   | Typ. | Max. |      |  |
| High-level output peak current ( $OUT$ , $OUTF$ , $OUTFC$ , 1ED32x0MC12H) <sup>10)</sup> | $I_{OH}$        | -      | 5    | -    | A    | Output on  |
| Low-level output peak current ( $OUT$ , $OUTF$ , 1ED3240MC12H) <sup>10)</sup>            | $I_{OL}$        | -      | 5    | -    | A    | Output off   |
| High-level output resistance ( $OUT$ , $OUTF$ , $OUTFC$ , 1ED32x0MC12H)                  | $R_{OH,1}$      | -      | 0.92 | 1.47 | Ω    | Output on, $I_{OH} = 0.1$ A                        |
| Low-level output resistance ( $OUT$ , $OUTF$ , $OUTFC$ , 1ED32x0MC12H)                   | $R_{OL,1}$      | -      | 0.73 | 1.1  | Ω    | Output off, $I_{OL} = 0.1$ A                       |
| High-level output peak current ( $OUT$ , $OUTF$ , $OUTFC$ , 1ED32x1MC12H) <sup>10)</sup> | $I_{OH}$        | -      | 9    | -    | A    | Output on  |
| Low-level output peak current ( $OUT$ , $OUTF$ , 1ED3241MC12H) <sup>10)</sup>            | $I_{OL}$        | -      | 9    | -    | A    | Output off   |
| High-level output resistance ( $OUT$ , $OUTF$ , $OUTFC$ , 1ED32x1MC12H)                  | $R_{OH,2}$      | -      | 0.51 | 0.81 | Ω    | Output on, $I_{OH} = 0.1$ A                        |
| Low-level output resistance ( $OUT$ , $OUTF$ , $OUTFC$ , 1ED32x1MC12H)                   | $R_{OL,2}$      | -      | 0.42 | 0.63 | Ω    | Output off, $I_{OL} = 0.1$ A                       |
| High-level output voltage ( $OUT$ , $OUTF$ , $OUTFC$ )                                   | $\Delta V_{OH}$ | -      | -    | 0.1  | V    | Output on, $V_{VCC2} - V_{OH}$ ; $I_{OH} = 20$ mA  |
| Low-level output voltage ( $OUT$ , $OUTF$ , $OUTFC$ )                                    | $\Delta V_{OL}$ | -      | -    | 0.1  | V    | Output off, $V_{VCC2} - V_{OH}$ ; $I_{OH} = 20$ mA |
| Low-level clamp peak current ( $OUTF$ , $OUTFC$ ) <sup>10)</sup>                         | $I_{CLAMPL}$    | -      | 2.1  | -    | A    | $V_{OL} = 2$ V                                     |

**(table continues...)**

<sup>9</sup> Parameter is not subject of production test - verified by design/ characterization

<sup>10</sup> Parameter is not subject of production test - verified by design/ characterization

**Electrical characteristics and parameters**

**Table 7 (continued) Gate driver**

| Parameter  | Symbol        | Values |      |      | Unit | Note or test condition  |
|--|---------------|--------|------|------|------|---|
|  |               | Min.   | Typ. | Max. |      |   |
| Short-circuit clamp voltage between <i>OUT</i> / <i>OUTF</i> / <i>OUTFC</i> and <i>VCC2</i> <sup>10)</sup> | $V_{CLP}$     | -      | -    | 1.3  | V    | Output on, $I_{OH} = 500\text{ mA}$ , $t < 10\text{ }\mu\text{s}$ |
| Active Miller clamp threshold voltage OFF ( <i>OUTF</i> , <i>OUTFC</i> )                                   | $V_{CLAMPL}$  | -      | 2    | 2.5  | V    | $V_{OL} - V_{VEE2}$ , $V_{/INF} = 0$                              |
| Clamping ON threshold voltage ( <i>OUTF</i> , <i>OUTFC</i> )   | $V_{CLAMPH}$  | 0.5    | 1    | -    | V    | $V_{VCC2} - V_{OH}$ , $V_{/INF} = 1$                              |
| Active Miller clamp delay time ( <i>OUTF</i> , <i>OUTFC</i> ) <sup>10)</sup>                               | $t_{dCLAMPL}$ | -      | -    | 80   | ns   | $V_{OL} \leq V_{VEE2} + V_{CLAMPL}$ , $V_{/INF} = 1$              |
| Clamping ON delay time (IGBT variants, <i>OUTF</i> , <i>OUTFC</i> ) <sup>10)</sup>                         | $t_{dCLAMPH}$ | -      | 890  | -    | ns   | $V_{OH} \geq V_{VCC2} - V_{CLAMPH}$ , $V_{/INF} = 1$              |

### 5.3.4 Dynamic characteristics

The load capacitance is 100 pF if not otherwise noted.

**Table 8 Dynamic characteristics**

| Parameter   | Symbol           | Values |      |      | Unit | Note or test condition                  |
|---|------------------|--------|------|------|------|---|
|   |                  | Min.   | Typ. | Max. |      |   |
| Input-to-output propagation delay ON  | $t_{PDON}$       | -      | -    | 110  | ns   | /N turn-on threshold to 10% output on   |
| Input-to-output propagation delay OFF   | $t_{PDOFF}$      | -      | -    | 110  | ns   | /N turn-off threshold to 90% output off |
| Input-to-output propagation delay distortion ( $t_{PDOFF} - t_{PDON}$ )                             | $t_{PDISTO}$     | -10    | 0    | 5    | ns   |   |
| Input-pulse suppression time  | $t_{INFLT}$      | 30     | -    | 40   | ns   |   |
| Input-to-output propagation delay mismatch <i>OUT</i> vs. <i>OUTF</i> / <i>OUTFC</i> <sup>11)</sup> | $t_{PDOUT-OUTF}$ | -      | <1   | -    | ns   |   |
| Input-to-output, part to part propagation delay variation   | $t_{PD,P2P}$     | -      | -    | 15   | ns   |   |
| Input-to-output propagation delay variation due to temperature                                      | $t_{PD,T}$       | -5     | -    | 12   | ns   |   |
| Rise time   | $t_{RISE}$       | -      | 1.6  | 15   | ns   | $C_{LOAD} = 100\text{ pF}$              |
| Fall time   | $t_{FALL}$       | -      | 1.5  | 15   | ns   | $C_{LOAD} = 100\text{ pF}$              |
| Rise time   | $t_{RISE}$       | -      | 9    | 30   | ns   | $C_{LOAD} = 1\text{ nF}$                |
| Fall time   | $t_{FALL}$       | -      | 8.5  | 30   | ns   | $C_{LOAD} = 1\text{ nF}$                |

<sup>10)</sup> Parameter is not subject of production test - verified by design/ characterization

<sup>11)</sup> Parameter is not subject of production test - verified by design/ characterization

**Isolation ratings and characteristics**

### 5.3.5 Active shutdown

**Table 9 Active shutdown**

| Parameter               | Symbol        | Values |      |      | Unit | Note or test condition                  |
|-------------------------|---------------|--------|------|------|------|---|
|                         |               | Min.   | Typ. | Max. |      |   |
| Active shutdown voltage | $V_{ACTSD,L}$ | -      | 1.5  | 2.0  | V    | $I_O = 10 \text{ mA}$ ; $V_{VCC2}$ open |

## 6 Isolation ratings and characteristics

### 6.1 Safety limiting values

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

**Table 10 Safety limiting values**

| Description  | Symbol   | Characteristic | Unit |
|--|----------|----------------|------|
| Maximum ambient safety temperature   | $T_S$    | 150            | °C   |
| Maximum input-side power dissipation at $T_A = 25^\circ\text{C}$ <sup>12)</sup>  | $P_{SI}$ | 100            | mW   |
| Maximum output-side power dissipation at $T_A = 25^\circ\text{C}$ <sup>13)</sup> | $P_{SO}$ | 1100           | mW   |

### 6.2 Certified according to VDE 0884-11 for reinforced insulation

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

**Table 11 Reinforced insulation ratings according to VDE 0884-11**

| Description  | Symbol     | Characteristic                | Unit     |
|--|------------|-------------------------------|----------|
| Installation classification per EN 60664-1, Table 1<br>for rated mains voltage $\leq 150 \text{ V (rms)}$<br>for rated mains voltage $\leq 300 \text{ V (rms)}$<br>for rated mains voltage $\leq 600 \text{ V (rms)}$<br>for rated mains voltage $\leq 1000 \text{ V (rms)}$ |            | I-IV<br>I-IV<br>I-III<br>I-II | –        |
| Climatic classification  |            | 40/125/21                     | –        |
| Pollution degree (EN 60664-1)  |            | 2                             | –        |
| Minimum external clearance   | $CLR$      | $>8$                          | mm       |
| Minimum external creepage  | $CPG$      | $>8$                          | mm       |
| Minimum comparative tracking index   | $CTI$      | 400                           | –        |
| Maximum repetitive insulation voltage  | $V_{IORM}$ | 1767                          | V (peak) |
| Highest allowable overvoltage  | $V_{IOTM}$ | 8000                          | V (peak) |

**(table continues...)**

<sup>12)</sup> IC input-side power dissipation is derated linearly at 9.62 mW/°C above 139.6 °C

<sup>13)</sup> IC output-side power dissipation is derated linearly at 7.35 mW/°C above 25 °C

## Timing diagrams

**Table 11** (continued) Reinforced insulation ratings according to VDE 0884-11

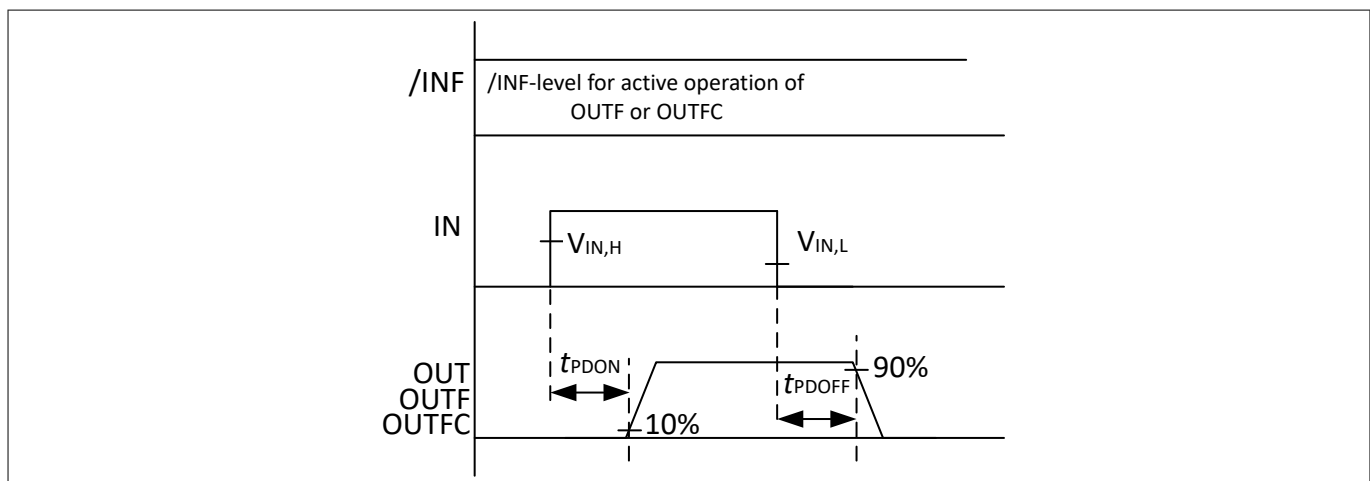
| Description  | Symbol     | Characteristic | Unit     |
|--|------------|----------------|----------|
| Maximum surge insulation voltage   | $V_{IOSM}$ | 6875           | V (peak) |
| Surge insulation test voltage $V_{TEST} = V_{IOSM} \times 1.6$   |            |                |          |
| Apparent charge, method a<br>$V_{pd(ini),a} = V_{IOTM}$ , $V_{pd(m)} = 1.6 \times V_{IORM}$ , $t_{ini} = 1 \text{ min}$              | $q_c$      | <5             | pC       |
| Apparent charge, method b<br>$V_{pd(ini),b} = 1.2 \times V_{IOTM}$ , $V_{pd(m)} = 1.875 \times V_{IORM}$ , $t_{ini,b} = 1 \text{ s}$ | $q_c$      | <5             | pC       |
| Insulation resistance at $T_{A, \max}$   | $R_{IO}$   | $> 10^{11}$    | $\Omega$ |
| Insulation resistance at $T_S$   | $R_{IO}$   | $> 10^9$       | $\Omega$ |
| Insulation capacitance   | $C_{IO}$   | 1.66           | pF       |

## 6.3 Recognized under UL 1577 (File E311313)

**Table 12** Recognized under UL 1577

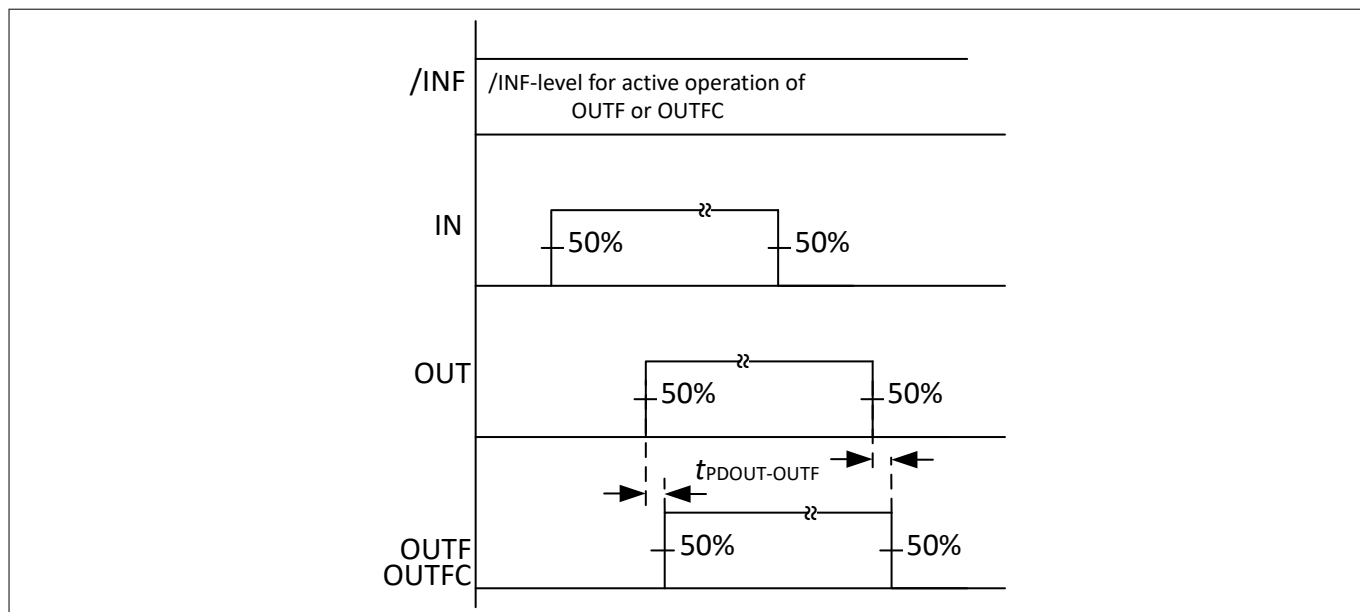
| Description                        | Symbol          | Characteristic | Unit    |
|------------------------------------|-----------------|----------------|---------|
| Insulation withstand voltage/1 min | $V_{ISO}$       | 5700           | V (rms) |
| Insulation test voltage/1 s        | $V_{ISO, TEST}$ | 6840           | V (rms) |

## 7 Timing diagrams

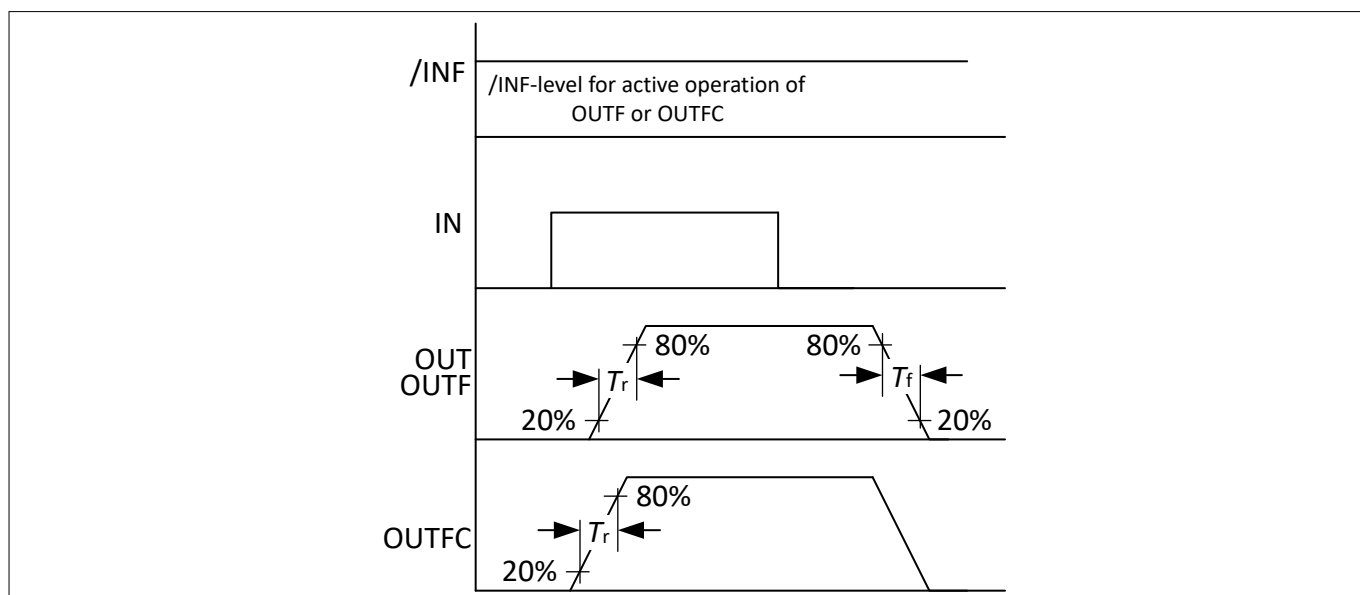


**Figure 9** Propagation delay

**Timing diagrams**

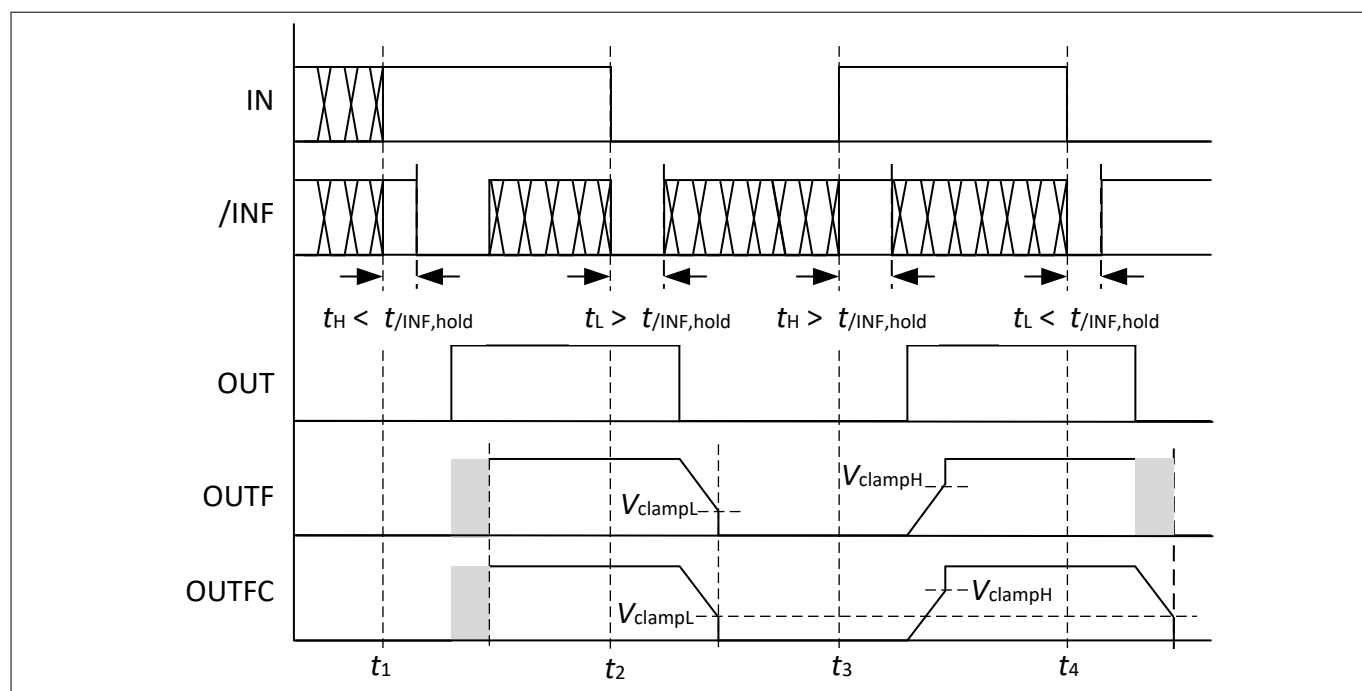


**Figure 10** **OUT - OUTF/OUTFC propagation delay mismatch**



**Figure 11** **Rise and fall time**

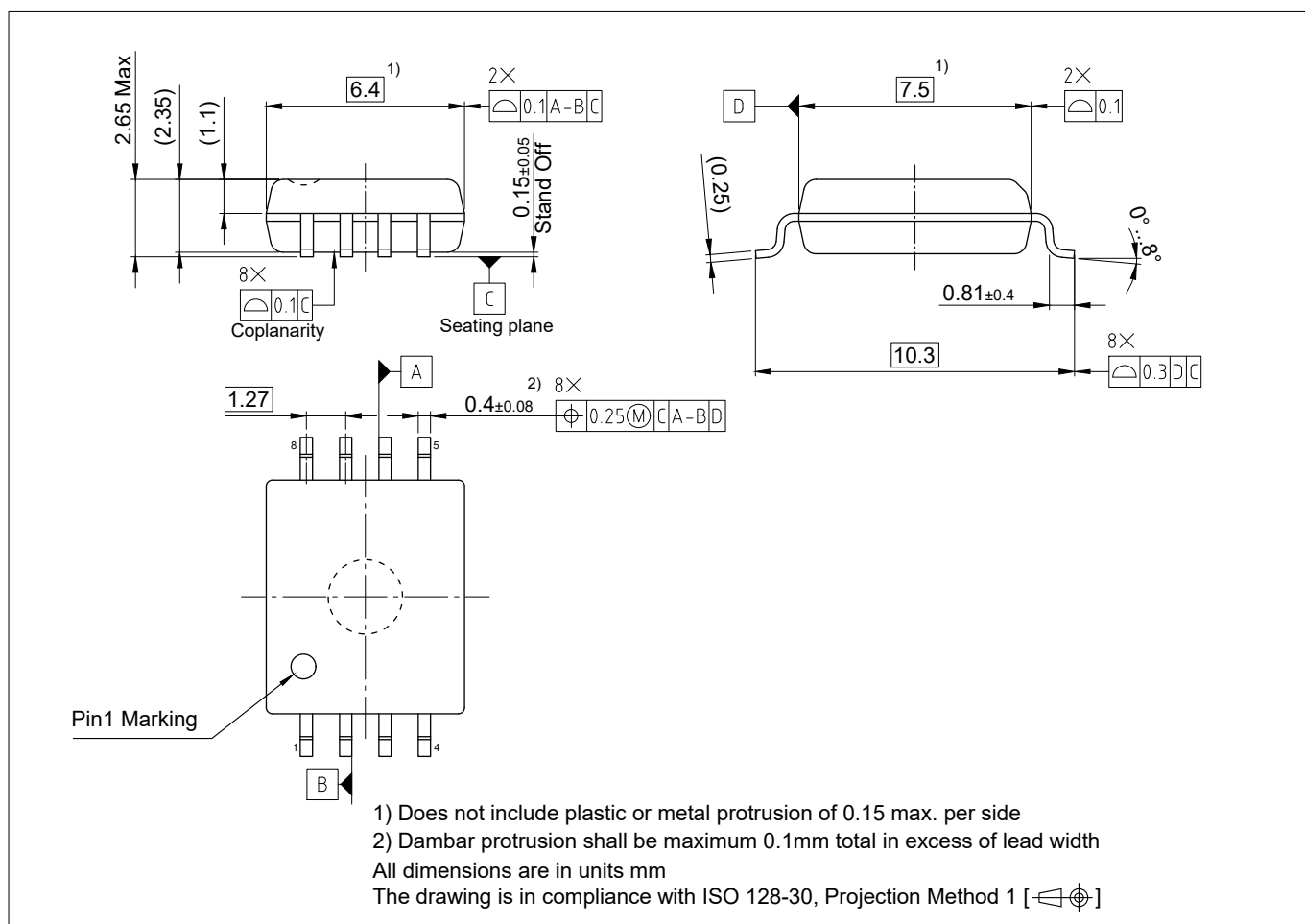
**Timing diagrams**



**Figure 12** /INF hold time

**Package dimensions**

## 8 Package dimensions



**Figure 13 PG-DSO-8-66 (Plastic (green) dual small outline package)**

## Revision history

| Document version | Date of release | Description of changes  |
|------------------|-----------------|---|
| 2.0              | 9.4.2021        | initial release   |
|                  | 1.9.2021        | New version number schema: Target/Preliminary datasheet: 0.XY; Final datasheet: 1.XY  |
| 1.10             | 15.2.2023       | Updated feature list and potential applications, corrected caption of fig. 1, updated related products, updated certification status, added marking information, corrected second paragraph of subchapter "Output terminal OUTFC", updated links to Evaluation Boards, corrected fig. 7 |

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