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EiceDRIVER™ 1EDI Compact

Single channel IGBT gate driver IC with clamp in wide body package

Features

- Single channel isolated IGBT driver
- For 600 V/650 V/1200 V IGBTs and MOSFETs
- Up to 3 A rail-to-rail output
- Active Miller clamp
- Galvanically isolated coreless transformer driver
- Wide input voltage operating range
- Suitable for operation at high ambient temperature

Applications

- AC and brushless DC motor drives
- High voltage DC/DC-converter and DC/AC-inverter
- Induction heating resonant application
- UPS-systems
- Welding
- Solar

Product Type	Output current configuration	Package
1EDI10I12MH	±1.0 A with 1.0 A Miller clamp	PG-DSO-8-59
1EDI20I12MH	±2.0 A with 2.0 A Miller clamp	PG-DSO-8-59
1EDI30I12MH	±3.0 A with 3.0 A Miller clamp	PG-DSO-8-59

Description

The 1EDI10I12MH, 1EDI20I12MH and 1EDI 30I12MH are galvanically isolated single channel IGBT driver in a PG-DSO-8-59 package that provide output currents up to 3 A and an integrated active Miller clamp circuit with the same current rating to protect against parasitic turn on.

The input logic pins operate on a wide input voltage range from 3 V to 15 V using scaled CMOS threshold levels to support even 3.3 V microcontrollers.

Data transfer across the isolation barrier is realized by the coreless transformer technology.

Every driver family member comes with logic input and driver output undervoltage lockout (UVLO) and active shutdown.

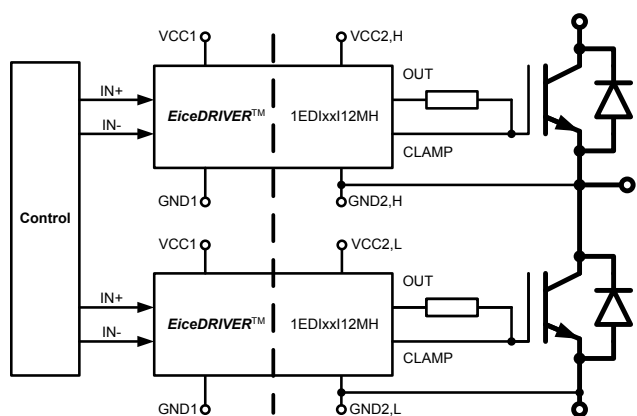


Table of Contents

Table of Contents

	Features	1
	Applications	1
	Description	1
	Table of Contents	2
1	Block Diagram	3
2	Pin Configuration and Functionality	4
2.1	Pin Configuration	4
2.2	Pin Functionality	4
3	Functional Description	6
3.1	Introduction	6
3.2	Supply	6
3.3	Protection Features	7
3.3.1	Undervoltage Lockout (UVLO)	7
3.3.2	Active Shut-Down	7
3.3.3	Short Circuit Clamping	7
3.3.4	Active Miller Clamp	7
3.4	Non-Inverting and Inverting Inputs	8
3.5	Driver Output	8
4	Electrical Parameters	9
4.1	Absolute Maximum Ratings	9
4.2	Operating Parameters	10
4.3	Electrical Characteristics	10
4.3.1	Voltage Supply	10
4.3.2	Logic Input	11
4.3.3	Gate Driver	12
4.3.4	Short Circuit Clamping	13
4.3.5	Active Miller Clamp	13
4.3.6	Dynamic Characteristics	14
4.3.7	Active Shut Down	15
5	Package Outline	16
6	Application Notes	17
6.1	Reference Layout for Thermal Data	17
6.2	Printed Circuit Board Guidelines	17
	Revision History	17
	Trademarks	18

Block Diagram

1 Block Diagram

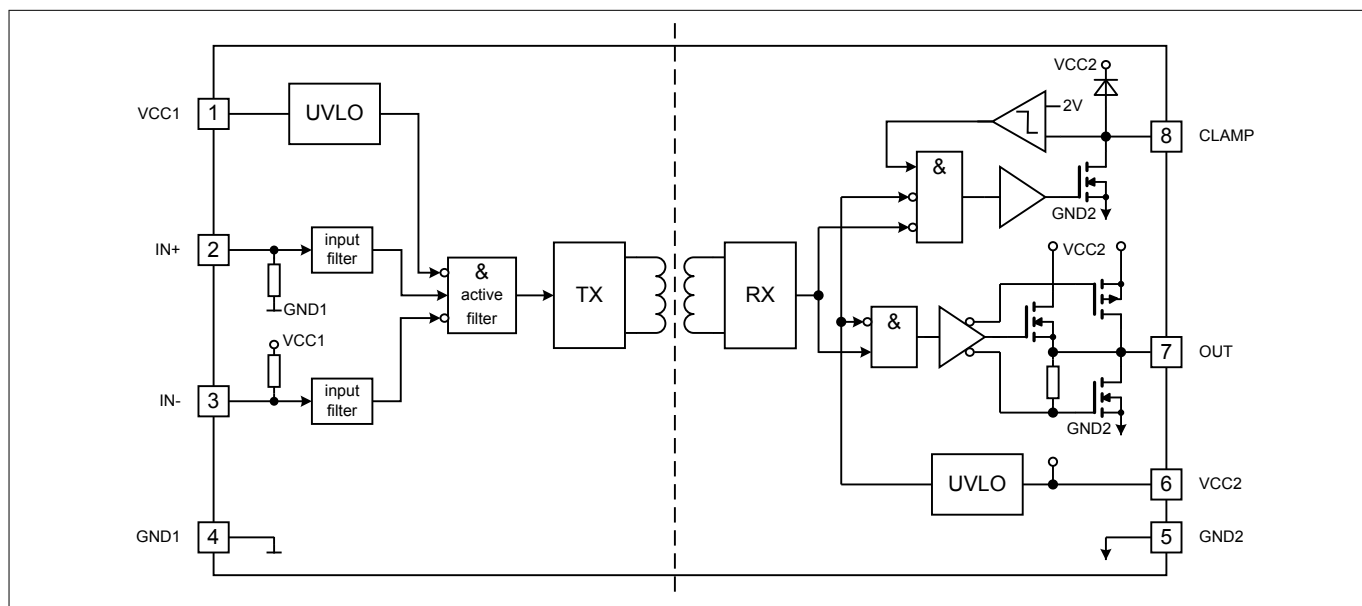


Figure 1 Block Diagram

Pin Configuration and Functionality

2 Pin Configuration and Functionality

2.1 Pin Configuration

Table 1 Pin Configuration

Pin No.	Name	Function
1	VCC1	Positive logic supply
2	IN+	Non-inverted driver input (active high)
3	IN-	Inverted driver input (active low)
4	GND1	Logic ground
5	GND2	Power ground
6	VCC2	Positive power supply voltage
7	OUT	Driver output
8	CLAMP	Active Miller clamp

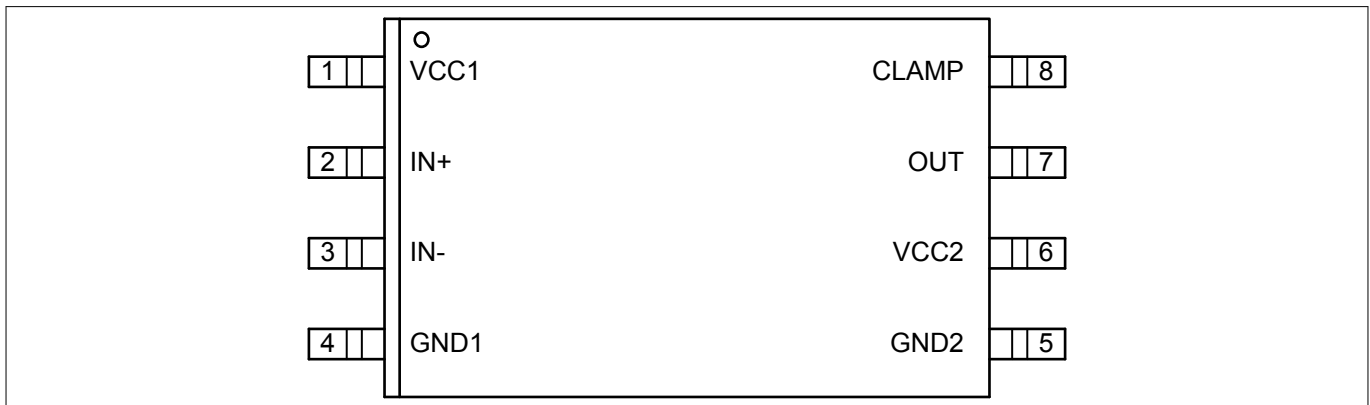


Figure 2 PG-DSO-8-59 (top view)

2.2 Pin Functionality

VCC1

Logic input supply voltage of 3.3 V up to 15 V wide operating range.

IN+ Non Inverting Driver Input

IN+ non-inverted control signal for driver output if IN- is set to low. (Output sourcing active at IN+ = high and IN- = low)

Due to internal filtering a minimum pulse width is defined to ensure robustness against noise at IN+. An internal weak pull-down-resistor favors off-state.

IN- Inverting Driver Input

IN- inverted control signal for driver output if IN+ is set to high. (Output sourcing active at IN- = low and IN+ = high)

Pin Configuration and Functionality

Due to internal filtering a minimum pulse width is defined to ensure robustness against noise at IN-. An internal weak pull-up-resistor favors off-state.

GND1

Ground connection of input circuit.

GND2 Reference Ground

Reference ground of the output driving circuit.

VCC2

Positive power supply pin of output driving circuit. A proper blocking capacitor has to be placed close to this supply pin.

OUT Driver Output

Combined source and sink output pin to external IGBT. The output voltage will be switched between VCC2 and GND2 and is controlled by IN+ and IN-. In case of an UVLO event this output will be switched off and an active shut down keeps the output voltage at a low level.

CLAMP Active Miller Clamp

Connect gate of external IGBT directly to this pin. As soon as the gate voltage has dropped below 2 V referred to GND2 during turn off state the CLAMP function ties its output to GND2 to avoid parasitic turn on of the connected IGBT.

Functional Description

3 Functional Description

3.1 Introduction

The 1EDIxx12MH is a general purpose IGBT gate driver. Basic control and protection features support fast and easy design of highly reliable systems.

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

With the rail-to-rail output and the additional active Miller clamp, dynamic turn on due to Miller capacitance is suppressed.

3.2 Supply

The driver can operate over a wide supply voltage range.

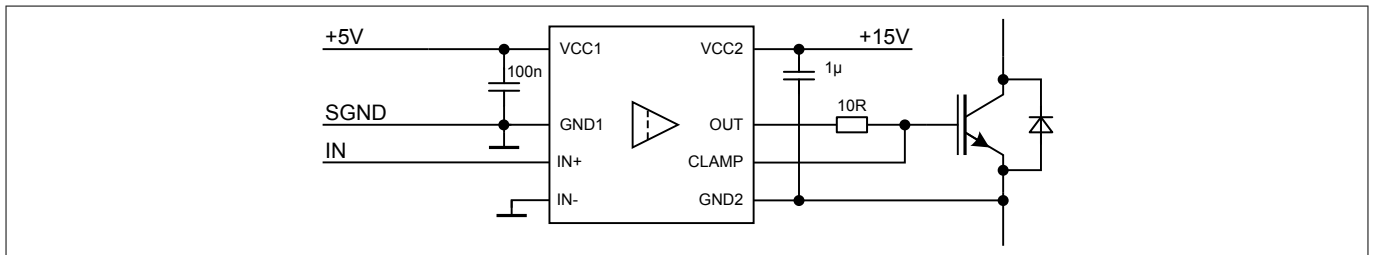


Figure 3 Application Example

The typical positive supply voltage for the driver is 15V at VCC2. Erratical dynamic turn on of the IGBT can be prevented with the active Miller clamp function, in which the CLAMP output is directly connected to the IGBT gate.

Functional Description

3.3 Protection Features

3.3.1 Undervoltage Lockout (UVLO)

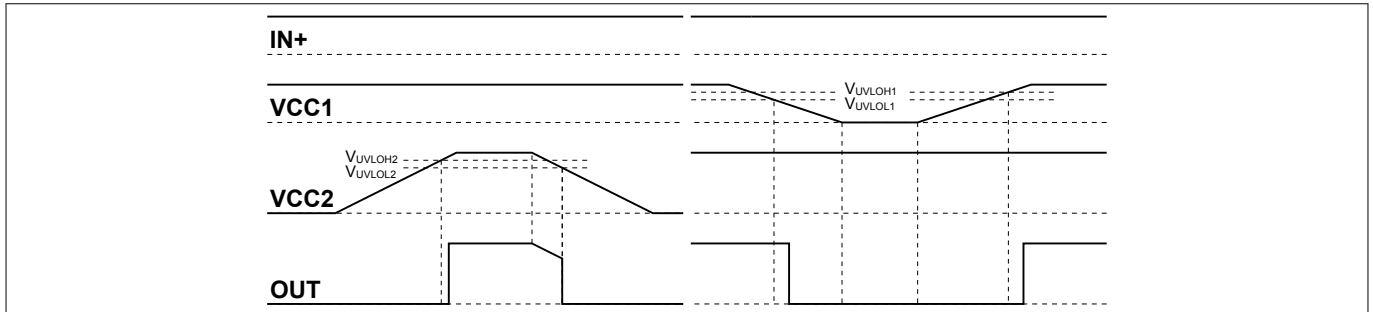


Figure 4 UVLO Behavior

To ensure correct switching of IGBTs the device is equipped with an undervoltage lockout for input and output independently. Operation starts only after both VCC levels have increased beyond the respective V_{UVLOH} levels

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

If the power supply voltage V_{VCC2} of the output chip goes down below V_{UVLOL2} the IGBT is switched off and signals from the input chip are ignored until V_{VCC2} reaches the power-up voltage V_{UVLOH2} again.

3.3.2 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 or an undervoltage lockout is in effect. The IGBT gate is clamped at OUT to GND2.

3.3.3 Short Circuit Clamping

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

3.3.4 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 drops below typical 2 V (referred to GND2). The clamp is designed for a Miller current in the same range as the nominal output current.

Functional Description

3.4 Non-Inverting and Inverting Inputs

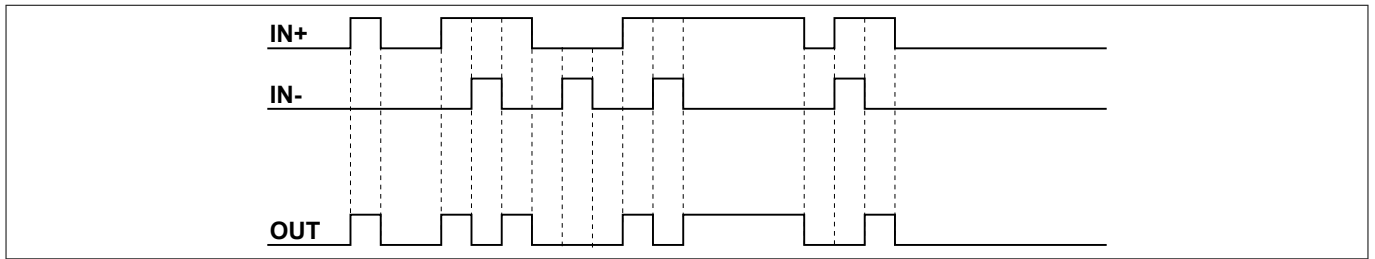


Figure 5 Typical Switching Behavior

There are two possible input modes to control the IGBT. At non-inverting mode IN+ controls the driver output while IN- is set to low. At inverting mode IN- controls the driver output while IN+ is set to high. A minimum input pulse width is defined to filter occasional glitches.

3.5 Driver Output

The output driver section uses 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 driver's supply is stable. Due to the low internal voltage drop, switching behavior of the IGBT is predominantly governed by the gate resistor. Furthermore, it reduces the power to be dissipated by the driver.

Electrical Parameters

4 Electrical Parameters

4.1 Absolute Maximum Ratings

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

Table 2 Absolute Maximum Ratings

Parameter	Symbol	Values		Unit	Note or Test Condition
		Min.	Max.		
Power supply output side	V _{VCC2}	-0.3	20 ¹⁾	V	2)
Gate driver output	V _{OUT}	V _{GND2} -0.3	V _{VCC2} +0.3	V	2)
Maximum short circuit clamping time	t _{CLP}	–	10	μs	I _{CLAMP/OUT} = 500 mA
Positive power supply input side	V _{VCC1}	-0.3	18.0	V	–
Logic input voltages (IN+,IN-)	V _{LogicIN}	-0.3	18.0	V	–
Pin CLAMP voltage	V _{CLAMP}	-0.3	V _{VCC2} +0.3 ¹⁾	V	2)
Input to output isolation voltage (GND2)	V _{GND2}	-1200	1200	V	GND2 - GND1
Junction temperature	T _J	-40	150	°C	–
Storage temperature	T _S	-55	150	°C	–
Power dissipation (Input side)	P _{D, IN}	–	25	mW	3) @T _A = 25°C
Power dissipation (Output side)	P _{D, OUT}	–	400	mW	3) @T _A = 25°C
Thermal resistance (Input side)	R _{THJA, IN}	–	145	K/W	3) @T _A = 85°C
Thermal resistance (Output side)	R _{THJA, OUT}	–	165	K/W	3) @T _A = 85°C
ESD capability	V _{ESD, HBM}	–	2	kV	Human body model ⁴⁾
	V _{ESD, CDM}	–	1	kV	Charged device model ⁵⁾

¹ May be exceeded during short circuit clamping.

² With respect to GND2.

³ See **Figure 9** for reference layouts for these thermal data. Thermal performance may change significantly with layout and heat dissipation of components in close proximity.

⁴ According to EIA/JESD22-A114-C (discharging a 100 pF capacitor through a 1.5 kΩ series resistor).

⁵ According to EIA/JESD22-C101 (specified waveform characteristics)

Electrical Parameters

4.2 Operating Parameters

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

Table 3 Operating Parameters

Parameter	Symbol	Values		Unit	Note or Test Condition
		Min.	Max.		
Power supply output side	V _{VCC2}	13	18	V	6)
Power supply input side	V _{VCC1}	3.1	17	V	–
Logic input voltages (IN+,IN-)	V _{LogicIN}	-0.3	17	V	–
Pin CLAMP voltage	V _{CLAMP}	V _{GND2} -0.3	V _{VCC2} ⁷⁾	V	6)
Switching frequency	f _{sw}	–	1.0	MHz	8)9)
Ambient temperature	T _A	-40	125	°C	–
Thermal coefficient, junction-top	Ψ _{th,jt}	–	4.8	K/W	9)@T _A = 85°C
Common mode transient immunity	dV _{ISO} /dt	–	100	kV/μs	9) @ 1000 V

4.3 Electrical Characteristics

Note: The electrical characteristics include the spread of values in supply voltages, load and junction temperatures given below. Typical values represent the median values at T_A = 25°C. Unless otherwise noted all voltages are given with respect to their respective GND (GND1 for pins 1 to 3, GND2 for pins 6 to 8).

4.3.1 Voltage Supply

Table 4 Voltage Supply

Parameter	Symbol	Values			Unit	Note or Test Condition
		Min.	Typ.	Max.		
UVLO threshold input chip	V _{UVLOH1}	–	2.85	3.1	V	–
	V _{UVLOL1}	2.55	2.75	–	V	–
UVLO hysteresis input chip (V _{UVLOH1} - V _{UVLOL1})	V _{HYS1}	0.09	0.10	–	V	–

⁶ With respect to GND2.

⁷ May be exceeded during short circuit clamping.

⁸ do not exceed max. power dissipation

⁹ Parameter is not subject to production test - verified by design/characterization

Electrical Parameters

Table 4 Voltage Supply (Continued)

Parameter	Symbol	Values			Unit	Note or Test Condition
		Min.	Typ.	Max.		
UVLO threshold output chip (IGBT supply)	V_{UVLOH2}	–	11.9	12.7	V	10)
	V_{UVLOL2}	10.5	11.0	–	V	10)
UVLO hysteresis output chip ($V_{UVLOH1} - V_{UVLOL1}$)	V_{HYS2}	0.7	0.85	–	V	–
Quiescent current input chip	I_{Q1}	–	0.6	1	mA	$V_{VCC1} = 5\text{ V}$ IN+ = High, IN- = Low =>OUT = High
Quiescent current output chip	I_{Q2}	–	1.2	2	mA	$V_{VCC2} = 15\text{ V}$ IN+ = High, IN- = Low =>OUT = High

4.3.2 Logic Input

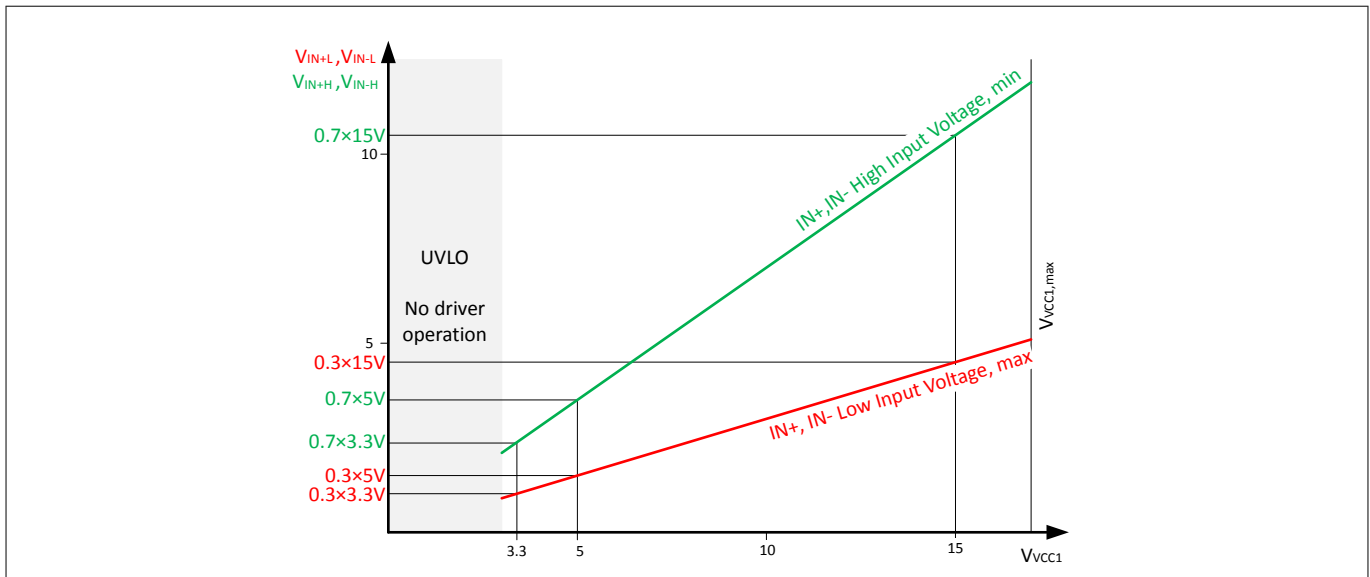


Figure 6 VCC1 scaled input threshold voltage of IN+ and IN-

Beginning from the input undervoltage lockout level, threshold levels for IN+ and IN- are scaled to V_{CC1}. The high input threshold is 70% of V_{CC1} and the low input threshold is at 30% of V_{CC1}.

¹⁰ With respect to GND2.

Electrical Parameters

Table 5 Logic Input

Parameter	Symbol	Values			Unit	Note or Test Condition
		Min.	Typ.	Max.		
IN+,IN- low input voltage	V_{IN+L} , V_{IN-L}	–	–	$0.3 \times V_{VCC1}$		¹¹⁾ $3.1 \text{ V} \leq V_{VCC1} \leq 17 \text{ V}$
IN+,IN- high input voltage	V_{IN+H} , V_{IN-H}	$0.7 \times V_{VCC1}$	–	–		
IN+,IN- low input voltage	V_{IN+L} , V_{IN-L}	–	–	1.5	V	$V_{VCC1} = 5.0 \text{ V}$
IN+,IN- high input voltage	V_{IN+H} , V_{IN-H}	3.5	–	–	V	
IN- input current	I_{IN-}	–	70	200	μA	$V_{VCC1} = 5.0 \text{ V}$, $V_{IN-} = \text{GND1}$
IN+ input current	I_{IN+}	–	70	200	μA	$V_{VCC1} = 5.0 \text{ V}$, $V_{IN+} = V_{VCC1}$

4.3.3 Gate Driver

Note: minimum Peak current rating valid over temperature range!

Table 6 Gate Driver

Parameter	Symbol	Values			Unit	Note or Test Condition
		Min.	Typ.	Max.		
High level output peak current (source)	$I_{OUT,H,PEAK}$			–	A	¹²⁾ IN+ = High, IN- = Low, $V_{VCC2} = 15 \text{ V}$
1EDI10I12MH		1.0	1.9			
1EDI20I12MH		2.0	3.5			
1EDI30I12MH		3.0	5.2			
Low level output peak current	$I_{OUT,L,PEAK}$			–	A	¹²⁾ IN+ = Low, IN- = Low, $V_{VCC2} = 15 \text{ V}$
1EDI10I12MH		1.0	1.7			
1EDI20I12MH		2.0	3.2			
1EDI30I12MH		3.0	4.5			

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

¹² specified min. output current is forced; voltage across the device $V_{(VCC2-OUT)}$ or $V_{(OUT-GND2)} < V_{VCC2}$.

Electrical Parameters

4.3.4 Short Circuit Clamping

Table 7 Short Circuit Clamping

Parameter	Symbol	Values			Unit	Note or Test Condition
		Min.	Typ.	Max.		
Clamping voltage (OUT) ($V_{OUT} - V_{VCC2}$)	V_{CLPout}	–	0.9	1.3	V	¹³⁾ IN+ = High, IN- = Low, $I_{OUT} = 500$ mA (pulse test $t_{CLPmax} = 10$ μ s)
Clamping voltage (CLAMP) ($V_{VCLAMP} - V_{VCC2}$)	$V_{CLPclamp1}$	–	1.3	–	V	¹³⁾ IN+ = High, IN- = Low, $I_{CLAMP} = 500$ mA (pulse test $t_{CLPmax} = 10$ μ s)
Clamping voltage (CLAMP)	$V_{CLPclamp2}$	–	0.7	1.1	V	¹³⁾ IN+ = High, IN- = Low, $I_{CLAMP} = 20$ mA

4.3.5 Active Miller Clamp

Table 8 Active Miller Clamp

Parameter	Symbol	Values			Unit	Note or Test Condition
		Min.	Typ.	Max.		
Low level clamp current 1EDI10I12MH 1EDI20I12MH 1EDI30I12MH	$I_{CLAMP,PEAK}$	1.0 2.0 3.0	–	–	A	¹⁴⁾ IN+ = Low, IN- = Low, $V_{CLAMP} = 15$ V pulsed $t_{pulse} = 2$ μ s
Clamp threshold voltage	V_{CLAMP}	1.6	2.0	2.4	V	¹⁵⁾

¹³⁾ With respect to GND2.

¹⁴⁾ Parameter is not subject to production test - verified by design/characterization

¹⁵⁾ With respect to GND2.

Electrical Parameters

4.3.6 Dynamic Characteristics

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

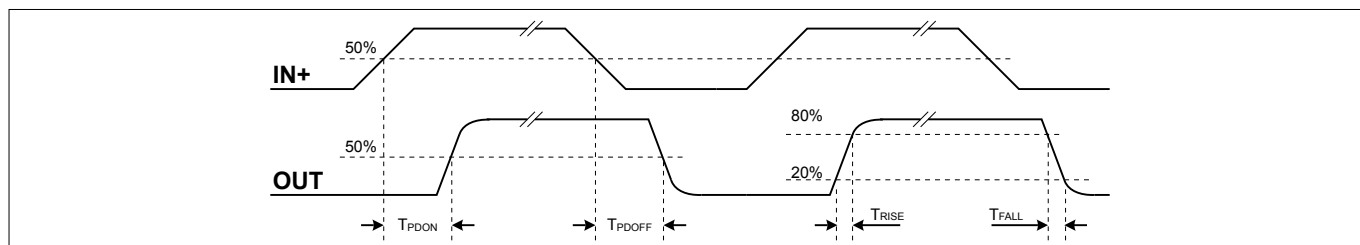


Figure 7 Propagation Delay, Rise and Fall Time

Table 9 Dynamic Characteristics

Parameter	Symbol	Values			Unit	Note or Test Condition
		Min.	Typ.	Max.		
Input IN to output propagation delay ON	T_{PDON}	270	300	330	ns	$C_{LOAD} = 100\text{ pF}$ $V_{IN+} = 50\%$, $V_{OUT} = 50\%$ @ 25°C
Input IN to output propagation delay OFF	T_{PDOFF}	270	300	330	ns	
Input IN to output propagation delay distortion ($T_{PDOFF} - T_{PDON}$)	T_{PDISTO}	-30	5	40	ns	
Input pulse suppression time IN+, IN-	T_{MININ+} , T_{MININ-}	230	240	-	ns	
IN input to output propagation delay ON variation due to temp	T_{PDONt}	-	-	14	ns	¹⁶⁾ $C_{LOAD} = 100\text{ pF}$ $V_{IN+} = 50\%$, $V_{OUT} = 50\%$
IN input to output propagation delay OFF variation due to temp	T_{PDONt}	-	-	14	ns	
IN input to output propagation delay distortion variation due to temp ($T_{PDOFF} - T_{PDON}$)	$T_{PDISTOt}$	-	-	8	ns	
Rise time	T_{RISE}	5	10	20	ns	$C_{LOAD} = 1\text{ nF}$ $V_L 20\%$, $V_H 80\%$
Fall time	T_{FALL}	3	9	19	ns	

¹⁶ Parameter is not subject to production test - verified by design/characterization

Electrical Parameters

4.3.7 Active Shut Down

Table 10 Active Shut Down

Parameter	Symbol	Values			Unit	Note or Test Condition
		Min.	Typ.	Max.		
Active shut down voltage	V _{ACTSD}	–	2.0	2.3	V	¹⁷⁾ I _{OUT} -/I _{OUT,PEAK} =0.1, V _{CC2} open

¹⁷⁾ With respect to GND2.

Package Outline

5 Package Outline

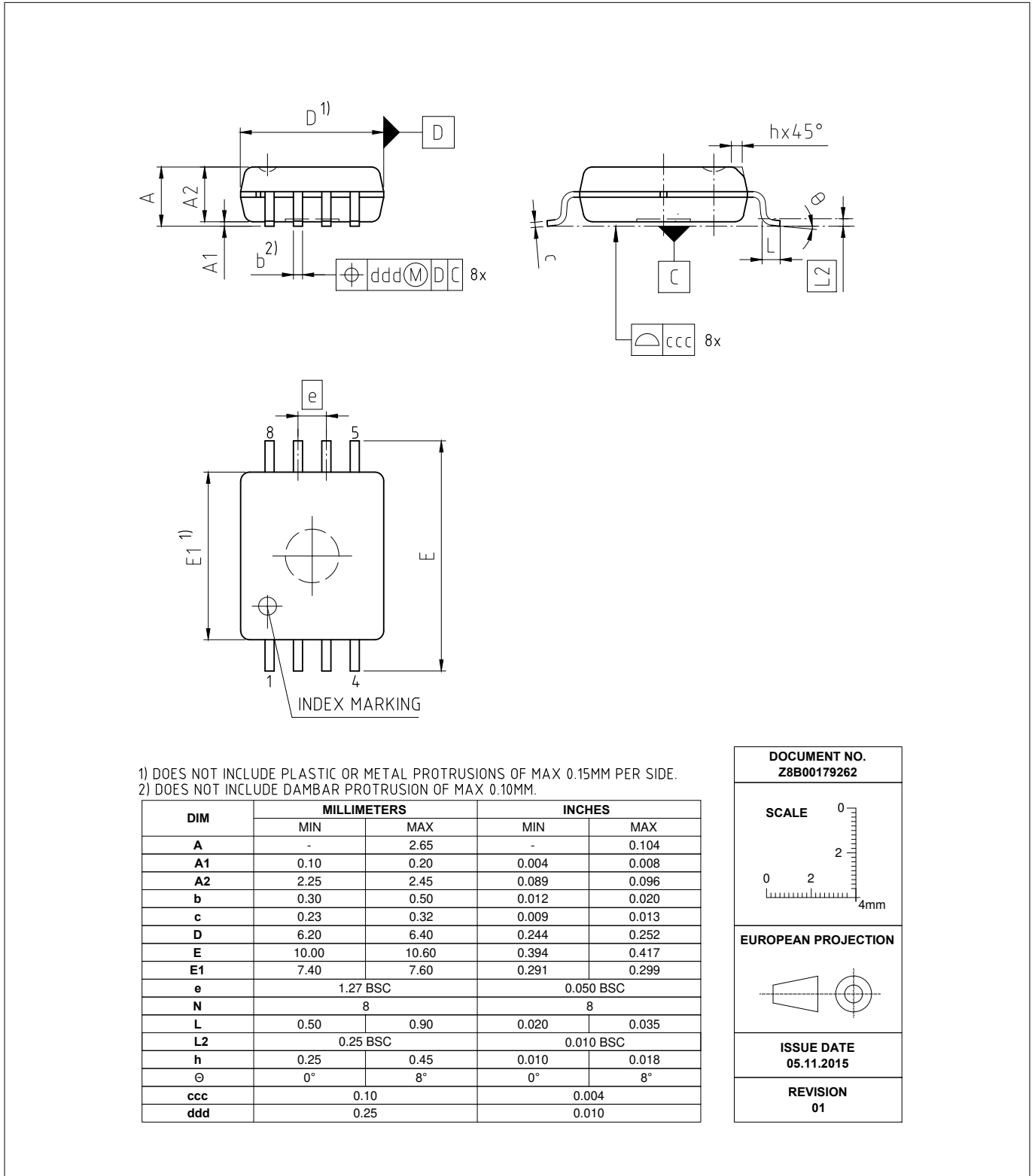


Figure 8 PG-DSO-8-59 (Plastic (Green) Dual Small Outline Package)

Application Notes

6 Application Notes

6.1 Reference Layout for Thermal Data

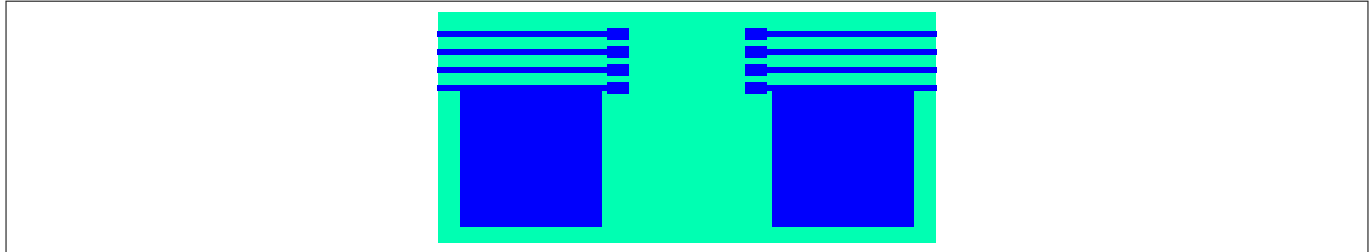


Figure 9 Reference Layout for Thermal Data (Copper thickness 35 μm)

This PCB layout represents the reference layout used for the thermal characterization.

Pin 4 (GND1) and pin 5 (GND2) require each a ground plane of 100 mm² for achieving maximum power dissipation. The package is built to dissipate most of the heat generated through these pins.

The thermal coefficient junction-top ($\Psi_{th,jt}$) can be used to calculate the junction temperature at a given top case temperature and driver power dissipation:

$$T_j = \Psi_{th,jt} \cdot P_D + T_{top}$$

6.2 Printed Circuit Board Guidelines

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

- Sufficient spacing should be kept between high voltage isolated side and low voltage side circuits.
- The same minimum distance between two adjacent high-side isolated parts of the PCB should be maintained to increase the effective isolation and to reduce parasitic coupling.
- In order to ensure low supply ripple and clean switching signals, bypass capacitor trace lengths should be kept as short as possible.

Revision History

Page or Item	Subjects (major changes since previous revision)
Rev. 2.0, 2016-07-05	
Logic Input	extended description of VCC1 scaled input thresholds
Rev. 1.0, 2016-04-14	
el. Parameters	missing product parameters updated
Rev. 0.51, 2015-11-05	
all pages	change of template, standardized package drawing included
Rev. 0.50, 2014-05-06	
all pages	initial version

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Edition 2016-07-05

Published by

Infineon Technologies AG

81726 Munich, Germany

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IFX-sch1433998947775

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