iC-DX

UNIVERSAL DIGITAL SENSOR OUTPUT DRIVER

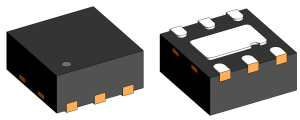
FEATURES

- Configurable high-side, low-side and push-pull operation
- Current limited output (< 450 mA)
- Active reverse polarity protection
- 150 mA output current
- 5 µs input filter for spike supression
- Wide supply voltage range from 8 to 30 V
- Driver shut-down with over temperature
- Integrated free-wheeling diode for inductive loads
- Sensor supply voltage output of 5 V, 10 mA

APPLICATIONS

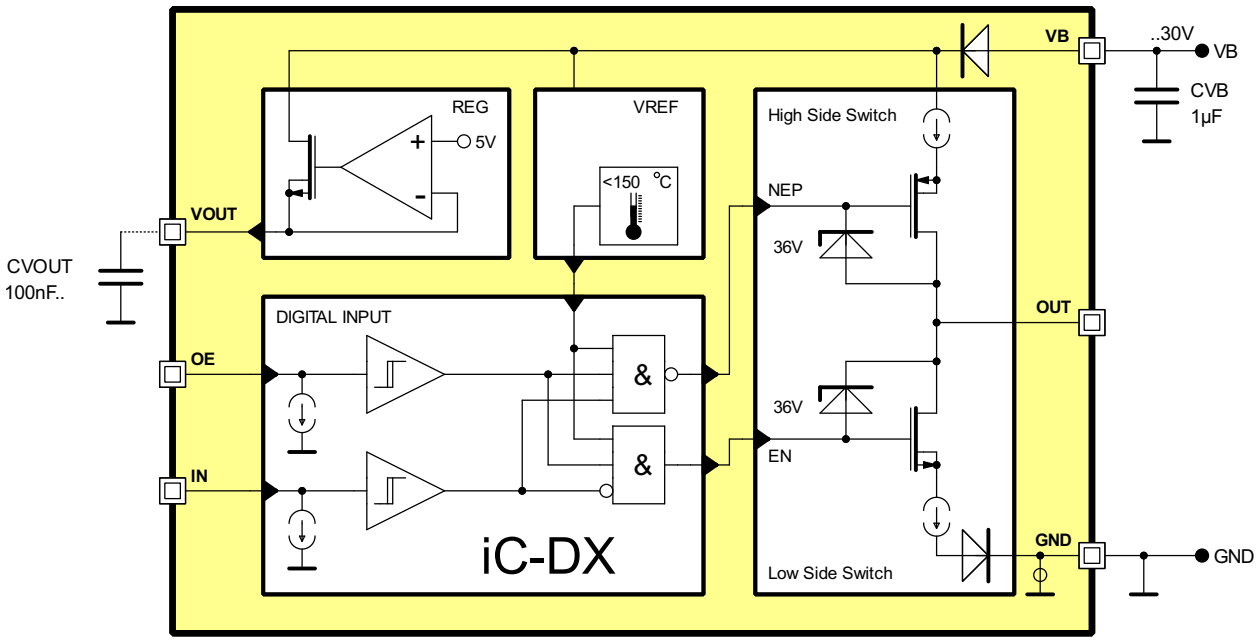
- Digital sensors
- Light barriers
- Proximity switches

PACKAGES



DFN6 2x2mm

BLOCK DIAGRAM



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DESCRIPTION

The iC-DX is a monolithic switch capable of driving ohmic, inductive and capacitive loads and features integrated reverse polarity protection. The supply voltage VB of the device can range from 8 to 30 V.

Output source/sink-current is at least 150 mA, with saturation voltages of 2 V max.

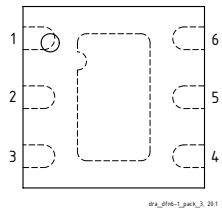
With input OE on high level state, the output works as a push-pull stage under control of pin IN. If pin IN is set either to high or low level, the output acts as a high-side (PNP) or low-side (NPN) driver which is activated by a high logic level on input OE.

Output transitions are slew-rate limited to minimize interference on lines. The output is current limited to 450 mA maximum and short circuit protected by shutting down the device with excessive temperature.

A regulated 5 V supply which can be loaded up to 10 mA is available at pin VOUT.

PACKAGING INFORMATION DFN6 2x2

PIN CONFIGURATION



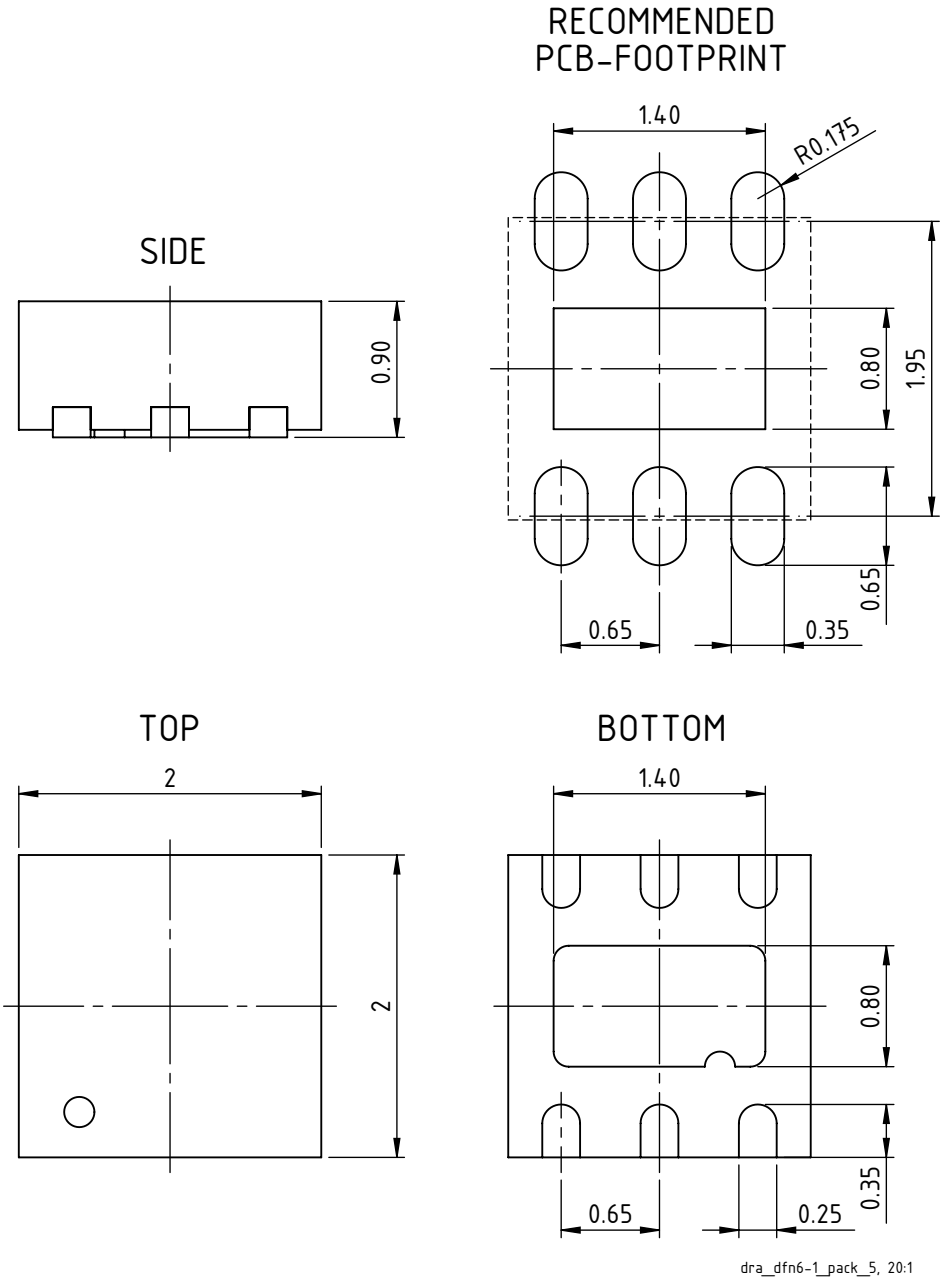
PIN FUNCTIONS

No.	Name	Function
1	VOUT	Regulated +5 V Voltage
2	GND	Ground
3	IN	Input
4	OE	Output Enabled
5	OUT	Driver Output
6	VB	Supply Voltage

The *Thermal Pad* is to be connected to a Ground Plane (GND) on the PCB.
Only pin 1 marking on top or bottom defines the package orientation (top label and coding is subject to change).

PACKAGE DIMENSIONS DFN6 2x2

All dimensions given in mm.



ABSOLUTE MAXIMUM RATINGS

Beyond these values damage may occur; device operation is not guaranteed.

Item No.	Symbol	Parameter	Conditions	Min.	Max.	Unit
G001	VB	Supply Voltage	Referenced to lowest voltage of GND, OUT Referenced to highest voltage of GND, OUT	 -36	36	V V
G002	OUT	OUT Voltage	Referenced to lowest voltage of VB, GND Referenced to highest voltage of GND, OUT	 -36	36	V V
G003	GND	GND Voltage	Referenced to lowest voltage of VB, OUT Referenced to highest voltage of GND, OUT	 -36	36	V V
G004	Es()	Maximum Surge Energy as indication for external protection design	Single pulse test between each pins of VB, OUT or GND. Pulse magnitude less than 55 V, duration less than 100 µs		6.5	mJ
G005	V()	Voltage at IN, OE		-0.3	7	V
G006	Tj	Junction Temperature		-40	150	°C
G007	Ts	Storage Temperature		-40	150	°C
G008	Vd()	ESD Susceptibility	HBM, 100 pF discharged through 1.5 kΩ		2	kV

THERMAL DATA

Operating Conditions: VB = 8..30 V

Item No.	Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
T01	Ta	Operating Ambient Temperature Range	no thermal shutdown	-40		+150	°C
T02	Rthja	Thermal Resistance Chip to Ambient	iC-DX surface mounted on evaluation board DX1M		130		K/W

All voltages are referenced to ground unless otherwise stated.
All currents flowing into the device pins are positive; all currents flowing out of the device pins are negative.

ELECTRICAL CHARACTERISTICS

Operating Conditions: VB = 8..30 V, Tj = -40..120°C, unless otherwise stated

Item No.	Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
General							
001	Vc()lo	Clamp Voltage lo at IN, OE, VOUT	I() = -1 mA	-1.4			V
002	VB	Permissible Supply Voltage	Referenced to GND	8	24	30	V
003	I(VB)	Supply Current in VB	no load, IN = lo, OE = lo IN = lo, OE = hi IN = hi, OE = hi			 0.9 1.2 1.5	 mA mA mA
004	V(VB)on	Turn-on threshold	increasing VB	6		8	V
005	Ilk(GND)rp	Reverse Polarity Leakage Current	V(VB) = 0; V(OUT) = 0; V(GND)= 0...30 V			300	uA
006	Ilk(OUT)rp	Reverse Polarity Leakage Current	V(VB)=0;V(GND)=0; V(OUT)= 0...30 V			300	uA
007	Ilk(VB)rp	Reverse Polarity Leakage Current	V(OUT) =0 ; GND open; ; V(VB)= 0...30 V			300	uA
Output characteristics							
101	Vs(IOUT)lo	Saturation voltage Low-Side driver	IN = lo, OE = hi I(OUT) = 10 mA I(OUT) = 100 mA I(OUT) = 150 mA		 0.2	 1.5 2	 V V V
102	Vs(IOUT)hi	Saturation voltage High-Side driver	IN = hi, OE = hi I(OUT) = -10 mA I(OUT) = -100 mA I(OUT) = -150 mA	 -1.5 -2	 -0.3		 V V V
103	Isc()lo	Short-Circuit Current lo in OUT	V(OUT) = 3 V...VB	150		450	mA
104	Isc()hi	Short-Circuit Current Hi in OUT	V() = 0...VB − 3 V	-450		-150	mA
105	Ilk()	Leakage Current at OUT	OUTPUT Disabled V(OUT) = -6...0 V V(OUT) = 0 V...VB V(OUT) > VB...30 V	 -100 -40 0		 0 40 100	 µA µA µA
106	SR()	Slew Rate (switch off → on, switch on → off)	VB = 30 V, Cl = 2.2 nF, I(OUT) = 0			40	V/µs
107	Vfw(OUT)lo	Freewheeling Voltage	I(OUT) = -1 mA, with reference to VB	-50		-36	V
108	Vfw(OUT)hi	Freewheeling Voltage	I(OUT) = 1 mA, with reference to GND	36		50	V
Temperature monitor							
201	Toff	Overtemperature shutdown	increasing Tj	151		198	°C
202	Ton	Overtemperature Release	decreasing Tj	150		197	ºC
203	Thys	Thermal Shutdown Hysteresis			5		ºC
Inputs OE, IN							
301	Vt()hi	Input Threshold Voltage hi at IN, OE				2	V
302	Vt()lo	Input Threshold Voltage lo at IN, OE		0.8			V
303	Vt()hys	Hysteresis at IN, OE	Vt()hys = Vt()hi − Vt()lo	200			mV
304	Ipd()	Pull-Down Current at IN, OE	V() > 0.4 V	2		150	µA
305	tpio	Propagation Delay IN, OE → OUT		2.1		6.5	µs
306	tsup()	Permissible Spurious Pulse Width at IN, OE				1.6	µs
307	ttrig()	Required Pulse Width at IN, OE		4			µs
Series regulator output VOUT							
401	V(VOUT)	Regulated output voltage	VB = 9..30 V, I(VOUT) = 10 .. 0 mA VB = 8..9 V, I(VOUT) = 10 .. 0 mA	4.7 4.5		5.3 5.3	V V
402	C(VOUT)	Capacitor at VOUT	I(VOUT) = 0 I(VOUT) > 0	0 0.1		10 10	µF µF
403	Isc(VOUT)	Short circuit current at VOUT	VOUT connected to GND			-125	mA

DESCRIPTION OF FUNCTIONS

iC-DX is a current limited switching channel which enables digital sensors to drive peripheral elements. They are designed to cope with high driver currents. The switches are reverse-polarity protected, feature a free-wheeling circuit for inductive loads, and a current limited output.

Reverse polarity protection

The pins VB, OUT an GND on the *line side* of the chip are reverse polarity protected. As far as the maximum voltage ratings are not exceeded, no possible supply combination at the *line side* pins can damage the chip.

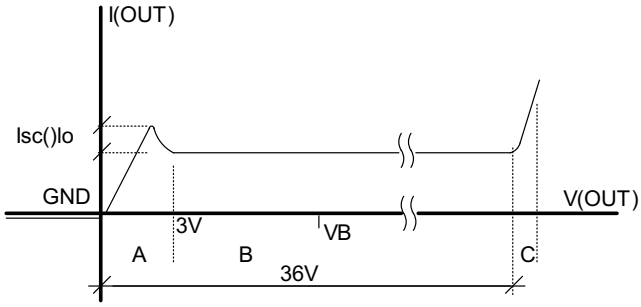


Figure 1: OUT characteristic when Low side active

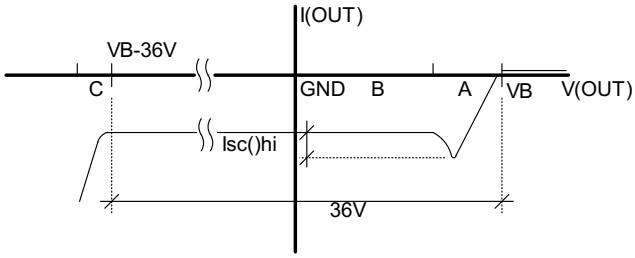


Figure 2: OUT characteristic when high side active

Output characteristics of OUT

The switching channel is current limited to a value between 150mA and 450mA. (cf. Electrical Characteristics Nos. 103, 104). The current limitation works only for voltages higher than 3 V at OUT resp. lower than VBO – 3 V. For smaller output voltages the current limitation is reduced in order to minimise the saturation voltages without increasing the power dissipation. Figures 1 and 2 show the characteristic of the switching channels when activated. Region "A" is the saturation range, where the current limitation is not fully active yet and region "B" is the current limited range. Region "C" corresponds to the free-wheeling circuit activated. The switching channel is designed so that the low side can only sink current and high side can only source current (no reverse current).

Free-wheeling circuit for inductive loads

The free-wheeling circuit is always present and does not depend on the current output status. It is activated by voltages higher than 36 V at OUT referenced to GND or lower than -36 V at OUT referenced to VB. In that case the correspondent channel will switch on without current limitation (see Figure 3).

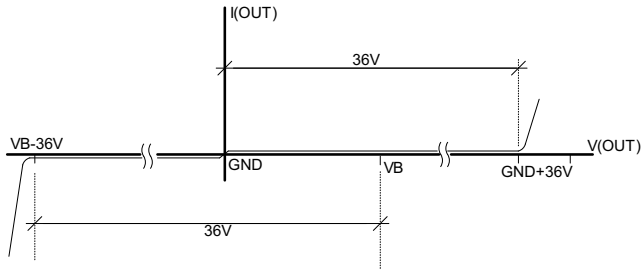


Figure 3: Free-wheeling characteristic

OPERATION MODES

The iC-DX can be operated in High-Side (PNP-Switch), Low-Side (NPN-Switch) and Push-Pull switch mode. Figure 4 shows the high-side operation where IN pin must be kept high and the OE pin controls the switch. Figure 5 shows the low-side operation where IN pin must be kept low and the OE pin controls the switch. Figure 6 shows the push-pull operation where OE pin must be kept high and the IN pin controls the switch.

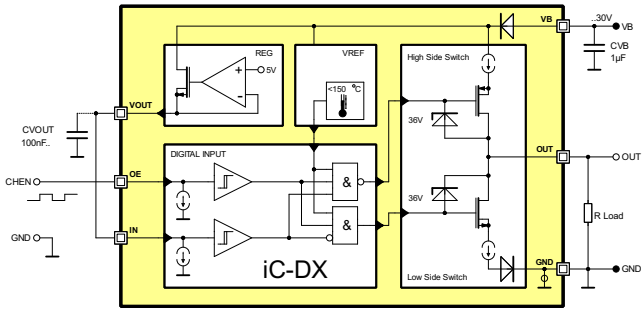


Figure 4: Configuration as High-Side (PNP-Switch)

Output Table. High-side mode (PNP-Switch)			
OE	IN	OUT	Mode
L	H	Z (L)	High-Side, passive pull down
H	H	H	High-Side, active pull up

Table 4: Output Function table Fig. 4. High-side mode (PNP-Switch) with external pull-down.

Output Table. Low-side mode (NPN-Switch)			
OE	IN	OUT	Mode
L	L	Z (H)	Low-Side, passive pull up
H	L	L	Low-Side, active pull down

Table 5: Output Function table Fig. 5. Low-side mode (NPN-Switch) with external pull-up.

Output Table. Push-Pull mode			
OE	IN	OUT	Mode
H	L	L	Push-Pull, active pull down
H	H	H	Push-Pull, active pull up

Table 6: Output Function table Fig. 6. Push-Pull mode

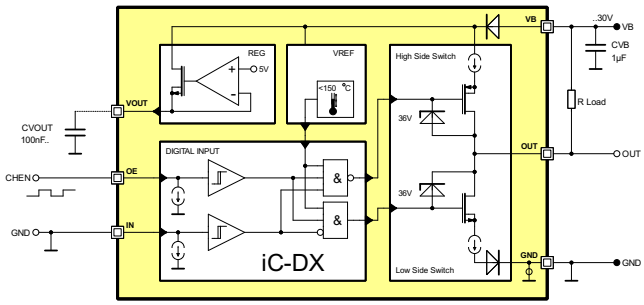


Figure 5: Configuration as Low-Side (NPN-Switch)

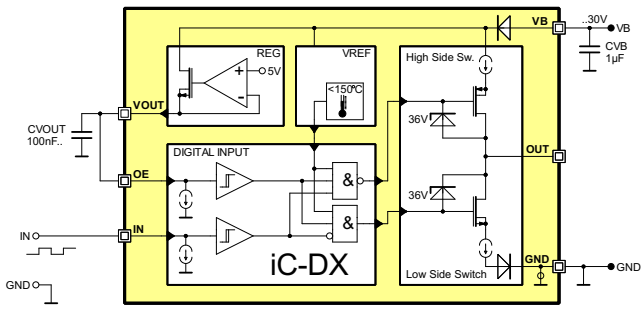


Figure 6: Configuration as Push-Pull

TIMING DESCRIPTION

The iC-DX has a built-in spurious pulse suppression that prevents short (undesired) pulses at the input pins from reaching the output.

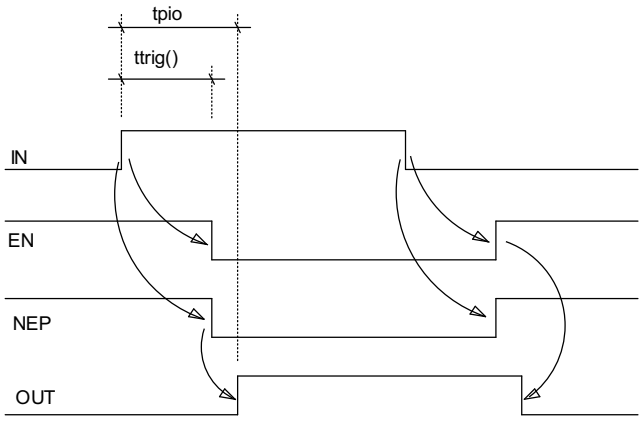


Figure 7: Timing diagram in push-pull operation mode

Every pulse at OE or IN pins shorter than 1.6 µs (cf. Electrical Characteristics No. 306) will be ignored and the output will not react. The minimum required pulse length to be sure that the output reacts is 4 µs (cf. Electrical Characteristics No. 307). That means that every pulse longer than 4 µs will be propagated to the output but with an additional propagation delay of 1.2 µs maximum. The resulting maximum propagation delay is 5.2 µs (cf. Electrical Characteristics No. 305).

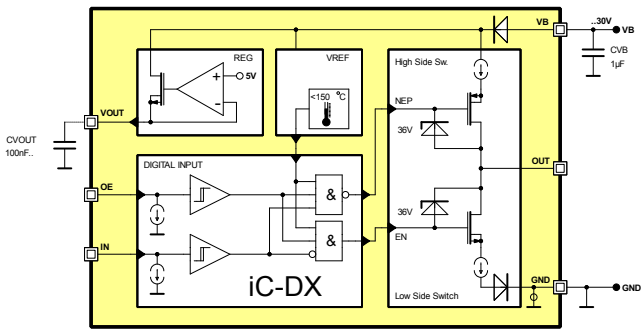


Figure 8: Block diagram with EN and NEP internal signals

CIRCUIT PROTECTION

The iC-DX is reverse polarity protected via internal circutry. As far as the maximum voltage ratings are not exceeded, no possible supply combination at the line side pins (VB, GND and OUT) can damage the chip.

Since the chip current consumption is relatively low, discharging of the backup capacitor C1 can be very slow, and injected charge through disturbances may in general result in capacitor voltage exceeding maximum ratings, leading to malfunction or destruction of circuitry and associated parts. Thus EMC requirements will afford more external circuitry. Figure 9 shows the iC-DX with the additional protective device D1, D2 and D3.

For over-voltage protection, the suppressor diodes D1,D2 and D3 absorbs transients on supply line injected externally on the cable. Clamp voltage of the diodes should be rated slightly above maximum specified supply voltage.
These currents can be passed to ground or to VB by the internal ESD diodes of the iC-DX. Whereas negative current injection will simply be drained off to ground, positive current injection will charge capacitor C1 further to higher voltages. If not suppressor diodes nor any other over-voltage protection is implemented, the backup capacitor C1 should be kept small. A typical 100nF value is normally OK.

Suggested protective devices

At VB_{max} of 36V, suppressor diodes with a breakdown voltage from 36V has to be chosen in order to minimize the energie in iC-DX for higer Voltages. For example Diode type like Vishay GSOT36C or PJSD36W from Pan Jit should be enough as protection.

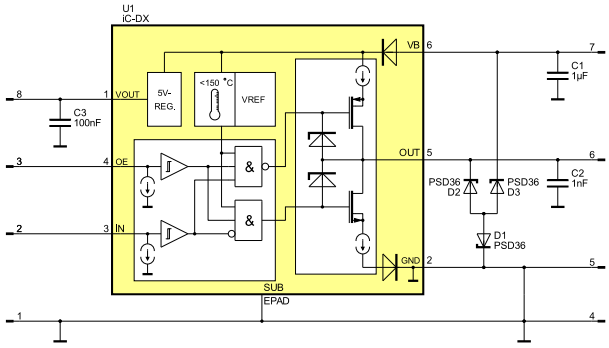


Figure 9: Circuit schematic showing protective devices

REVISION HISTORY

Rel	Rel.Date	Chapter	Modification	Page
A3	28.04.11		preliminary release	

Rel	Rel.Date	Chapter	Modification	Page
B1	19.06.13	ABSOLUTE MAXIMUM RATINGS	Parameter G004 introduced	4

Rel	Rel.Date	Chapter	Modification	Page
C1	03.12.14		preliminary label on front page removed	1
		THERMAL DATA	parameter T02 value Rthja introduced	4

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Type	Package	Order Designation
iC-DX	DFN6	iC-DX DFN6

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