

EiceDRIVER™

2ED020I12-F2

Dual IGBT Driver IC

Final Data Sheet

Rev. 2.0, 2012-06-05

Industrial Power Control

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## 1 Overview

### Main Features

- Dual channel isolated IGBT Driver
- For 600V/1200 V IGBTs
- 2 A rail-to-rail output
- Vcesat-detection
- Active Miller Clamp

### Product Highlights

- Coreless transformer isolated driver
- Galvanic Insulation
- Integrated protection features
- Small footprint
- Suitable for operation at high ambient temperature

### Typical Application

- AC and Brushless DC Motor Drives
- High Voltage DC/DC-Converter
- UPS-Systems
- Welding

### Description

The 2ED020I12-F2 is a galvanic isolated dual channel IGBT driver in PG-DSO-36-58 package that provides two fully independent driver outputs with a current capability of typically 2A.

All logic pins are 5V 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 2ED020I12-F2 provides several protection features like IGBT desaturation protection, active Miller clamping and active shut down.



| Product Name | Gate Drive Current | Package      |
|--------------|--------------------|--------------|
| 2ED020I12-F2 | ±2 A               | PG-DSO-36-58 |

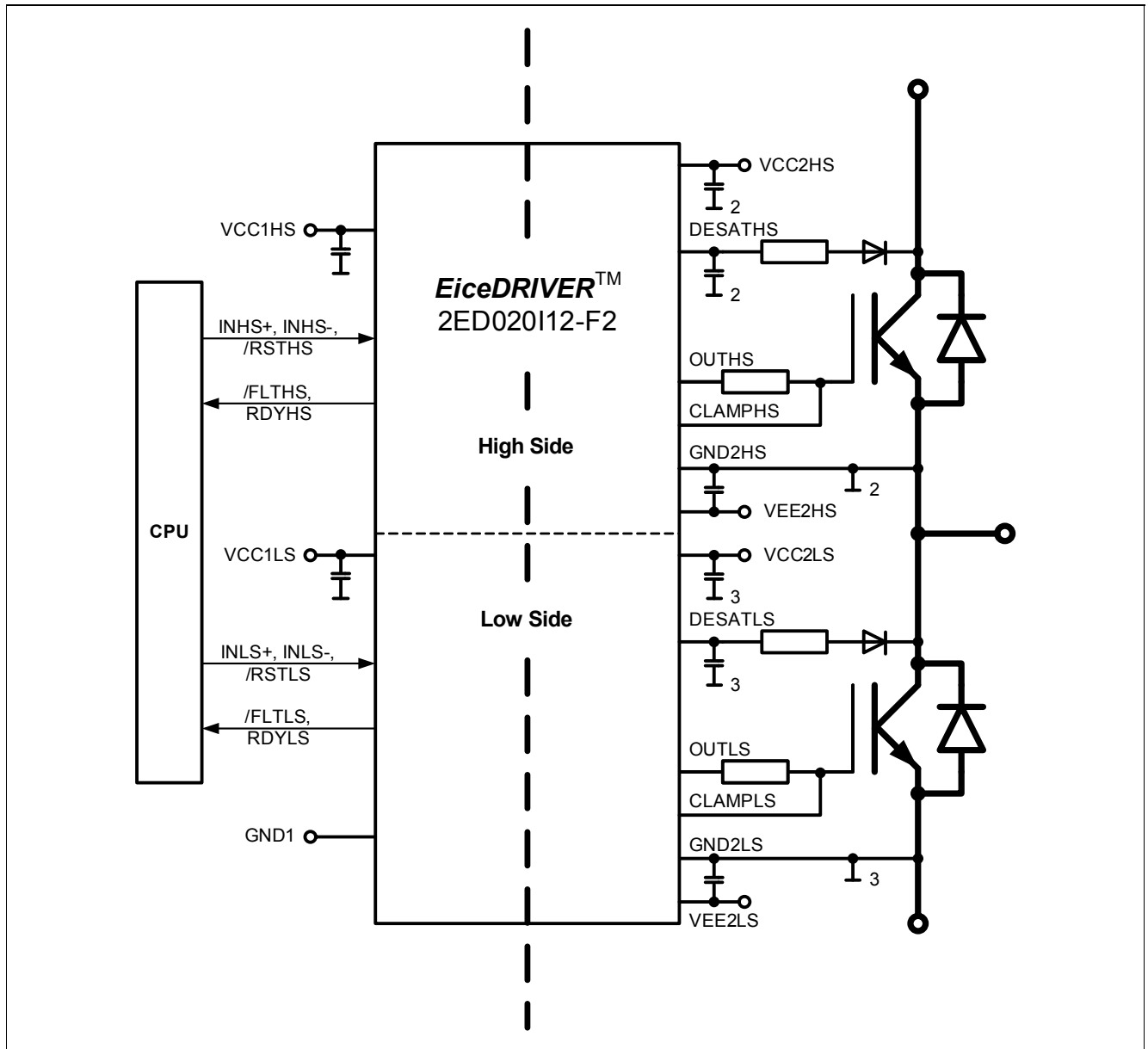


Figure 1 Typical Application

## 2 Block Diagram

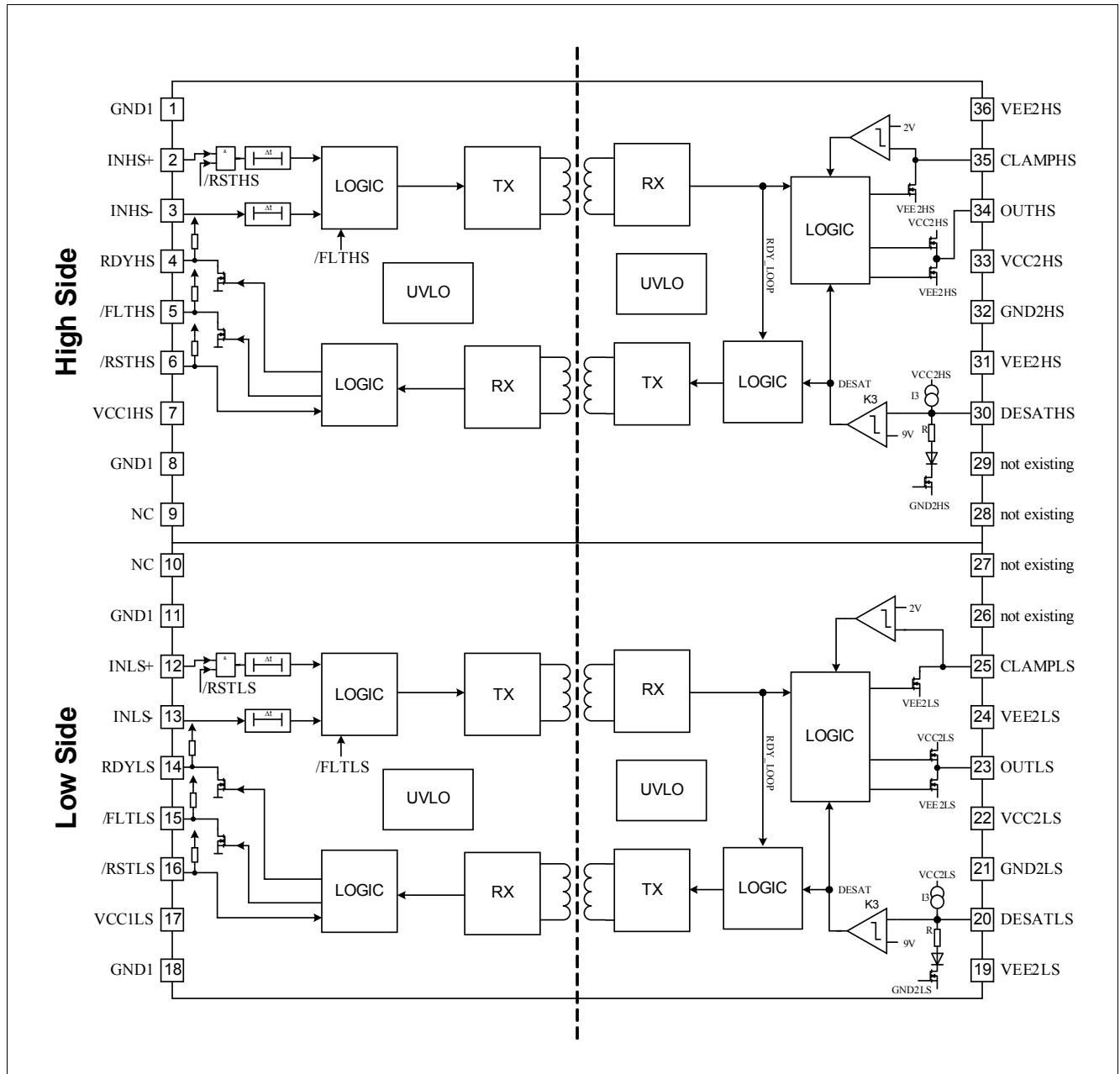


Figure 2 Block Diagram 2ED020112-F2

## 3 Pin Configuration and Functionality

### 3.1 Pin Configuration

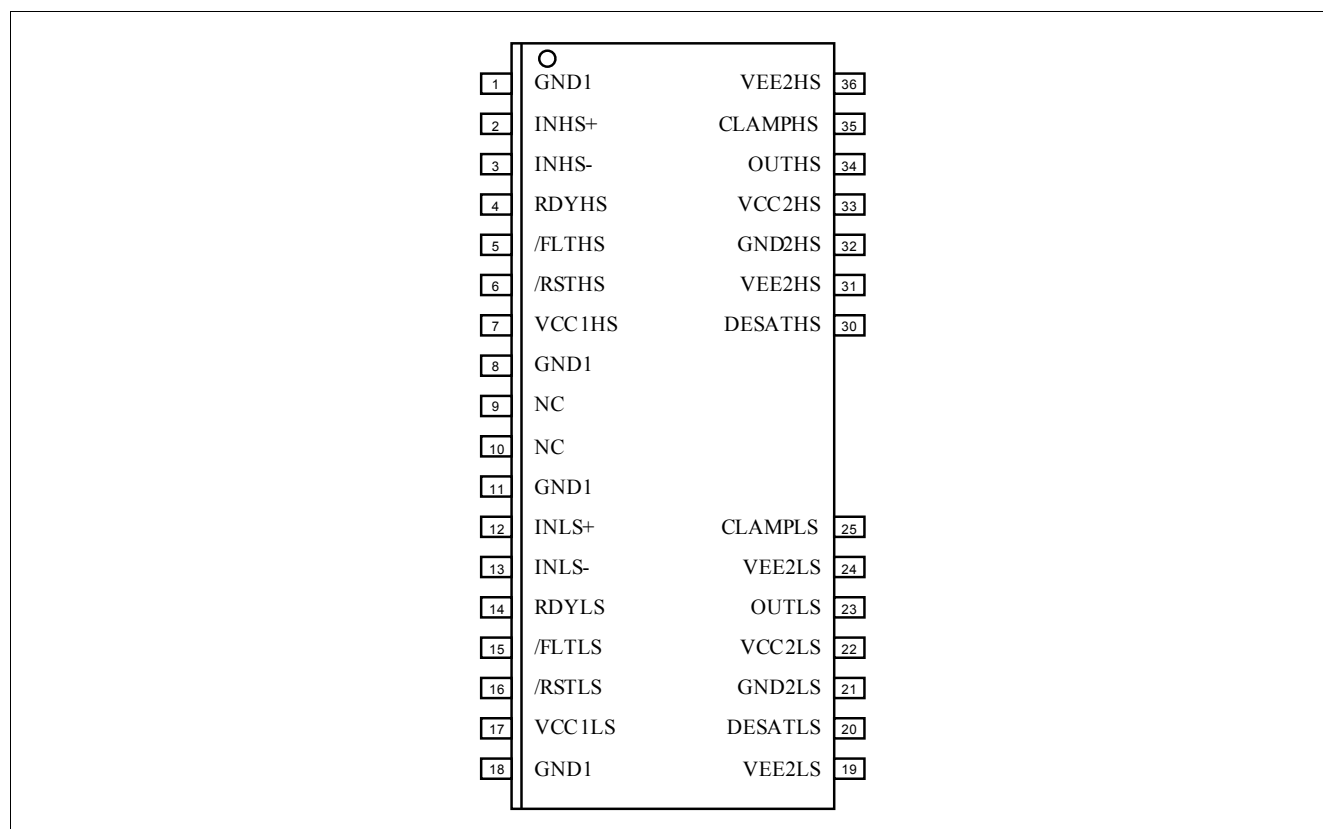
Remark: xxxHS and xxxLS at the end of pin name only indicate an order for description, both drivers are isolated and could be used as high side or low side without any preference.

**Table 1 Pin Configuration**

| Pin No. | Name    | Function                                 |
|---------|---------|------------------------------------------|
| 1       | GND1    | Common ground input side                 |
| 2       | INHS+   | Non inverted driver input high side      |
| 3       | INHS-   | Inverted driver input high side          |
| 4       | RDYHS   | Ready output high side                   |
| 5       | /FLT HS | Inverted fault output high side          |
| 6       | /RST HS | Inverted reset input high side           |
| 7       | VCC1HS  | Positive power supply input high side    |
| 8       | GND1    | Common ground input side                 |
| 9       | NC      | Not used, internally connected to Pin 10 |
| 10      | NC      | Not used, internally connected to Pin 9  |
| 11      | GND1    | Common ground input side                 |
| 12      | INLS+   | Non inverted driver input low side       |
| 13      | INLS-   | Inverted driver input lowside            |
| 14      | RDYLS   | Ready output low side                    |
| 15      | /FLT LS | Inverted fault output low side           |
| 16      | /RST LS | Inverted reset input low side            |
| 17      | VCC1LS  | Positive power supply input low side     |
| 18      | GND1    | Common ground input side                 |
| 19      | VEE2LS  | Negative power supply low side driver    |
| 20      | DESATLS | Desaturation protection low side driver  |
| 21      | GND2LS  | Signal ground low side driver            |
| 22      | VCC2LS  | Power supply low side driver             |
| 23      | OUTLS   | Output low side driver                   |
| 24      | VEE2LS  | Negative power supply low side driver    |
| 25      | CLAMPLS | Miller clamping low side driver          |
| 26      |         | Pin not existing, cut out                |
| 27      |         | Pin not existing, cut out                |
| 28      |         | Pin not existing, cut out                |
| 29      |         | Pin not existing, cut out                |
| 30      | DESATHS | Desaturation protection high side driver |
| 31      | VEE2HS  | Negative power supply high side driver   |

**Table 1** Pin Configuration (cont'd)

| Pin No. | Name    | Function                               |
|---------|---------|----------------------------------------|
| 32      | GND2HS  | Signal ground high side driver         |
| 33      | VCC2HS  | Power supply high side driver          |
| 34      | OUTHHS  | Output high side driver                |
| 35      | CLAMPHS | Miller clamping high side driver       |
| 36      | VEE2HS  | Negative power supply high side driver |



**Figure 3** PG-DSO-36-58 (top view)

### 3.2 Pin Functionality

Remark: xxxHS and xxxLS at the end of pin name only indicate an order for description, both drivers are isolated and could be used as high side or low side without any preference.

#### GND1

Common ground connection of the input side.

#### INHS+, INLS+ Non Inverting Driver Input

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

**INHS–, INLS– Inverting Driver Input**

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

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

**/RSTHS, /RSTLS Reset Input**

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

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

**/FLTHS, /FLTLS Fault Output**

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

**RDYHS, RDYLS Ready Status Output**

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

**VCC1HS, VCC1LS Positive Supply**

5 V power supply of the input chip

**VEE2HS, VEE2LS Negative Supply**

Negative power supply pins of the output chip. If no negative supply voltage is available, both pins have to be connected to GND2xx.

**DESATHS, DESATLS 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.

**CLAMPHS, CLAMPLS 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 2 V below VEE2xx.

**GND2HS, GND2LS Reference Ground**

Reference ground of the output chip.

**OUTHs, OUTLS Driver Output**

Output pin to drive an IGBT. The voltage is switched between VEE2xx and VCC2xx. In normal operating mode Vout is controlled by INxx+, INxx- and /RSTxx. During error mode (UVLO, internal error or DESATxx Vout is set to VEE2xx independent of the input control signals.

**VCC2HS, VCC2LS Positive Supply**

Positive power supply pin of the output side.

## 4 Functional Description

### 4.1 Introduction

The 2ED020I12-F2 is an advanced IGBT dual gate driver that can be also used for driving power MOS devices. Control and protection functions are included to make possible the design of high reliability systems.

The device consists of two galvanic separated driver. The input can be directly connected to a standard 5 V DSP or microcontroller with CMOS in/output and the output driver are connected to the high side and low side switch.

The rail-to-rail driver outputs 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.

The device also includes IGBT desaturation protection with FAULT status outputs.

Two READY status outputs reports if the device is supplied and operates correctly.

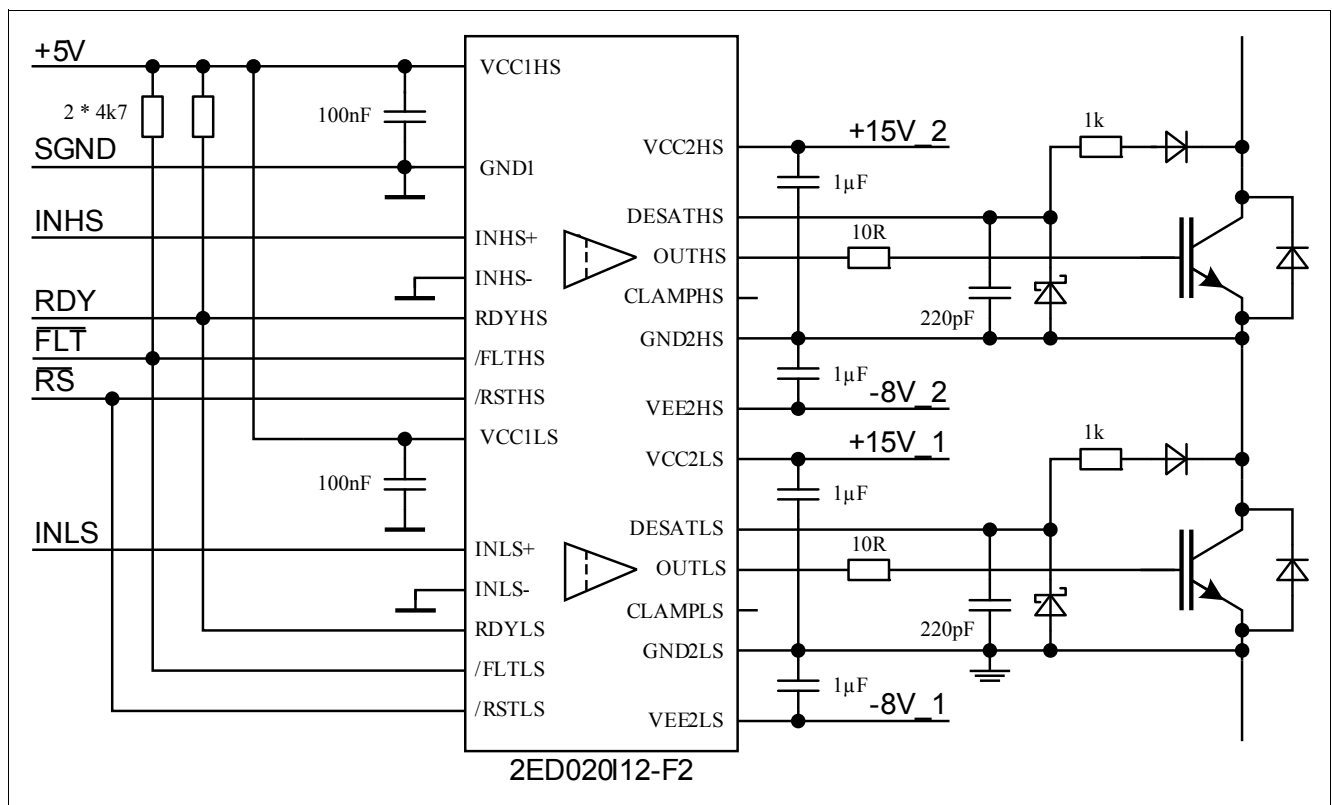


Figure 4 Application Example Bipolar Supply

### 4.2 Supply

The driver 2ED020I12-F2 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 15V at VCC2 and a negative voltage of -8V at VEE2, please refer to [Figure 4](#). 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 CLAMPxx to IGBT gate is redundant and therefore typically not necessary.

## Functional Description Internal Protection Features

For unipolar supply configuration the driver is typically supplied with a positive voltage of 15V 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, please refer to [Figure 5](#).

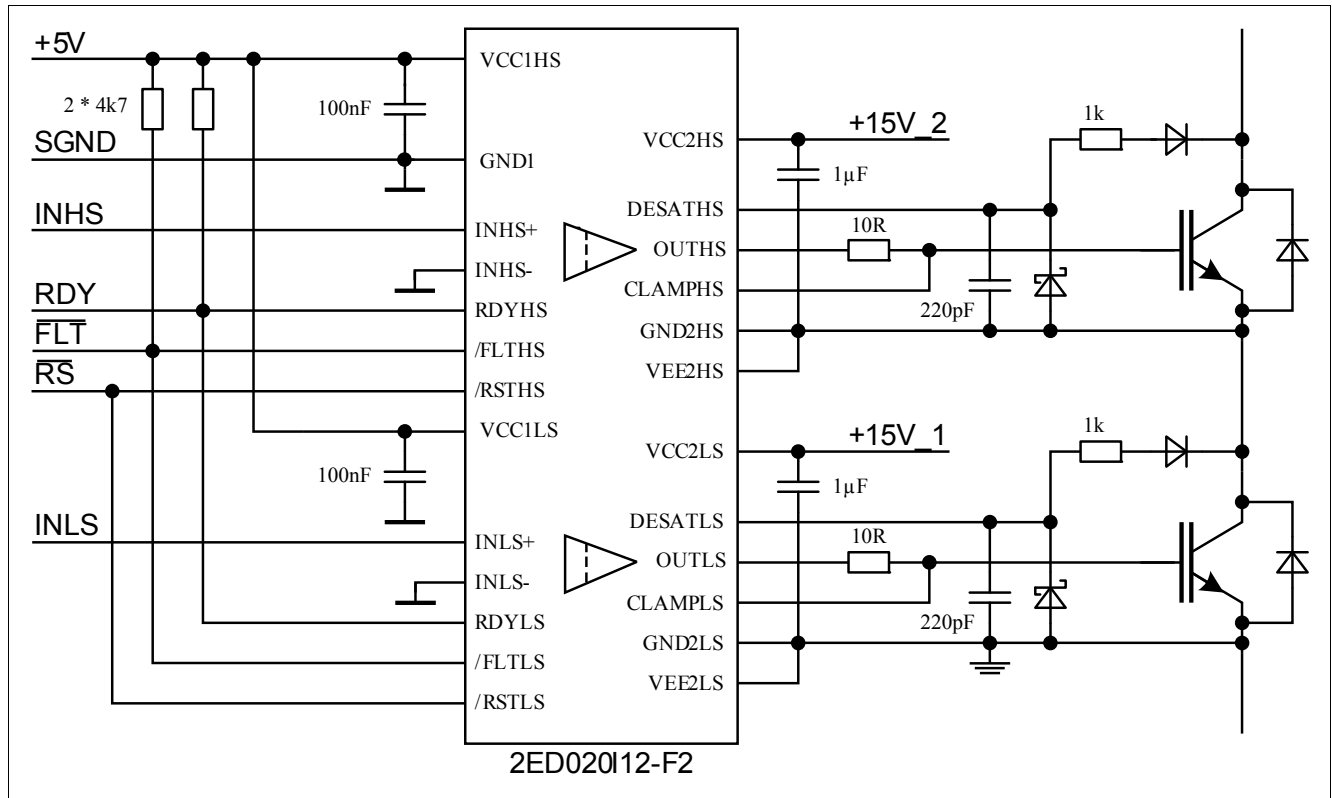


Figure 5 Application Example Unipolar Supply

## 4.3 Internal Protection Features

### 4.3.1 Undervoltage Lockout (UVLO)

To ensure correct switching of IGBTs the device is equipped with undervoltage lockout for all driver outputs as well as for input section, please see [Figure 9](#).

If the power supply voltage  $V_{VCC1xx}$  of the input section drops below  $V_{UVLO1}$  a turn-off signal is sent to the output driver before power-down. The IGBT is switched off and the signals at  $INxx+$  and  $INxx-$  are ignored as long as  $V_{VCC1xx}$  reaches the power-up voltage  $V_{UVLOH1}$ .

If the power supply voltage  $V_{VCC2xx}$  of the output driver goes down below  $V_{UVLO2}$  the IGBT is switched off and signals from the input chip are ignored as long as  $V_{VCC2xx}$  reaches the power-up voltage  $V_{UVLOH2}$ .  $VEE2xx$  is not monitored, otherwise negative supply voltage range from 0 V to -12 V would not be possible.

### 4.3.2 READY Status Output

The READY outputs 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 READY signal since its state only depends on the status of the former mentioned protection signals.

### 4.3.3 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 READY output reports an internal error.

### 4.3.4 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 OUTxx to VEE2xx.

## 4.4 Non-Inverting and Inverting Inputs

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

## 4.5 Driver Outputs

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 behaviour of the IGBT is predominantly governed by the gate resistor. Furthermore, it reduces the power to be dissipated by the driver.

## 4.6 External Protection Features

### 4.6.1 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 FAULT output is activated, please refer to [Figure 8](#). 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.

### 4.6.2 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 VEE2). The clamp is designed for a Miller current up to 2 A.

### 4.6.3 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 OUTxx and CLAMPxx 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.

## 4.7 RESET

The reset inputs have two functions.

Firstly, /RSTxx is in charge of setting back the FAULT output. If /RSTxx is low longer than a given time, /FLTxx will be cleared at the rising edge of /RSTxx; otherwise, it will remain unchanged. Moreover, it works as enable/shutdown of the input logic.

## 5 Electrical Parameters

### 5.1 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. The specification for all driver signals is valid for HS and LS with out special notice, e.g. IN+ covers INHS+ as well as INLS+. The signals from driver output side are measured with respect to their specific GND2HS or GND2LS.*

**Table 2 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<br>( $V_{VCC2} - V_{VEE2}$ ) | $V_{max2}$     | –              | 28                    | V       | –                                |
| Gate driver output                                                    | $V_{OUT}$      | $V_{VEE2}-0.3$ | $V_{max2}+0.3$        | 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                    | $\mu s$ | $I_{CLAMP/OUT} = 500 \text{ mA}$ |
| Positive power supply input side                                      | $V_{VCC1}$     | -0.3           | 6.5                   | V       | –                                |
| 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           | $V_{VCC2} + 0.3^{2)}$ | °C      | 3) –                             |
| Input to output isolation voltage (GND2)                              | $V_{ISO}$      | -1200          | 1200                  | V       |                                  |
| Output to output isolation voltage (GND2HS vs GND2LS)                 | $V_{ISO\_OUT}$ | -1200          | 1200                  | V       | 1)                               |
| 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) @ $T_A = 25^\circ C$          |
| Power dissipation, per output part                                    | $P_{D, OUT}$   | –              | 400                   | mW      | 4) @ $T_A = 25^\circ C$          |
| Power dissipation, total                                              | $P_{D, tot}$   | –              | 1000                  | mW      | 4) @ $T_A = 25^\circ C$          |

**Electrical Parameters Absolute Maximum Ratings**
**Table 2 Absolute Maximum Ratings (cont'd)**

| Parameter                        | Symbol         | Values |      | Unit | Note / Test Condition                                                                                                     |
|----------------------------------|----------------|--------|------|------|---------------------------------------------------------------------------------------------------------------------------|
|                                  |                | Min.   | Max. |      |                                                                                                                           |
| Thermal resistance (Input part)  | $R_{THJA,IN}$  | —      | 375  | K/W  | <sup>4)</sup> @ $T_A = 25^\circ\text{C}$ ,<br>$P_{D, IN\_HS+LS} = 200\text{ mW}$ ,<br>$P_{D, OUT\_HS+LS} = 800\text{ mW}$ |
| Thermal resistance (Output part) | $R_{THJA,OUT}$ | —      | 110  | K/W  | <sup>4)</sup> @ $T_A = 25^\circ\text{C}$ ,<br>$P_{D, IN\_HS+LS} = 200\text{ mW}$ ,<br>$P_{D, OUT\_HS+LS} = 800\text{ mW}$ |
| ESD Capability                   | $V_{ESD}$      | —      | 1    | kV   | Human Body Model <sup>5)</sup>                                                                                            |

1) With respect to GND2.

2) May be exceeded during short circuit clamping.

3) With respect to VEE2.

4) IC power dissipation is derated linearly at 11.8 mW/°C above 65°C. 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).

## 5.2 Operating Parameters

*Note: Within the operating range the IC operates as described in the functional description. Unless otherwise noted all parameters refer to GND1. The specification for all driver signals is valid for HS and LS with out special notic, e.g. IN+ covers INHS+ as well as INLS+. The signals from driver output side are measured with respect to their specific GND2HS or GND2LS.*

**Table 3 Operating Parameters**

| Parameter                                                             | Symbol          | Values           |                 | Unit  | Note / Test Condition |
|-----------------------------------------------------------------------|-----------------|------------------|-----------------|-------|-----------------------|
|                                                                       |                 | Min.             | Max.            |       |                       |
| Positive power supply output side                                     | $V_{VCC2}$      | 13               | 20              | V     | 1)                    |
| Negative power supply output side                                     | $V_{VEE2}$      | -12              | 0               | V     | 1)                    |
| Maximum power supply voltage output side<br>( $V_{VCC2} - V_{VEE2}$ ) | $V_{max2}$      | –                | 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 CLAMP voltage                                                     | $V_{CLAMP}$     | $V_{VEE2} - 0.3$ | $V_{VCC2}^{2)}$ | V     | –                     |
| Pin DESAT voltage                                                     | $V_{DESAT}$     | -0.3             | $V_{VCC2}$      | V     | 1)                    |
| Pin TLSET voltage                                                     | $V_{TLSET}$     | -0.3             | $V_{VCC2}$      | V     | 1)                    |
| Ambient temperature                                                   | $T_A$           | -40              | 125             | °C    | –                     |
| Common mode transient immunity <sup>3)</sup>                          | $ dV_{ISO}/dt $ | –                | 50              | kV/μs | @ 500 V               |

1) With respect to GND2.

2) May be exceeded during short circuit clamping.

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

## 5.3 Recommended Operating Parameters

*Note: Unless otherwise noted all parameters refer to GND1. The specification for all driver signals is valid for HS and LS with out special notic, e.g. IN+ covers INHS+ as well as INLS+. The signals from driver output side are measured with respect to their specific GND2HS or GND2LS.*

**Table 4 Recommended Operating Parameters**

| Parameter                         | Symbol     | Value | Unit | Note / Test Condition |
|-----------------------------------|------------|-------|------|-----------------------|
| Positive power supply output side | $V_{VCC2}$ | 15    | V    | 1)                    |
| Negative power supply output side | $V_{VEE2}$ | -8    | V    | 1)                    |
| Positive power supply input side  | $V_{VCC1}$ | 5     | V    | –                     |

1) With respect to GND2.

## 5.4 Electrical Characteristics

*Note: The electrical characteristics involve the spread of values for the supply voltages, load and junction temperatures given below. Typical values represent the median values, which are related to production processes at  $T = 25^{\circ}\text{C}$ . Unless otherwise noted all voltages are given with respect to GND. The specification for all driver signals is valid for HS and LS with out special notic, e.g. IN+ covers INHS+ as well as INLS+. The signals from driver output side are measured with respect to their specific GND2HS or GND2LS.*

### 5.4.1 Voltage Supply

**Table 5 Voltage Supply**

| Parameter                                                               | Symbol              | Values |      |      | Unit | Note / Test Condition                                                                                                                           |
|-------------------------------------------------------------------------|---------------------|--------|------|------|------|-------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                         |                     | Min.   | Typ. | Max. |      |                                                                                                                                                 |
| UVLO Threshold Input Chip                                               | $V_{\text{UVLOH1}}$ | –      | 4.1  | 4.3  | V    | –                                                                                                                                               |
|                                                                         | $V_{\text{UVLOH1}}$ | 3.5    | 3.8  | –    | V    | –                                                                                                                                               |
| UVLO Hysteresis Input Chip ( $V_{\text{UVLOH1}} - V_{\text{UVLOL1}}$ )  | $V_{\text{HYS1}}$   | 0.15   | –    | –    | V    | –                                                                                                                                               |
| UVLO Threshold Output Chip                                              | $V_{\text{UVLOH2}}$ | –      | 12.0 | 12.6 | V    | –                                                                                                                                               |
|                                                                         | $V_{\text{UVLOL2}}$ | 10.4   | 11.0 | –    | V    | –                                                                                                                                               |
| UVLO Hysteresis Output Chip ( $V_{\text{UVLOH1}} - V_{\text{UVLOL1}}$ ) | $V_{\text{HYS2}}$   | 0.7    | 0.9  | –    | V    | –                                                                                                                                               |
| Quiescent Current Input Chip                                            | $I_{\text{Q1}}$     | –      | 7    | 9    | mA   | $V_{\text{VCC1}} = 5 \text{ V}$<br>IN+ = High,<br>IN- = Low<br>=>OUT = High,<br>RDY = High,<br>/FLT = High                                      |
| Quiescent Current Output Chip                                           | $I_{\text{Q2}}$     | –      | 4    | 6    | mA   | $V_{\text{VCC2}} = 15 \text{ V}$<br>$V_{\text{VEE2}} = -8 \text{ V}$<br>IN+ = High,<br>IN- = Low<br>=>OUT = High,<br>RDY = High,<br>/FLT = High |

## 5.4.2 Logic Input and Output

**Table 6**     **Logic Input and Output**

| Parameter                                                                 | Symbol                                                          | Values |      |      | Unit | Note / Test Condition                                              |
|---------------------------------------------------------------------------|-----------------------------------------------------------------|--------|------|------|------|--------------------------------------------------------------------|
|                                                                           |                                                                 | Min.   | Typ. | Max. |      |                                                                    |
| IN+, IN-, $\overline{\text{RST}}$ Low Input Voltage                       | $V_{\text{IN+L}},$<br>$V_{\text{IN-L}},$<br>$V_{\text{RSTL\#}}$ | –      | –    | 1.5  | V    | –                                                                  |
| IN+, IN-, $\overline{\text{RST}}$ High Input Voltage                      | $V_{\text{IN+H}},$<br>$V_{\text{IN-H}},$<br>$V_{\text{RSTH\#}}$ | 3.5    | –    | –    | V    | –                                                                  |
| IN-, $\overline{\text{RST}}$ Input Current                                | $I_{\text{IN-}}, I_{\text{RST\#}}$                              | -400   | -100 | –    | μA   | $V_{\text{IN-}} = \text{GND1}$<br>$V_{\text{RST\#}} = \text{GND1}$ |
| IN+ Input Current                                                         | $I_{\text{IN+}},$                                               | –      | 100  | 400  | μA   | $V_{\text{IN+}} = \text{VCC1}$                                     |
| RDY, $\overline{\text{FLT}}$ Pull Up Current                              | $I_{\text{PRDY}}, I_{\text{PFLT\#}}$                            | -400   | -100 | –    | μA   | $V_{\text{RDY}} = \text{GND1}$<br>$V_{\text{FLT\#}} = \text{GND1}$ |
| Input Pulse Suppression IN+, IN-                                          | $T_{\text{MININ+}},$<br>$T_{\text{MININ-}}$                     | 30     | 40   | –    | ns   | –                                                                  |
| Input Pulse Suppression $\overline{\text{RST}}$ for ENABLE/SHUTDOWN       | $T_{\text{MINRST}}$                                             | 30     | 40   | –    | ns   | –                                                                  |
| Pulse Width $\overline{\text{RST}}$ for Resetting $\overline{\text{FLT}}$ | $T_{\text{RST}}$                                                | 800    | –    | –    | ns   | –                                                                  |
| $\overline{\text{FLT}}$ Low Voltage                                       | $V_{\text{FLTL}}$                                               | –      | –    | 300  | mV   | $I_{\text{SINK(FLT\#)}} = 5 \text{ mA}$                            |
| RDY Low Voltage                                                           | $V_{\text{RDYL}}$                                               | –      | –    | 300  | mV   | $I_{\text{SINK(RDY)}} = 5 \text{ mA}$                              |

### 5.4.3 Gate Driver

**Table 7 Gate Driver**

| Parameter                      | Symbol             | Values                 |                          |                          | Unit | Note / Test Condition                                                                                            |
|--------------------------------|--------------------|------------------------|--------------------------|--------------------------|------|------------------------------------------------------------------------------------------------------------------|
|                                |                    | Min.                   | Typ.                     | Max.                     |      |                                                                                                                  |
| High Level Output Voltage      | $V_{\text{OUTH1}}$ | $V_{\text{CC2}} - 1.2$ | $V_{\text{CC2}} - 0.8$   | –                        | V    | $I_{\text{OUTH}} = -20 \text{ mA}$                                                                               |
|                                | $V_{\text{OUTH2}}$ | $V_{\text{CC2}} - 2.5$ | $V_{\text{CC2}} - 2.0$   | –                        | V    | $I_{\text{OUTH}} = -200 \text{ mA}$                                                                              |
|                                | $V_{\text{OUTH3}}$ | $V_{\text{CC2}} - 9$   | $V_{\text{CC2}} - 5$     | –                        | V    | $I_{\text{OUTH}} = -1 \text{ A}$                                                                                 |
|                                | $V_{\text{OUTH4}}$ |                        | $V_{\text{CC2}} - 10$    | –                        | V    | $I_{\text{OUTH}} = -2 \text{ A}$                                                                                 |
| High Level Output Peak Current | $I_{\text{OUTH}}$  | -1.5                   | -2.0                     | –                        | A    | IN+ = High,<br>IN- = Low;<br>OUT = High                                                                          |
| Low Level Output Voltage       | $V_{\text{OUTL1}}$ | –                      | $V_{\text{VEE2}} + 0.04$ | $V_{\text{VEE2}} + 0.09$ | V    | $I_{\text{OUTL}} = 20 \text{ mA}$                                                                                |
|                                | $V_{\text{OUTL2}}$ | –                      | $V_{\text{VEE2}} + 0.3$  | $V_{\text{VEE2}} + 0.85$ | V    | $I_{\text{OUTL}} = 200 \text{ mA}$                                                                               |
|                                | $V_{\text{OUTL3}}$ | –                      | $V_{\text{VEE2}} + 2.1$  | $V_{\text{VEE2}} + 5$    | V    | $I_{\text{OUTL}} = 1 \text{ A}$                                                                                  |
|                                | $V_{\text{OUTL4}}$ | –                      | $V_{\text{VEE2}} + 7$    | –                        | V    | $I_{\text{OUTL}} = 2 \text{ A}$                                                                                  |
| Low Level Output Peak Current  | $I_{\text{OUTL}}$  | 1.5                    | 2.0                      | –                        | A    | IN+ = Low,<br>IN- = Low;<br>OUT = Low,<br>$V_{\text{VCC2}} = 15 \text{ V}$ ,<br>$V_{\text{VEE2}} = -8 \text{ V}$ |

### 5.4.4 Active Miller Clamp

**Table 8 Active Miller Clamp**

| Parameter               | Symbol               | Values |                          |                          | Unit | Note / Test Condition              |
|-------------------------|----------------------|--------|--------------------------|--------------------------|------|------------------------------------|
|                         |                      | Min.   | Typ.                     | Max.                     |      |                                    |
| Low Level Clamp Voltage | $V_{\text{CLAMPL1}}$ | –      | $V_{\text{VEE2}} + 0.03$ | $V_{\text{VEE2}} + 0.08$ | V    | $I_{\text{OUTL}} = 20 \text{ mA}$  |
|                         | $V_{\text{CLAMPL2}}$ | –      | $V_{\text{VEE2}} + 0.3$  | $V_{\text{VEE2}} + 0.8$  | V    | $I_{\text{OUTL}} = 200 \text{ mA}$ |
|                         | $V_{\text{CLAMPL3}}$ | –      | $V_{\text{VEE2}} + 1.9$  | $V_{\text{VEE2}} + 4.8$  | V    | $I_{\text{OUTL}} = 1 \text{ A}$    |
| Low Level Clamp Current | $I_{\text{CLAMPL}}$  | 2      | –                        | –                        | A    | <sup>1)</sup>                      |
| Clamp Threshold Voltage | $V_{\text{CLAMP}}$   | 1.6    | 2.1                      | 2.4                      | V    | Related to VEE2                    |

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

### 5.4.5 Short Circuit Clamping

**Table 9 Short Circuit Clamping**

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

### 5.4.6 Dynamic Characteristics

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

**Table 10 Dynamic Characteristics**

| Parameter                                                                                                       | Symbol        | Values |      |      | Unit | Note / Test Condition                                                       |
|-----------------------------------------------------------------------------------------------------------------|---------------|--------|------|------|------|-----------------------------------------------------------------------------|
|                                                                                                                 |               | Min.   | Typ. | Max. |      |                                                                             |
| IN+, IN- input to output<br>propa-gation delay ON                                                               | $T_{PDON}$    | 145    | 170  | 195  | ns   | $C_{LOAD} = 100$ pF<br>$V_{IN+} = 50\%$ ,<br>$V_{OUT} = 50\%$ @ 25°C        |
| IN+, IN- input to output<br>propa-gation delay OFF                                                              | $T_{PDOFF}$   | 145    | 165  | 190  | ns   |                                                                             |
| IN+, IN- input to output<br>propa-gation delay<br>distortion ( $T_{PDOFF} - T_{PDON}$ )                         | $T_{PDISTO}$  | -35    | -5   | 25   | ns   |                                                                             |
| IN+, IN- input to output<br>propagation delay ON<br>variation due to temp                                       | $T_{PDONT}$   | —      | —    | 25   | ns   | <sup>1)</sup> $C_{LOAD} = 100$ pF<br>$V_{IN+} = 50\%$ ,<br>$V_{OUT} = 50\%$ |
| IN+, IN- input to output<br>propagation delay OFF<br>variation due to temp                                      | $T_{PDOFFt}$  | —      | —    | 40   | ns   | <sup>1)</sup> $C_{LOAD} = 100$ pF<br>$V_{IN+} = 50\%$ ,<br>$V_{OUT} = 50\%$ |
| IN+, IN- input to output<br>propagation delay<br>distortion variation due to<br>temp ( $T_{PDOFF} - T_{PDON}$ ) | $T_{PDISTOt}$ | —      | —    | 20   | ns   | <sup>1)</sup> $C_{LOAD} = 100$ pF<br>$V_{IN+} = 50\%$ ,<br>$V_{OUT} = 50\%$ |

**Electrical Parameters** **Electrical Characteristics**
**Table 10 Dynamic Characteristics (cont'd)**

| Parameter | Symbol     | Values |      |      | Unit | Note / Test Condition                              |
|-----------|------------|--------|------|------|------|----------------------------------------------------|
|           |            | Min.   | Typ. | Max. |      |                                                    |
| Rise Time | $T_{RISE}$ | 10     | 30   | 60   | ns   | $C_{LOAD} = 1 \text{ nF}$<br>$V_L 10\%, V_H 90\%$  |
|           |            | 200    | 400  | 800  | ns   | $C_{LOAD} = 34 \text{ nF}$<br>$V_L 10\%, V_H 90\%$ |
| Fall Time | $T_{FALL}$ | 10     | 50   | 90   | ns   | $C_{LOAD} = 1 \text{ nF}$<br>$V_L 10\%, V_H 90\%$  |
|           |            | 200    | 350  | 600  | ns   | $C_{LOAD} = 34 \text{ nF}$<br>$V_L 10\%, V_H 90\%$ |

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

**5.4.7 Desaturation Protection**
**Table 11 Desaturation Protection**

| Parameter                            | Symbol            | Values |      |      | Unit | Note / Test Condition                                                                 |
|--------------------------------------|-------------------|--------|------|------|------|---------------------------------------------------------------------------------------|
|                                      |                   | Min.   | Typ. | Max. |      |                                                                                       |
| Blanking Capacitor Charge Current    | $I_{DESATC}$      | 450    | 500  | 550  | μA   | $V_{VCC2} = 15 \text{ V}$ ,<br>$V_{VEE2} = -8 \text{ V}$<br>$V_{DESAT} = 2 \text{ V}$ |
| Blanking Capacitor Discharge Current | $I_{DESATD}$      | 9      | 14   | —    | mA   | $V_{VCC2} = 15 \text{ V}$ ,<br>$V_{VEE2} = -8 \text{ V}$<br>$V_{DESAT} = 6 \text{ V}$ |
| Desaturation Reference Level         | $V_{DESAT}$       | 8.3    | 9    | 9.5  | V    | $V_{VCC2} = 15 \text{ V}$                                                             |
| Desaturation Filter Time             | $T_{DESATfilter}$ | —      | 250  | —    | ns   | $V_{VCC2} = 15 \text{ V}$ ,<br>$V_{VEE2} = -8 \text{ V}$<br>$V_{DESAT} = 9 \text{ V}$ |
| Desaturation Sense to OUT Low Delay  | $T_{DESATOUT}$    | —      | 350  | 430  | ns   | $V_{OUT} = 90\%$<br>$C_{LOAD} = 1 \text{ nF}$                                         |
| Desaturation Sense to FLT Low Delay  | $T_{DESATFLT}$    | —      | —    | 2.25 | μs   | $V_{FLT\#} = 10\%$ ;<br>$I_{FLT\#} = 5 \text{ mA}$                                    |
| Desaturation Low Voltage             | $V_{DESATL}$      | 0.4    | 0.6  | 0.95 | V    | IN+ = Low, IN- = Low,<br>OUT = Low                                                    |
| Leading edge blanking                | $T_{DESATleb}$    | —      | 400  | —    | ns   | Not subject of production test                                                        |

## 5.4.8 Active Shut Down

**Table 12 Active Shut Down**

| Parameter                | Symbol           | Values |      |      | Unit | Note /<br>Test Condition                       |
|--------------------------|------------------|--------|------|------|------|------------------------------------------------|
|                          |                  | Min.   | Typ. | Max. |      |                                                |
| Active Shut Down Voltage | $V_{ACTSD}^{1)}$ | –      | –    | 2.0  | V    | $I_{OUT} = -200\text{ mA}$ ,<br>$V_{CC2}$ open |

1) With reference to VEE2

## 6 Timing Diagramms

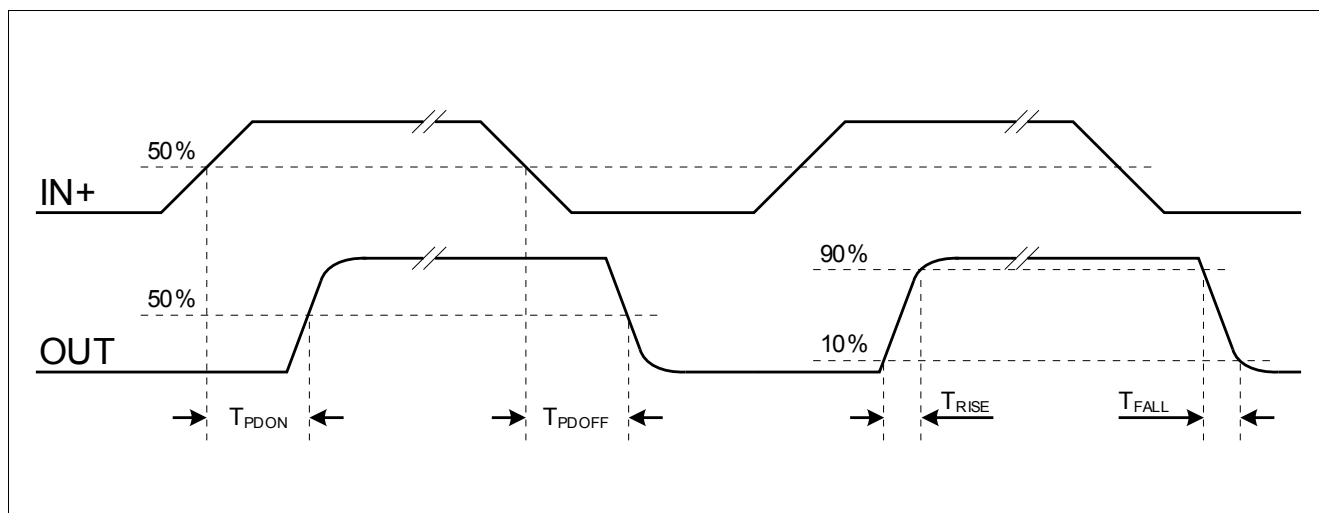


Figure 6 Propagation Delay, Rise and Fall Time

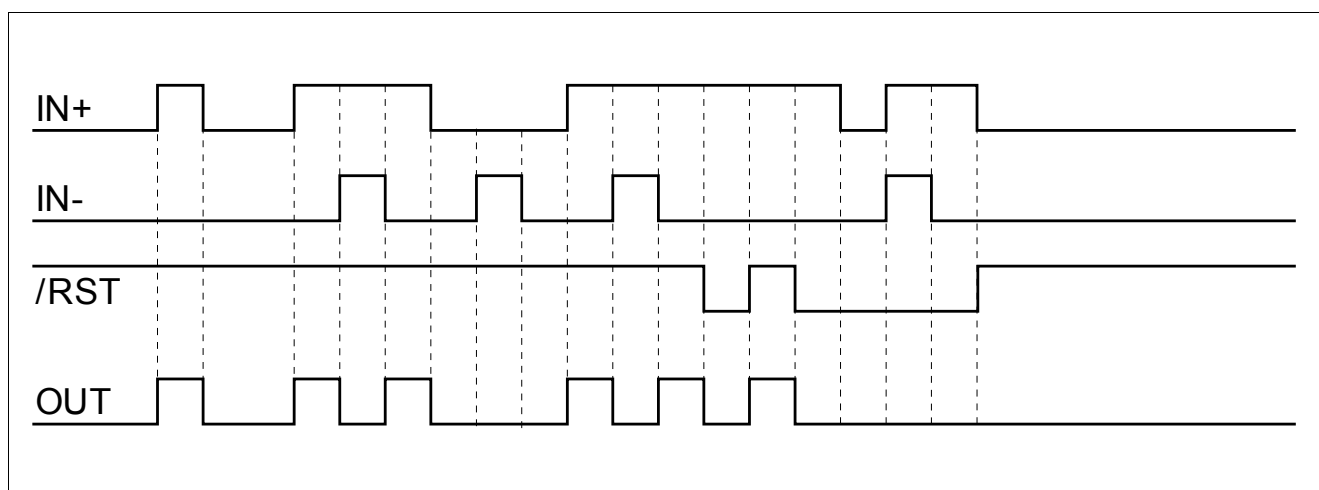


Figure 7 Typical Switching Behavior

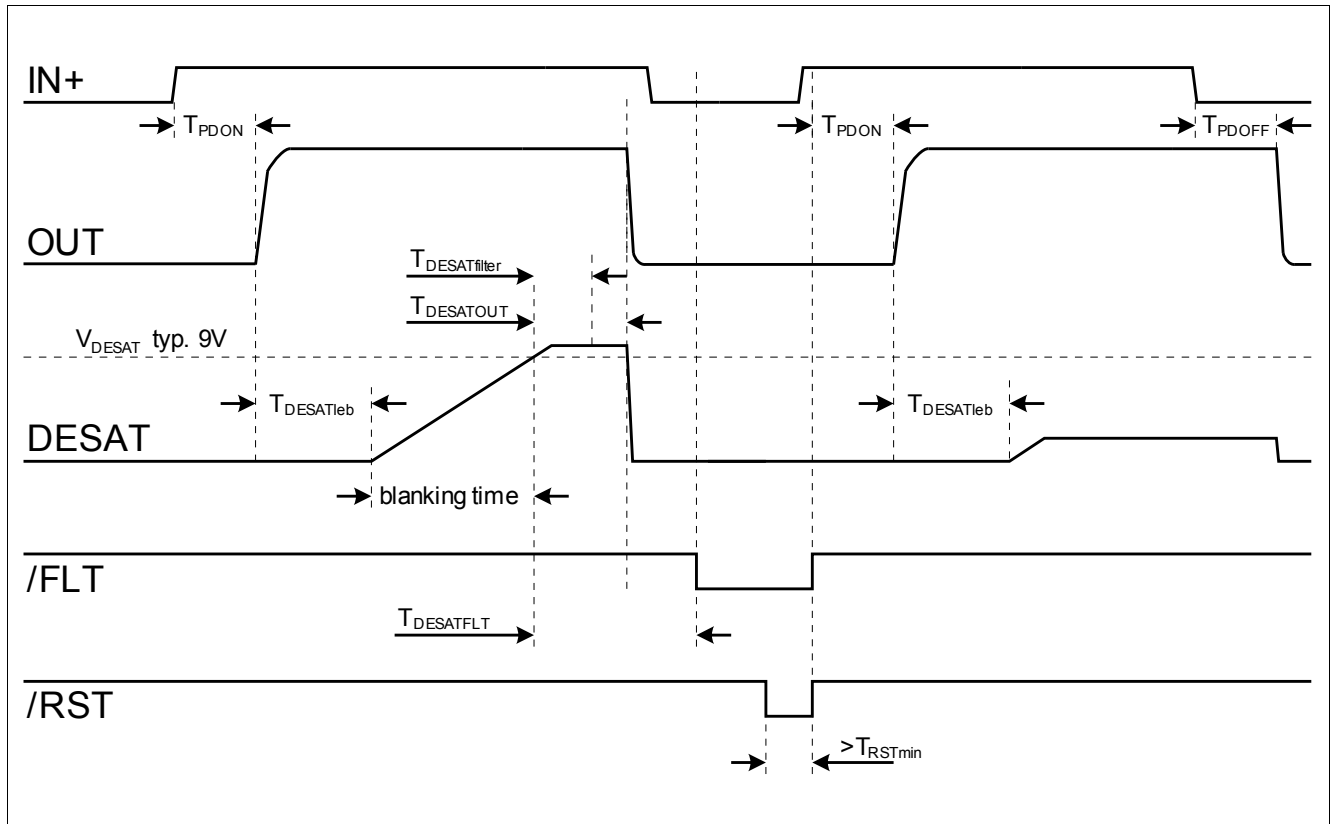


Figure 8 DESAT Switch-Off Behavior

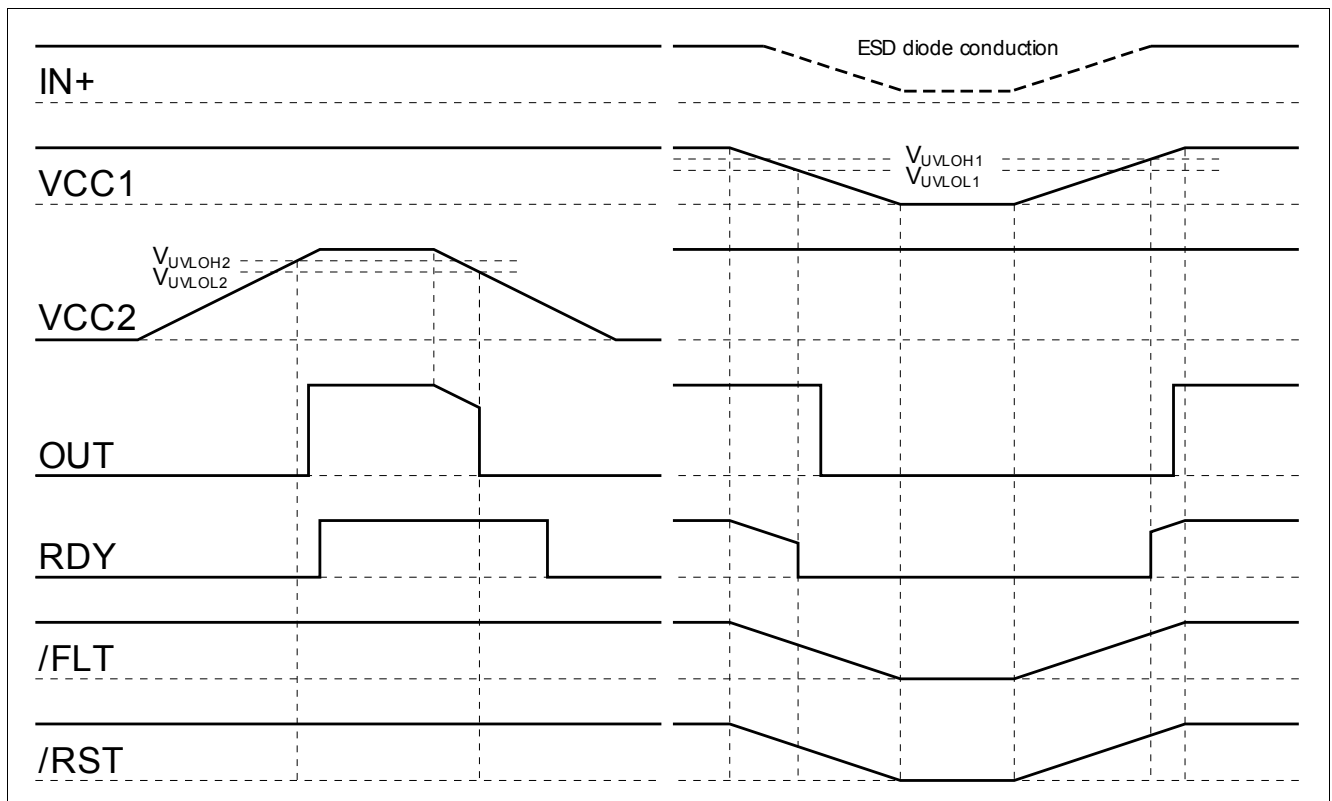
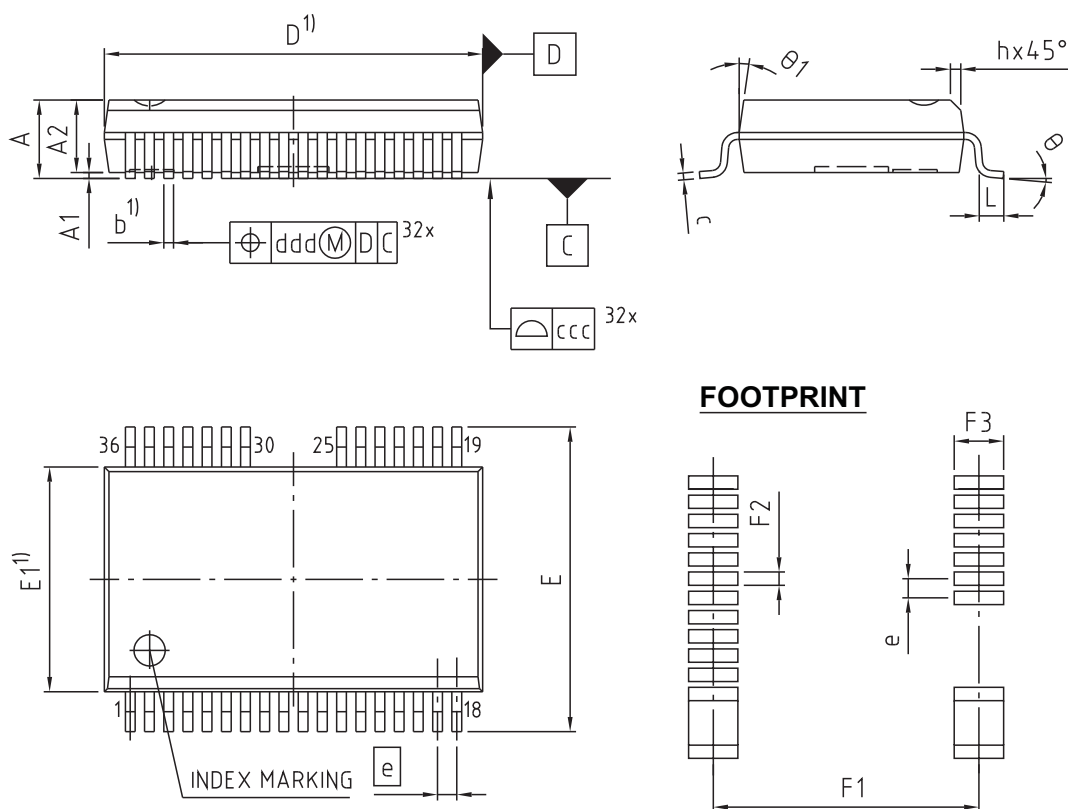


Figure 9 UVLO Behavior

## 7 Package Outlines



1) DOES NOT INCLUDE MOLD FLASH OR PROTRUSIONS.

| DIM | MILLIMETERS |       | INCHES    |       |
|-----|-------------|-------|-----------|-------|
|     | MIN         | MAX   | MIN       | MAX   |
| A   | -           | 2.65  | -         | 0.104 |
| A1  | 0.10        | 0.20  | 0.004     | 0.008 |
| A2  | 2.25        | 2.45  | 0.089     | 0.096 |
| b   | 0.25        | 0.41  | 0.010     | 0.016 |
| c   | 0.23        | 0.32  | 0.009     | 0.013 |
| D   | 12.60       | 12.80 | 0.496     | 0.504 |
| E   | 10.00       | 10.60 | 0.394     | 0.417 |
| E1  | 7.40        | 7.60  | 0.291     | 0.299 |
| e   | 0.65 BSC    |       | 0.026 BSC |       |
| N   | 32          |       | 32        |       |
| L   | 0.50        | 0.90  | 0.020     | 0.035 |
| h   | 0.25        | 0.45  | 0.010     | 0.018 |
| T   | 0°          | 8°    | 0°        | 8°    |
| T1  | 0°          | 8°    | 0°        | 8°    |
| ccc | 0.10        |       | 0.004     |       |
| ddd | 0.17        |       | 0.007     |       |
| F1  | 9.73        |       | 0.383     |       |
| F2  | 0.45        |       | 0.018     |       |
| F3  | 1.67        |       | 0.066     |       |

|                             |
|-----------------------------|
| DOCUMENT NO.<br>Z8B00159298 |
| SCALE<br>0 1.0 2mm          |
| EUROPEAN PROJECTION         |
| ISSUE DATE<br>25.03.2011    |
| REVISION<br>02              |

Figure 10 PG-DSO-36-58 (Plastic (Green) Dual Small Outline Package)

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