



# VND5025BK-E

## Double channel high-side driver with analog current sense for automotive applications

### Features

Max transient supply voltage	V <sub>CC</sub>	41 V
Operating voltage range	V <sub>CC</sub>	4.5 to 36 V
Max on-state resistance (per ch.)	R <sub>ON</sub>	25 mΩ
Current limitation (typ)	I <sub>LIMH</sub>	60 A
Off-state supply current	I <sub>S</sub>	2 μA <sup>(1)</sup>

1. Typical value with all loads connected.

#### ■ Features

- In-rush current active management by power limitation
- Very low standby current
- 3.0 V CMOS compatible input
- Optimized electromagnetic emission
- Very low electromagnetic susceptibility
- In compliance with the 2002/95/EC European directive
- Two classes with different 'I' @ 3A' ranges
- Package: ECOPACK<sup>®</sup>

#### ■ Diagnostic functions

- 3 A current sense precision of +/-8%
- Proportional load current sense
- High current sense precision for wide range currents
- Current sense disable
- Thermal shutdown indication
- Very low current sense leakage

#### ■ Protection

- Undervoltage shutdown
- Overvoltage clamp
- Load current limitation
- Self-limiting of fast thermal transients
- Protection against loss of ground and loss of V<sub>CC</sub>
- Thermal shutdown
- Reverse battery protection



- Electrostatic discharge protection

### Description

The VND5025BK-E is a monolithic device made using STMicroelectronics™ VIPower™ M0-5 technology, intended for driving resistive or inductive loads with one side connected to ground, and suitable for driving LEDs.

Active V<sub>CC</sub> pin voltage clamp protects the device against low energy spikes (see ISO7637 transient compatibility table). This device integrates an analog current sense which delivers a current proportional to the load current (according to a known ratio) when CS\_DIS is driven low or left open. When CS\_DIS is driven high, the CURRENT SENSE pin is in a high impedance condition.

Output current limitation protects the device in overload condition. In case of long overload duration, the device limits the dissipated power to safe level up to thermal shutdown intervention. Thermal shutdown with automatic restart allows the device to recover normal operation as soon as fault condition disappears.

**Table 1. Device summary**

Package	Order codes	
	Tube	Tape and reel
PowerSSO-24™	VND5025BK-E	VND5025BKTR-E
	VND5025B1K-E	VND5025B1KTR-E
	VND5025B2K-E	VND5025B2KTR-E

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# 1 Block diagram and pin description

Figure 1. Block diagram

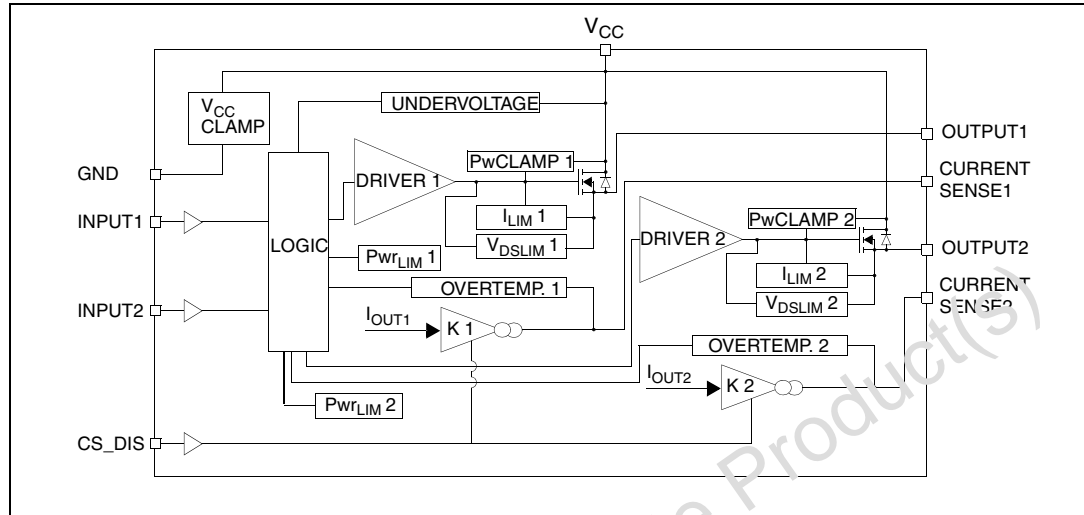


Table 2. Pin functions

Name	Function
V <sub>CC</sub>	Battery connection.
OUTPUT <sub>1,2</sub>	Power output.
GND	Ground connection; must be reverse battery protected by an external diode/resistor network.
INPUT <sub>1,2</sub>	Voltage controlled input pin with hysteresis, CMOS compatible; controls output switch state.
CURRENT SENSE <sub>1,2</sub>	Analog current sense pin; delivers a current proportional to the load current.
CS_DIS	Active high CMOS compatible pin to disable the current sense pin.

Figure 2. Configuration diagram (top view)

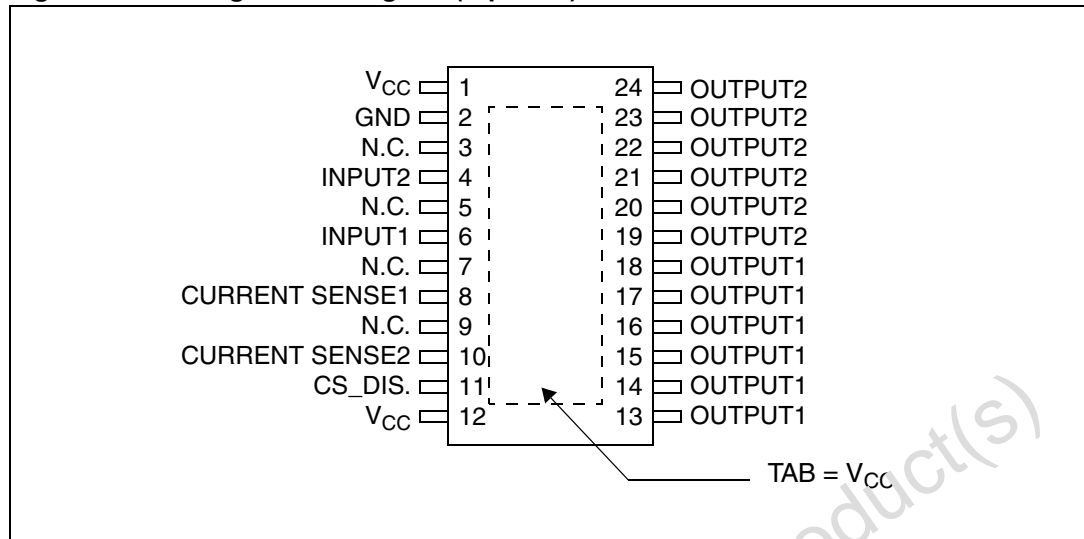


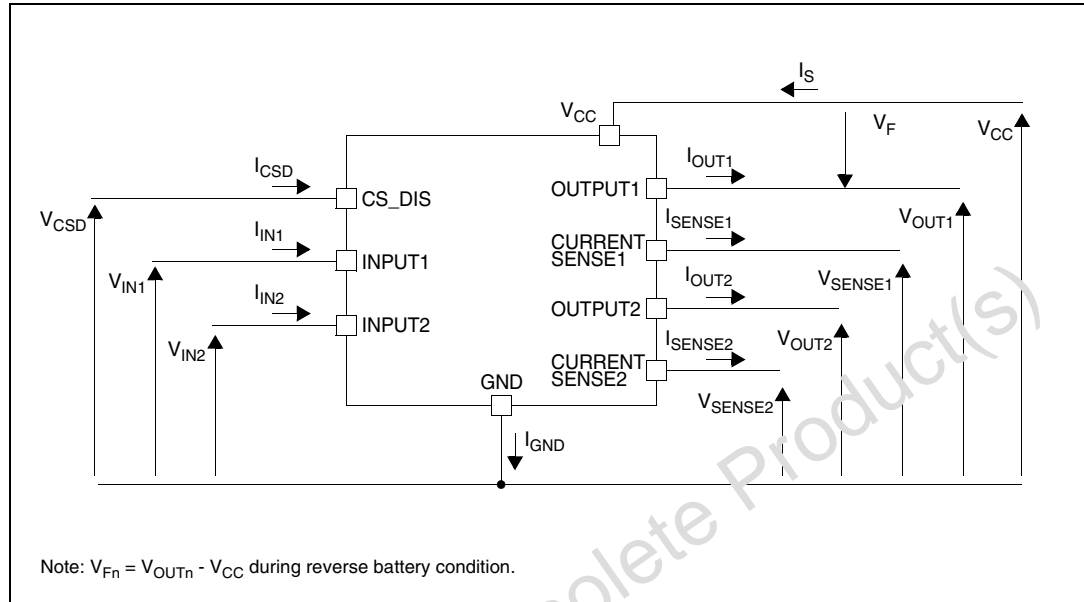
Table 3. Suggested connections for unused and not connected pins

Connection / pin	Current sense	N.C.	Output	Input	CS_DIS
Floating	N.R. <sup>(1)</sup>	X	X	X	X
To Ground	Through 1kΩ resistor	X	N.R.	Through 10kΩ resistor	Through 10kΩ resistor

1. Not recommended.

## 2 Electrical specification

Figure 3. Current and voltage conventions



### 2.1 Absolute maximum ratings

Stressing the device above the rating listed in the “Absolute maximum ratings” table may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those indicated in the Operating sections of this specification is not implied. Exposure to the conditions in table below for extended periods may affect device reliability. Refer also to the STMicroelectronics SURE Program and other relevant quality document.

Table 4. Absolute maximum ratings

Symbol	Parameter	Value	Unit
$V_{CC}$	DC supply voltage	41	V
$-V_{CC}$	Reverse DC supply voltage	0.3	
$-I_{GND}$	DC reverse ground pin current	200	mA
$I_{OUT}$	DC output current	Internally limited	A
$-I_{OUT}$	Reverse DC output current	24	
$I_{IN}$	DC input current	-1 to 10	mA
$I_{CSD}$	DC current sense disable input current		
$-I_{CSENSE}$	DC reverse CS pin current	200	
$V_{CSENSE}$	Current sense maximum voltage	$V_{CC} - 41$ to $+V_{CC}$	V

**Table 4. Absolute maximum ratings (continued)**

Symbol	Parameter	Value	Unit
$E_{MAX}^{(1)}$	Maximum switching energy (single pulse) ( $L = 0.3 \text{ mH}$ ; $R_L = 0 \text{ }\Omega$ ; $V_{bat} = 13.5 \text{ V}$ ; $T_{jstart} = 150 \text{ }^\circ\text{C}$ ; $I_{OUT} = I_{limL}(\text{Typ.})$ )	109	mJ
$V_{ESD}$	Electrostatic discharge (Human Body Model: $R = 1.5 \text{ k}\Omega$ ; $C = 100 \text{ pF}$ )		
	- Input	4000	V
	- Current sense	2000	V
	- CS_DIS	4000	V
	- Output	5000	V
	- $V_{CC}$	5000	V
$V_{ESD}$	Charge device model (CDM-AEC-Q100-011)	750	V
$T_j$	Junction operating temperature	-40 to 150	°C
$T_{stg}$	Storage temperature	-55 to 150	

1. See [Section 3.4](#) for details.

## 2.2 Thermal data

**Table 5. Thermal data**

Symbol	Parameter	Maximum value	Unit
$R_{thj-case}$	Thermal resistance junction-case (with one channel ON)	1.35	°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient	See <a href="#">Figure 29</a>	



## 2.3 Electrical characteristics

8 V < V<sub>CC</sub> < 36 V; -40 °C < T<sub>j</sub> < 150 °C, unless otherwise specified.

**Table 6. Power section**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V <sub>CC</sub>	Operating supply voltage		4.5	13	36	V
V <sub>USD</sub>	Undervoltage shutdown			3.5	4.5	
V <sub>USDhyst</sub>	Undervoltage shut-down hysteresis			0.5		
R <sub>ON</sub>	On-state resistance <sup>(1)</sup>	I <sub>OUT</sub> = 3 A; T <sub>j</sub> = 25 °C			25	mΩ
		I <sub>OUT</sub> = 3 A; T <sub>j</sub> = 150 °C			50	
		I <sub>OUT</sub> = 3 A; V <sub>CC</sub> = 5 V; T <sub>j</sub> = 25 °C			35	
V <sub>clamp</sub>	Clamp voltage	I <sub>S</sub> = 20 mA	41	46	52	V
I <sub>S</sub>	Supply current	Off-state; V <sub>CC</sub> = 13 V; T <sub>j</sub> = 25 °C; V <sub>IN</sub> = V <sub>OUT</sub> = V <sub>SENSE</sub> = V <sub>CSD</sub> = 0 V		2 <sup>(2)</sup>	5 <sup>(2)</sup>	μA
		On-state; V <sub>CC</sub> = 13 V; V <sub>IN</sub> = 5 V; I <sub>OUT</sub> = 0 A		3	6	mA
I <sub>L(off)</sub>	Off-state output current <sup>(1)</sup>	V <sub>IN</sub> = V <sub>OUT</sub> = 0 V; V <sub>CC</sub> = 13 V; T <sub>j</sub> = 25 °C	0	0.01	3	μA
		V <sub>IN</sub> = 5 V; I <sub>OUT</sub> = 0 V; V <sub>CC</sub> = 13 V; T <sub>j</sub> = 125 °C	0		5	
V <sub>F</sub>	Output - V <sub>CC</sub> diode voltage <sup>(1)</sup>	-I <sub>OUT</sub> = 4 A; T <sub>j</sub> = 150 °C			0.7	V

1. For each channel.
2. PowerMOS leakage included.

**Table 7. Switching (V<sub>CC</sub> = 13V; T<sub>j</sub> = 25 °C)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
t <sub>d(on)</sub>	Turn-on delay time	R <sub>L</sub> = 4.3 Ω (see <a href="#">Figure 8</a> )	—	35	—	μs
t <sub>d(off)</sub>	Turn-off delay time		—	50	—	
(dV <sub>OUT</sub> /dt) <sub>on</sub>	Turn-on voltage slope	R <sub>L</sub> = 4.3 Ω	—	See <a href="#">Figure 21</a>	—	V/μs
(dV <sub>OUT</sub> /dt) <sub>off</sub>	Turn-off voltage slope		—	See <a href="#">Figure 22</a>	—	
W <sub>ON</sub>	Switching energy losses during t <sub>WON</sub>	R <sub>L</sub> = 4.3 Ω (see <a href="#">Figure 8</a> )	—	0.45	—	mJ
W <sub>OFF</sub>	Switching energy losses during t <sub>WOFF</sub>		—	0.35	—	

**Table 8. Logic input**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V <sub>IL</sub>	Input low level voltage				0.9	V
I <sub>IL</sub>	Low level input current	V <sub>IN</sub> = 0.9 V	1			μA
V <sub>IH</sub>	Input high level voltage		2.1			V
I <sub>IH</sub>	High level input current	V <sub>IN</sub> = 2.1 V			10	μA
V <sub>I(hyst)</sub>	Input hysteresis voltage		0.25			V
V <sub>ICL</sub>	Input clamp voltage	I <sub>IN</sub> = 1 mA	5.5		7	
		I <sub>IN</sub> = -1 mA		-0.7		
V <sub>CSDL</sub>	CS_DIS low level voltage				0.9	μA
I <sub>CSDL</sub>	Low level CS_DIS current	V <sub>CSD</sub> = 0.9 V	1			
V <sub>CSDH</sub>	CS_DIS high level voltage		2.1			V
I <sub>CSDH</sub>	High level CS_DIS current	V <sub>CSD</sub> = 2.1 V			10	μA
V <sub>CSD(hyst)</sub>	CS_DIS hysteresis voltage		0.25			V
V <sub>CSCL</sub>	CS_DIS clamp voltage	I <sub>CSD</sub> = 1 mA	5.5		7	
		I <sub>CSD</sub> = -1 mA		-0.7		

**Table 9. Protection and diagnostics (1)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I <sub>LIMH</sub>	DC short circuit current	V <sub>CC</sub> = 13 V	43	60	85	A
		5 V < V <sub>CC</sub> < 36 V				
I <sub>LIML</sub>	Short circuit current during thermal cycling	V <sub>CC</sub> = 13 V; T <sub>R</sub> < T <sub>j</sub> < T <sub>TSD</sub>		24		
T <sub>TSD</sub>	Shutdown temperature		150	175	200	°C
T <sub>R</sub>	Reset temperature		T <sub>RS</sub> + 1	T <sub>RS</sub> + 5		
T <sub>RS</sub>	Thermal reset of STATUS		135			
T <sub>HYST</sub>	Thermal hysteresis (T <sub>TSD</sub> -T <sub>R</sub> )			7		
V <sub>DEMAG</sub>	Turn-off output voltage clamp	I <sub>OUT</sub> = 2 A; V <sub>IN</sub> = 0; L = 6 mH	V <sub>CC</sub> - 41	V <sub>CC</sub> - 46	V <sub>CC</sub> - 52	V
V <sub>ON</sub>	Output voltage drop limitation	I <sub>OUT</sub> = 0.2 A T <sub>j</sub> = -40 °C to 150 °C (see <a href="#">Figure 9</a> )		40		mV

1. To ensure long term reliability under heavy overload or short circuit conditions, protection and related diagnostic signals must be used together with a proper software strategy. If the device is subjected to abnormal conditions, this software must limit the duration and number of activation cycles.

Table 10. Current sense (8 V < V<sub>CC</sub> < 16 V)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
K <sub>LED</sub>	I <sub>OUT</sub> /I <sub>SENSE</sub>	I <sub>OUT</sub> = 0.05 A; V <sub>SENSE</sub> = 0.5 V; V <sub>CSD</sub> = 0 V; T <sub>j</sub> = -40 °C to 150 °C	1740	3300	4570	
K <sub>0</sub>	I <sub>OUT</sub> /I <sub>SENSE</sub>	I <sub>OUT</sub> = 0.5 A; V <sub>SENSE</sub> = 0.5 V; V <sub>CSD</sub> = 0 V; T <sub>j</sub> = -40 °C to 150 °C	1920	3020	3930	
K <sub>1</sub>	I <sub>OUT</sub> /I <sub>SENSE</sub>	I <sub>OUT</sub> = 2 A; V <sub>SENSE</sub> = 4 V; V <sub>CSD</sub> = 0 V; T <sub>j</sub> = -40 °C T <sub>j</sub> = 25 °C to 150 °C	2090 2320	2810 2810	3440 3200	
dK <sub>1</sub> /K <sub>1</sub> <sup>(1)(2)</sup>	Current sense ratio drift	I <sub>OUT</sub> = 2 A; V <sub>SENSE</sub> = 4 V; V <sub>CSD</sub> = 0 V; T <sub>j</sub> = -40 °C to 150 °C	-8		+5	%
K <sub>2</sub>	I <sub>OUT</sub> /I <sub>SENSE</sub>	I <sub>OUT</sub> = 3 A; V <sub>SENSE</sub> = 4 V; V <sub>CSD</sub> = 0 V; T <sub>j</sub> = -40 °C to 150 °C ClassB ClassB1 ClassB2	2510 2510 2690		3160 2960 3160	
dK <sub>2</sub> /K <sub>2</sub> <sup>(1)(2)</sup>	Current sense ratio drift	I <sub>OUT</sub> = 3 A; V <sub>SENSE</sub> = 4 V; V <sub>CSD</sub> = 0 V; T <sub>j</sub> = -40 °C to 150 °C	-6		+6	%
K <sub>3</sub>	I <sub>OUT</sub> /I <sub>SENSE</sub>	I <sub>OUT</sub> = 10 A; V <sub>SENSE</sub> = 4 V; V <sub>CSD</sub> = 0 V; T <sub>j</sub> = -40 °C T <sub>j</sub> = 25 °C to 150 °C	2610 2650	2760 2760	2970 2870	
dK <sub>3</sub> /K <sub>3</sub> <sup>(1)(2)</sup>	Current sense ratio drift	I <sub>OUT</sub> = 10 A; V <sub>SENSE</sub> = 4 V; V <sub>CSD</sub> = 0 V; T <sub>j</sub> = -40 °C to 150 °C	-3		+3	%
I <sub>SENSE0</sub>	Analog sense leakage current	I <sub>OUT</sub> = 0 A; V <sub>SENSE</sub> = 0 V; V <sub>CSD</sub> = 5 V; V <sub>IN</sub> = 0 V; T <sub>j</sub> = -40 °C to 150 °C	0		1	μA
		V <sub>CSD</sub> = 0 V; V <sub>IN</sub> = 5 V; T <sub>j</sub> = -40 °C to 150 °C	0		2	μA
		I <sub>OUT</sub> = 2 A; V <sub>SENSE</sub> = 0 V; V <sub>CSD</sub> = 5 V; V <sub>IN</sub> = 5 V; T <sub>j</sub> = -40 °C to 150 °C	0		1	μA
V <sub>SENSE</sub>	Max analog Sense output voltage	I <sub>OUT</sub> = 3 A; V <sub>CSD</sub> = 0 V	5			V
V <sub>SENSEH</sub>	Analog sense output voltage in over temperature condition	V <sub>CC</sub> = 13 V; R <sub>SENSE</sub> = 3.9 kΩ		9		
I <sub>SENSEH</sub>	Analog sense output current in over temperature condition	V <sub>CC</sub> = 13 V; V <sub>SENSE</sub> = 5 V		8		

**Table 10. Current sense (8 V < V<sub>CC</sub> < 16 V) (continued)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
t <sub>DSENSE1H</sub>	Delay response time from falling edge of CS_DIS pin	V <sub>SENSE</sub> < 4 V, 0.5 < I <sub>OUT</sub> < 10 A I <sub>SENSE</sub> = 90 % of I <sub>SENSEMAX</sub> (see Figure 4)		50	100	μs
t <sub>DSENSE1L</sub>	Delay response time from rising edge of CS_DIS pin	V <sub>SENSE</sub> < 4 V, 0.5 < I <sub>OUT</sub> < 10 A I <sub>SENSE</sub> = 10 % of I <sub>SENSEMAX</sub> (see Figure 4)		5	20	
t <sub>DSENSE2H</sub>	Delay response time from rising edge of INPUT pin	V <sub>SENSE</sub> < 4 V, 0.5 < I <sub>OUT</sub> < 10 A I <sub>SENSE</sub> = 90 % of I <sub>SENSEMAX</sub> (see Figure 4)		70	300	
Δt <sub>DSENSE2H</sub>	Delay response time between rising edge of output current and rising edge of current sense	V <sub>SENSE</sub> < 4 V, I <sub>SENSE</sub> = 90 % of I <sub>SENSEMAX</sub> , I <sub>OUT</sub> = 90 % of I <sub>OUTMAX</sub> , I <sub>OUTMAX</sub> = 3 A (see Figure 5)			110	
t <sub>DSENSE2L</sub>	Delay response time from falling edge of INPUT pin	V <sub>SENSE</sub> < 4 V, 0.5 < I <sub>OUT</sub> < 10 A I <sub>SENSE</sub> = 10 % of I <sub>SENSEMAX</sub> (see Figure 4)		100	250	

1. Parameter guaranteed by design; it is not tested.
2. Current sense ratio drift is the deviation of factor K for a given device (measured over the range -40 °C to 150 °C and 8 V < V<sub>CC</sub> < 16 V) from its value measured at T<sub>j</sub> = 25 °C, V<sub>CC</sub> = 13 V.

**Figure 4. Current sense delay characteristics**

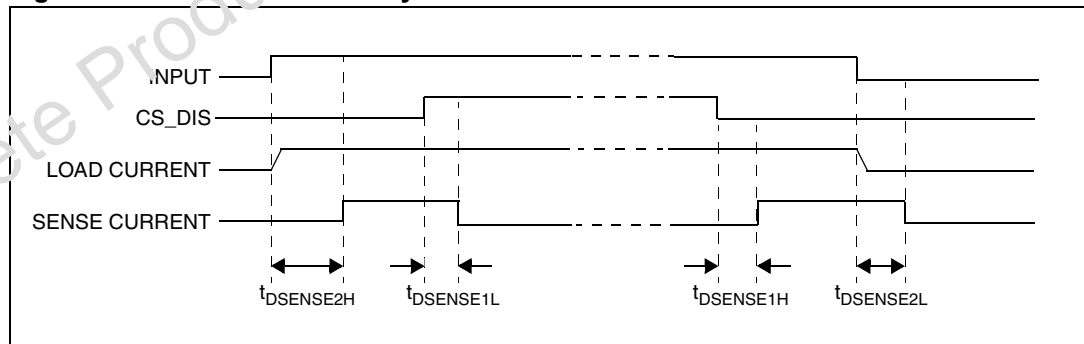
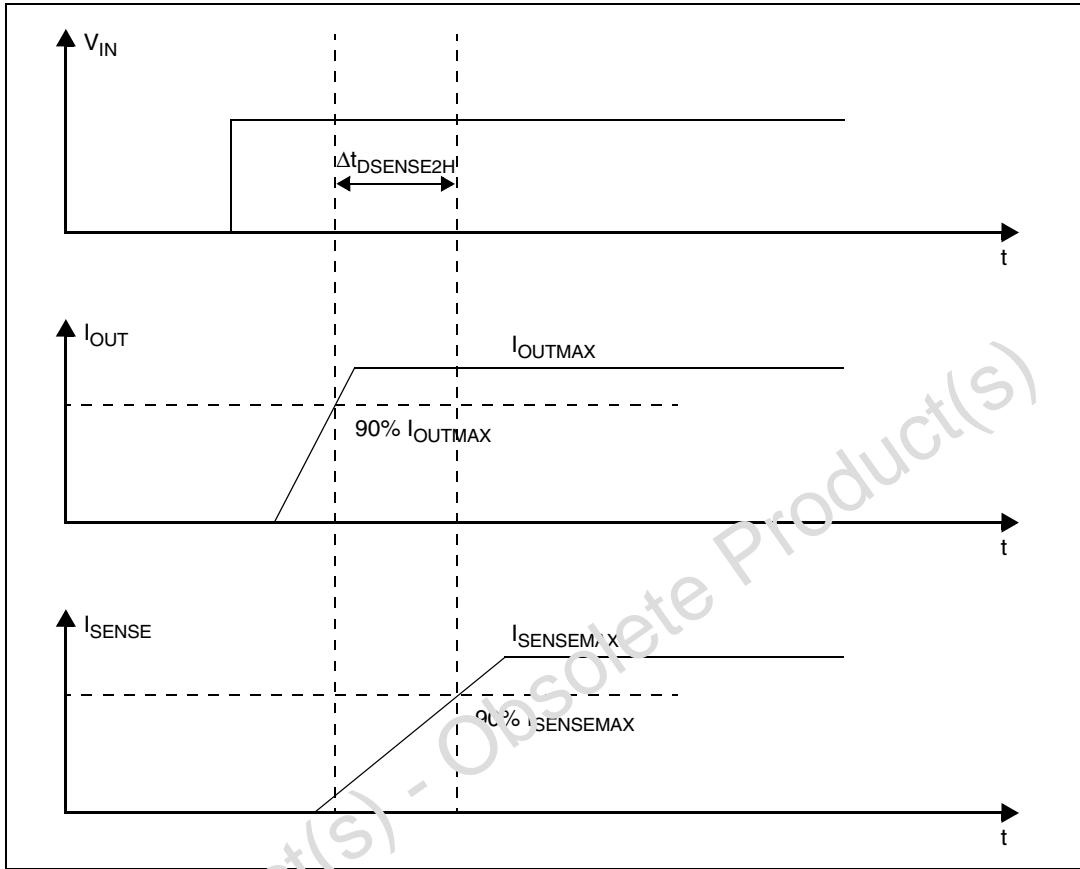


Figure 5. Delay response time between rising edge of output current and rising edge of current sense (CS enabled)



Obsolete Product(s) - Obsolete Product(s)

Figure 6.  $I_{OUT}/I_{SENSE}$  VS  $I_{OUT}$

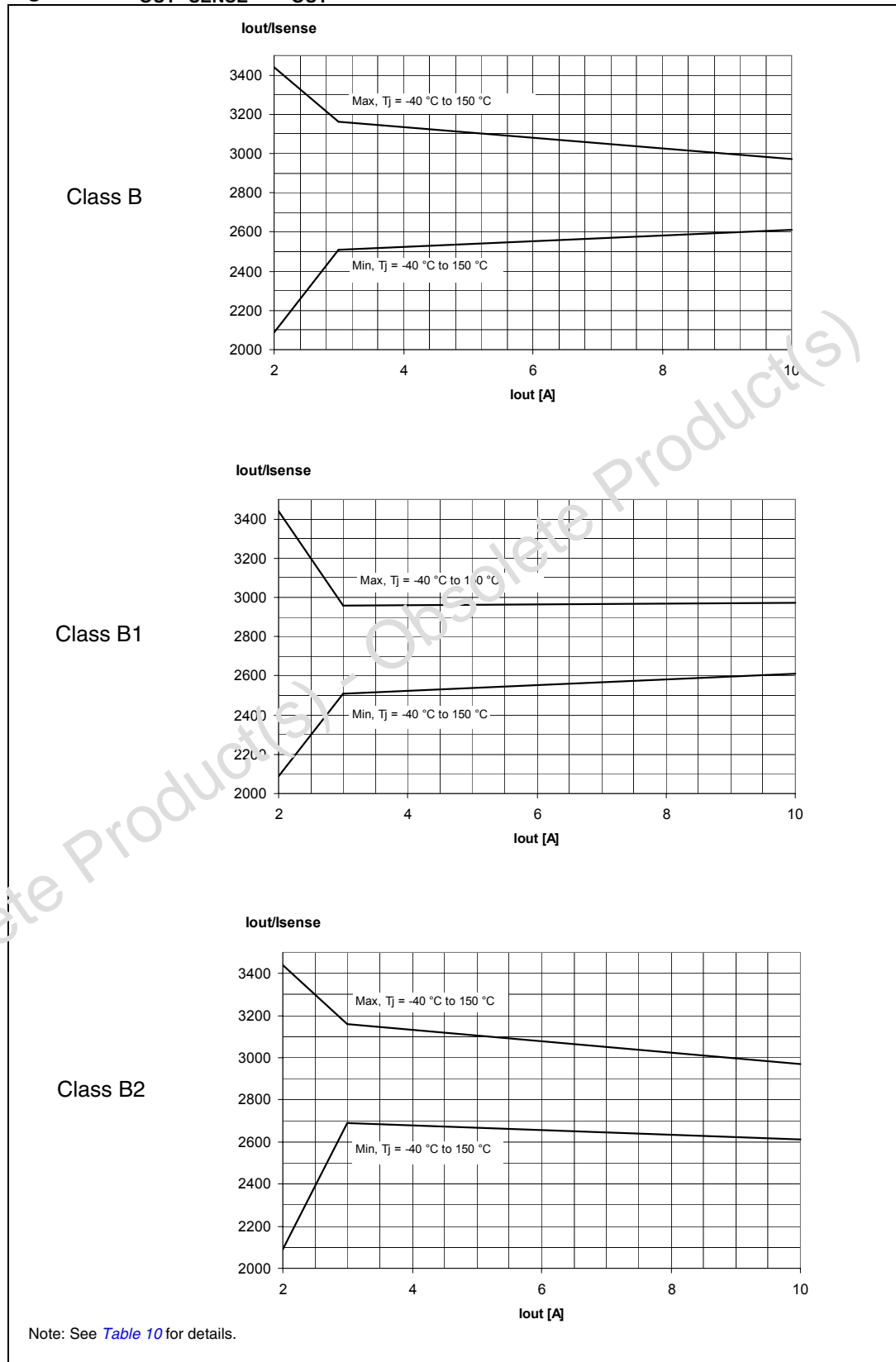


Figure 7. Maximum current sense ratio drift vs load current

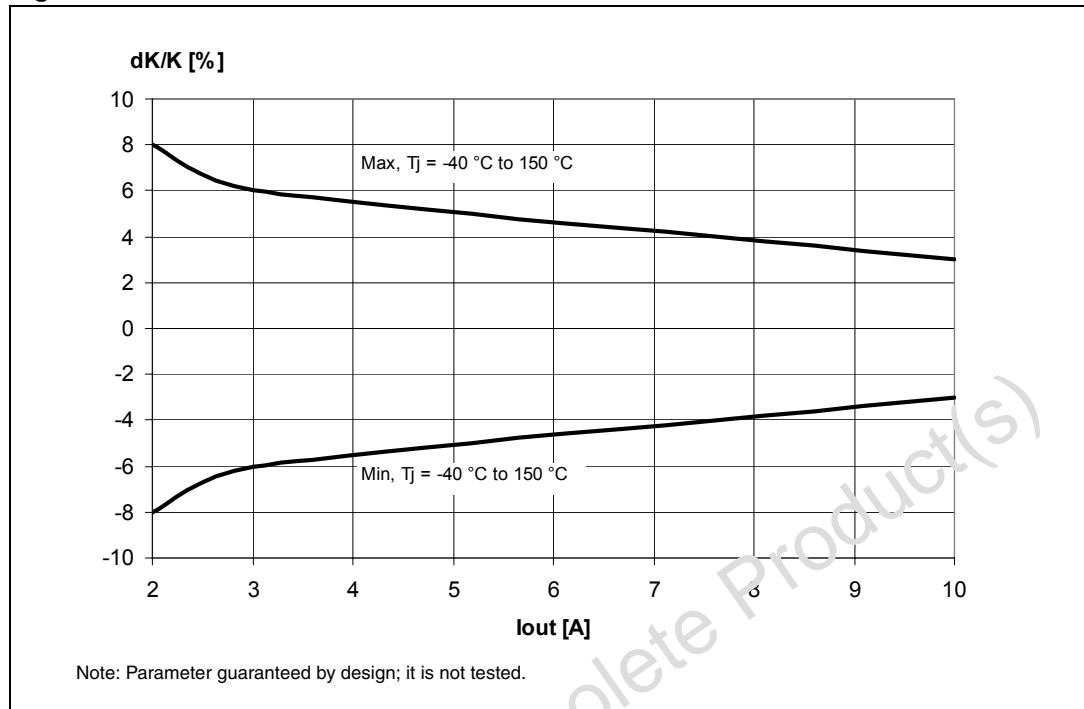


Table 11. Truth table

Conditions	Input	Output	Sense (V <sub>CSD</sub> = 0 V) <sup>(1)</sup>
Normal operation	L	L	0
	H	H	Nominal
Overtemperature	L	L	0
	H		V <sub>SENSEH</sub>
Undervoltage	L	L	0
	H		0
Short circuit to GND (R <sub>SC</sub> ≤ 10mΩ)	L	L	0
	H		0 if T <sub>j</sub> < T <sub>TSD</sub> V <sub>SENSEH</sub> if T <sub>j</sub> > T <sub>TSD</sub>
Short circuit to V <sub>CC</sub>	L	H	0
	H		< Nominal
Negative output voltage clamp	L	L	0

1. If the V<sub>CSD</sub> is high, the SENSE output is at a high impedance; its potential depends on leakage currents and external circuit.

Figure 8. Switching characteristics

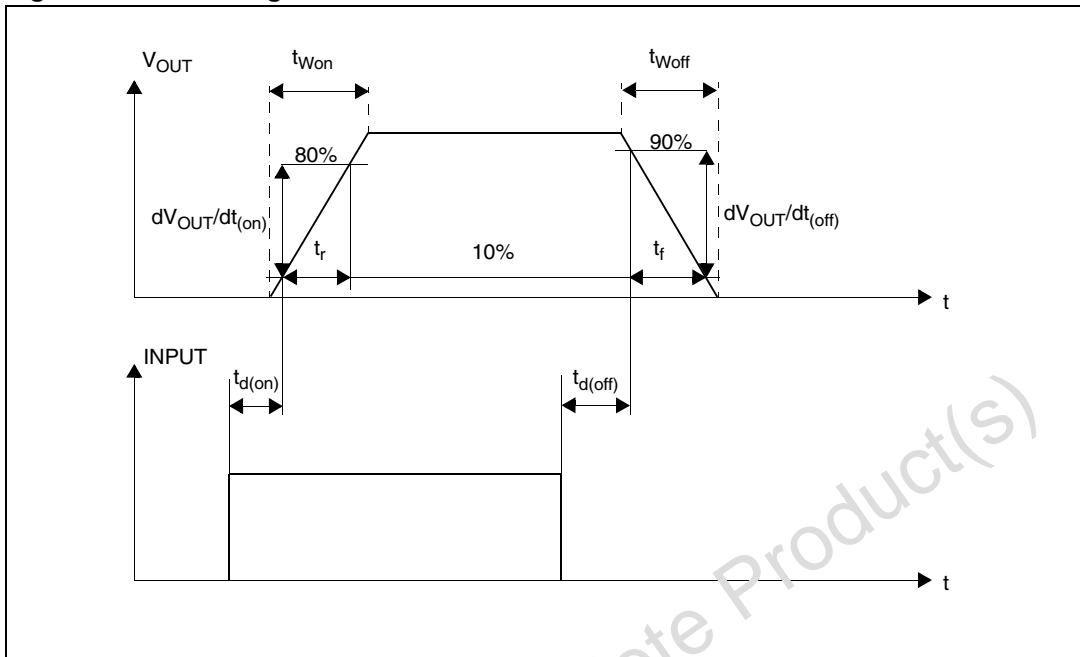
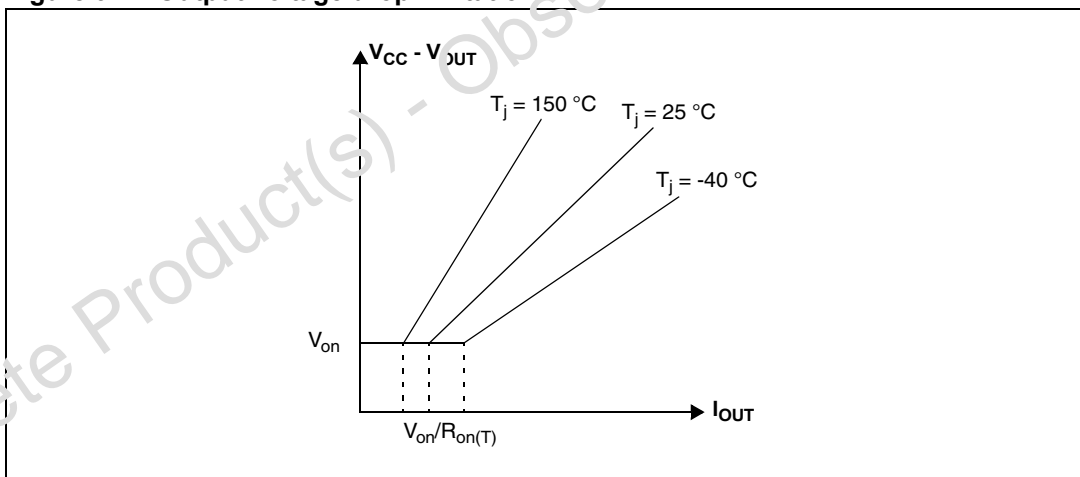


Figure 9. Output voltage drop limitation





**Table 12. Electrical transient requirements (part 1/3)**

ISO 7637-2: 2004(E) Test pulse	Test levels <sup>(1)</sup>		Number of pulses or test times	Burst cycle/pulse repetition time		Delays and Impedance
	III	IV		Min.	Max.	
1	-75V	-100V	5000 pulses	0.5s	5s	2 ms, 10Ω
2a	+37V	+50V	5000 pulses	0.2s	5s	50μs, 2Ω
3a	-100V	-150V	1h	90ms	100ms	0.1 μs, 50Ω
3b	+75V	+100V	1h	90ms	100ms	0.1 μs, 50Ω
4	-6V	-7V	1 pulse			100ms, 0.01Ω
5b <sup>(2)</sup>	+65V	+87V	1 pulse			400ms, 2Ω

1. The above test levels must be considered referred to V<sub>CC</sub> = 13.5V except for pulse 5b.

2. Valid in case of external load dump clamp: 40V maximum referred to ground.

**Table 13. Electrical transient requirements (part 2/3)**

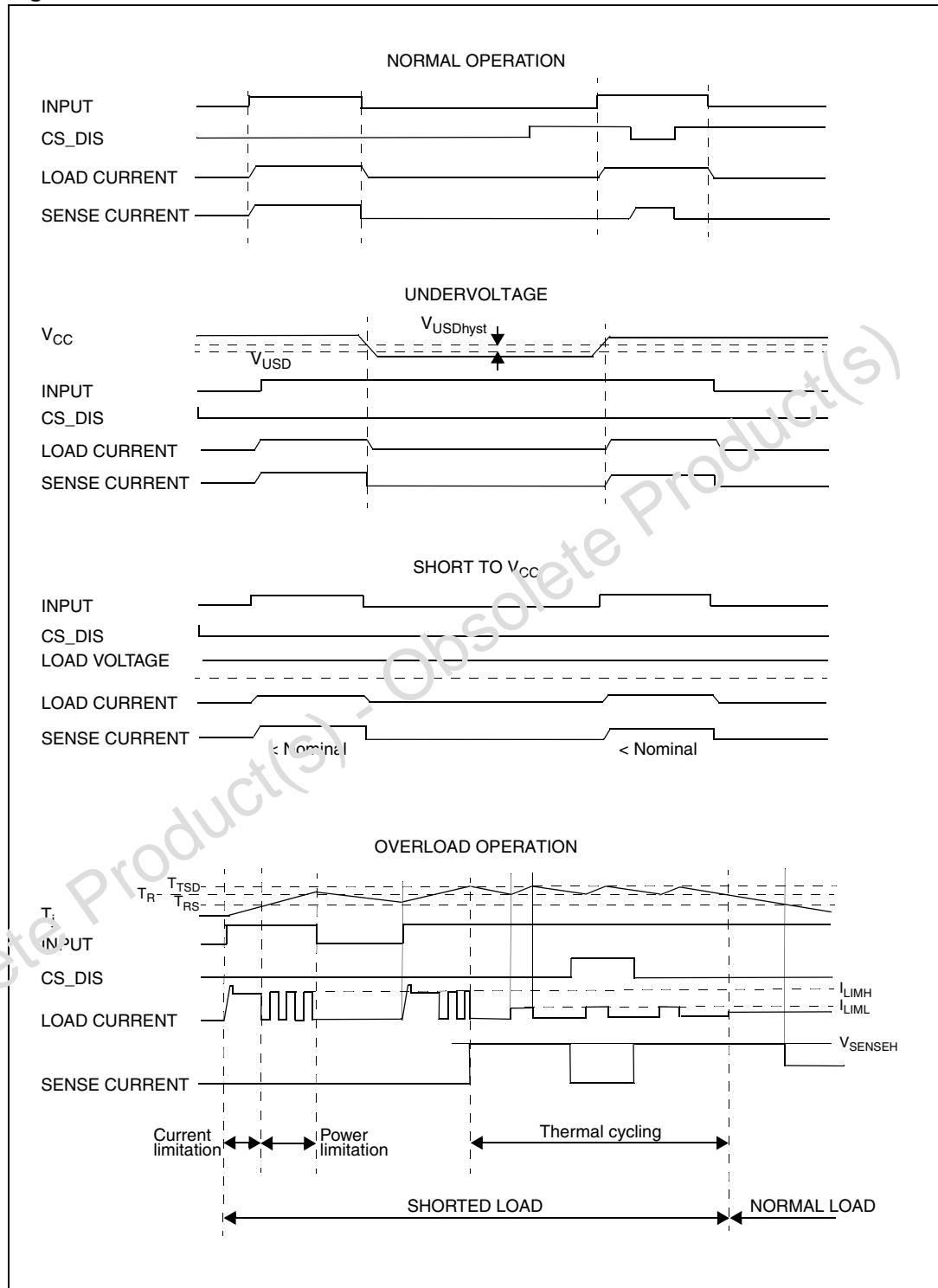
ISO 7637-2: 2004E Test pulse	Test level results	
	III	VI
1	C	C
2a	C	C
3a	C	C
3b	C	C
4	C	C
5b <sup>(1)</sup>	C	C

1. Valid in case of external load dump clamp: 40V maximum referred to ground.

**Table 14. Electrical transient requirements (part 3/3)**

Class	Contents
C	All functions of the device <b>performed</b> as designed after exposure to disturbance.
E	One or more functions of the device <b>did not perform</b> as designed after exposure to disturbance and cannot be returned to proper operation without replacing the device.

Figure 10. Waveforms



## 2.4 Electrical characteristics curves

Figure 11. Off-state output current

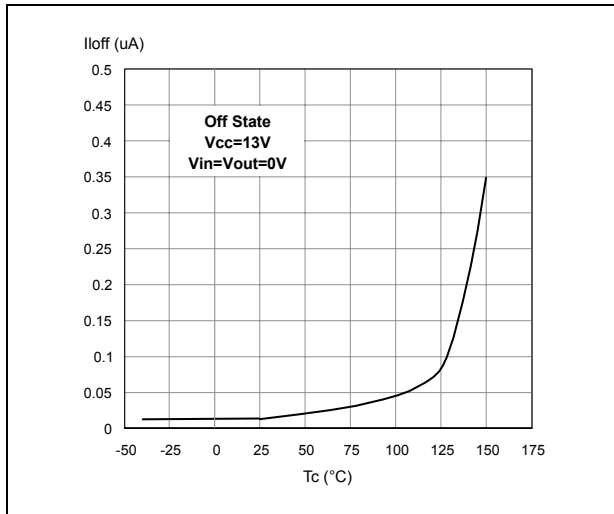


Figure 12. High level input current

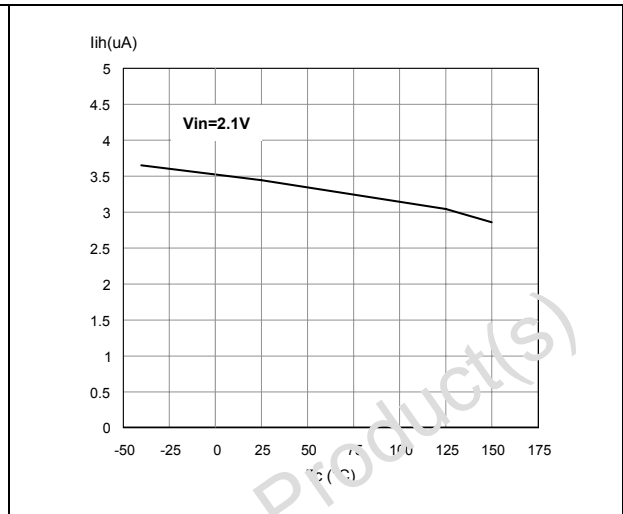


Figure 13. Input clamp voltage

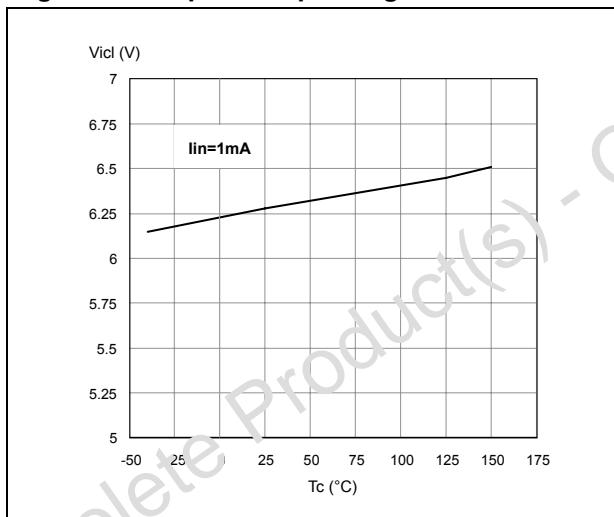


Figure 14. Input high level

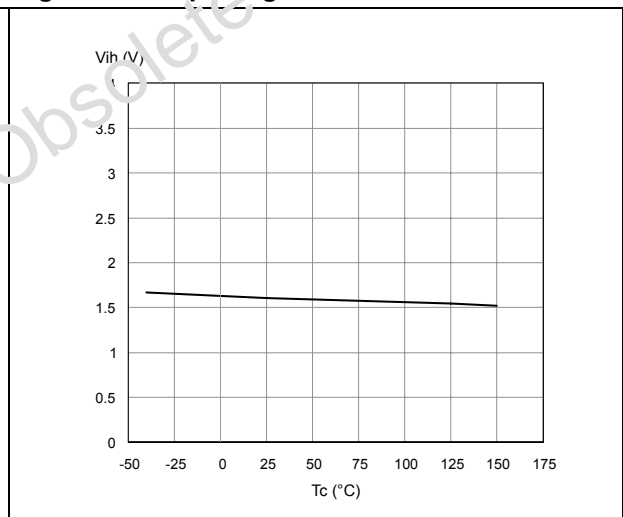


Figure 15. Input low level

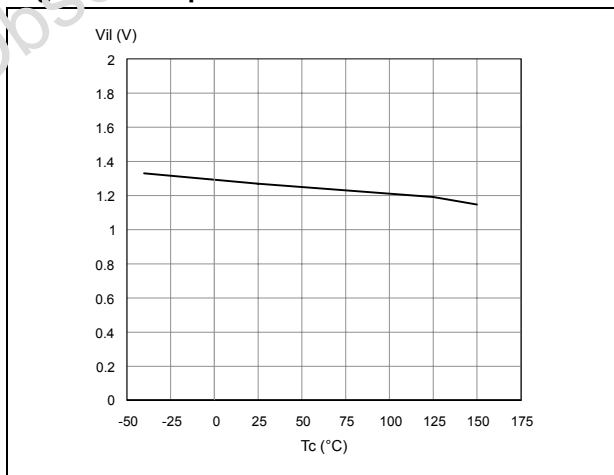


Figure 16. Input hysteresis voltage

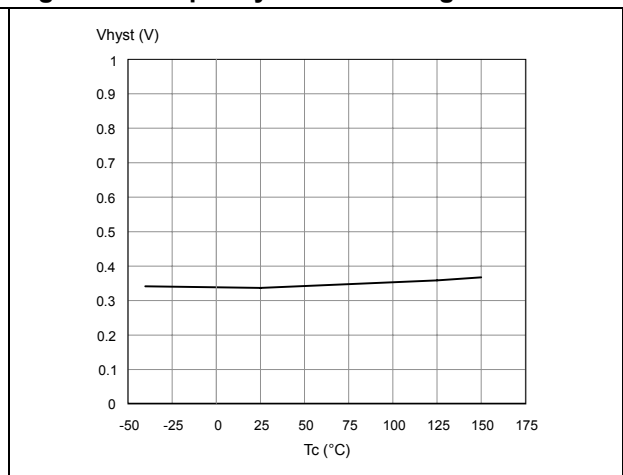


Figure 17. On-state resistance vs  $T_{case}$

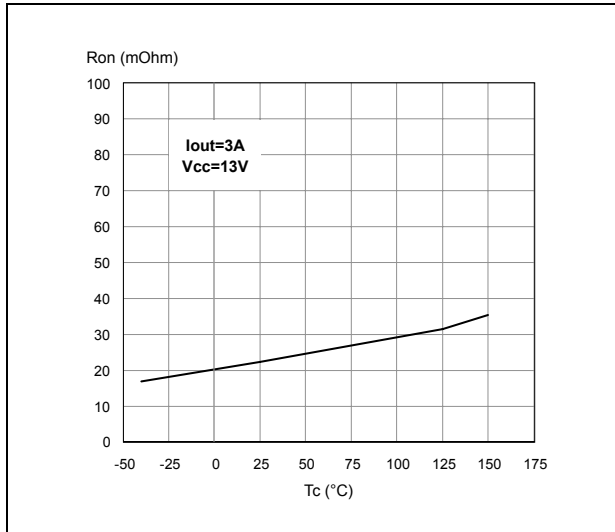


Figure 18. On-state resistance vs  $V_{CC}$

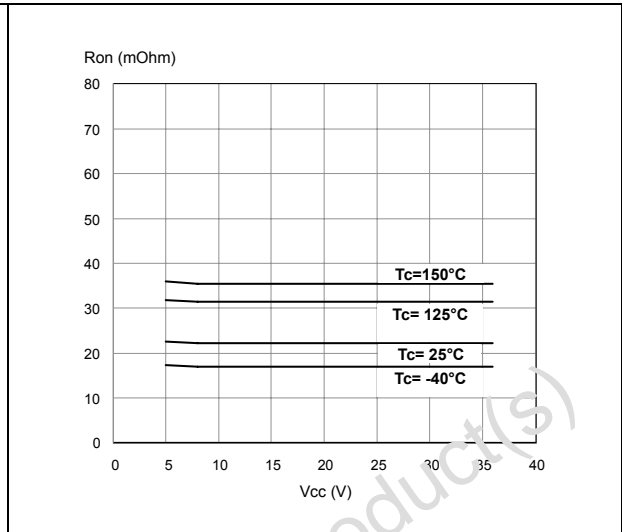


Figure 19. Undervoltage shutdown

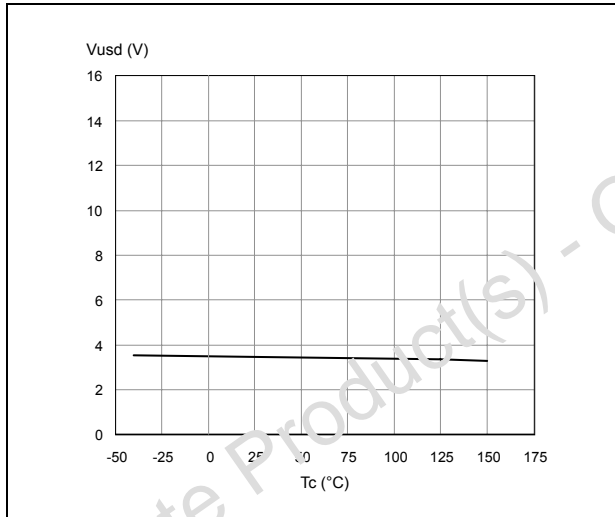


Figure 20.  $I_{LIMH}$  vs  $T_{case}$

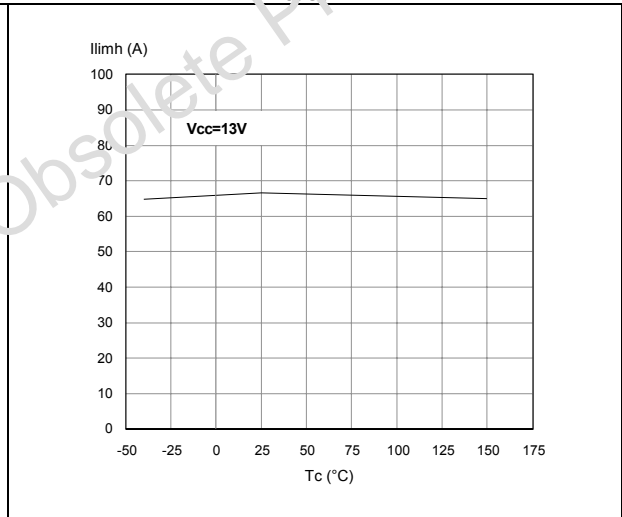


Figure 21. Turn-on voltage slope

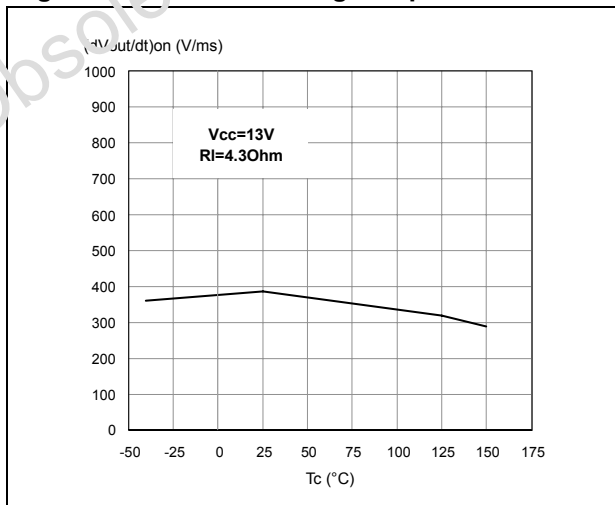


Figure 22. Turn-off voltage slope

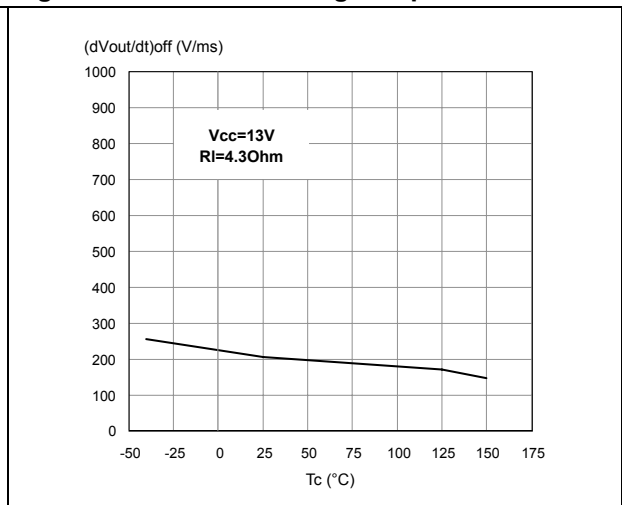


Figure 23. CS\_DIS high level voltage

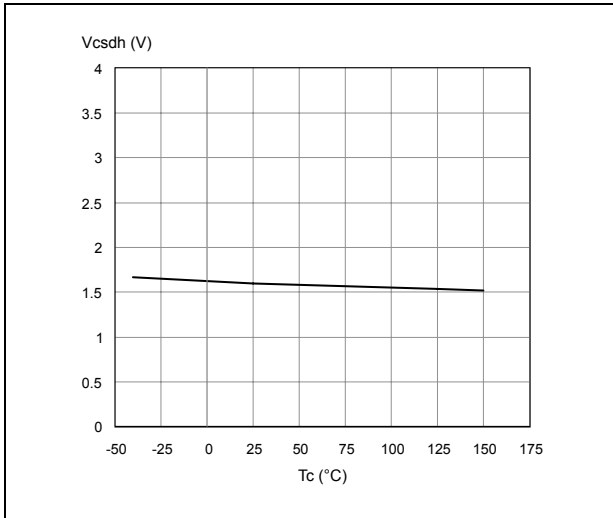


Figure 24. CS\_DIS low level voltage

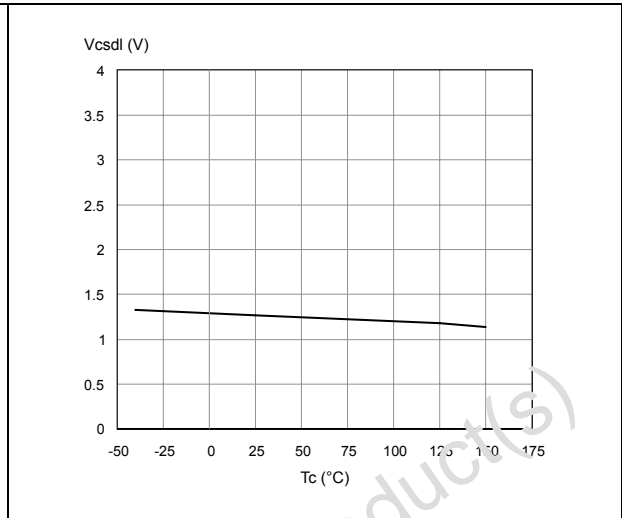
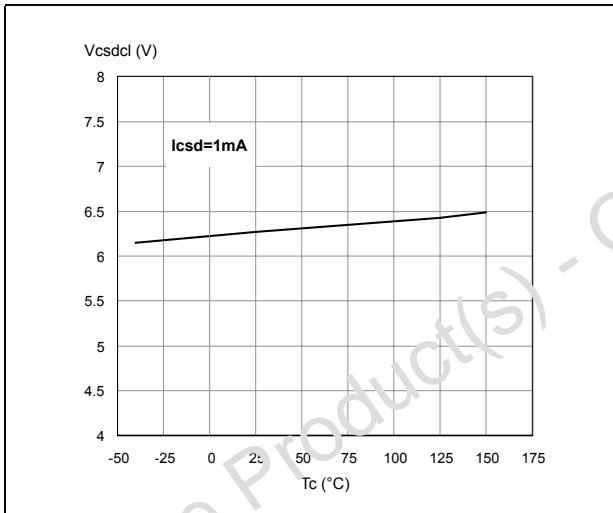


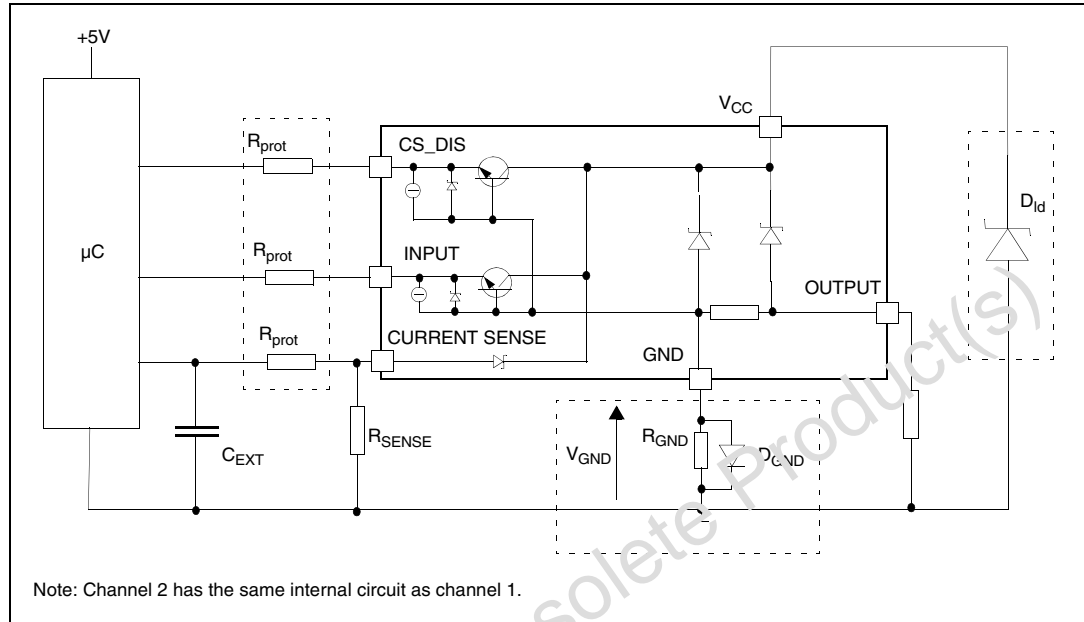
Figure 25. CS\_DIS clamp voltage



Obsolete Product(s) - Obsolete Product(s)

### 3 Application information

Figure 26. Application schematic



#### 3.1 GND protection network against reverse battery

This section provides two solutions for implementing a ground protection network against reverse battery.

##### 3.1.1 Solution 1: resistor in the ground line (R<sub>GND</sub> only)

This first solution can be used with any type of load.

The following formulas indicate how to dimension the R<sub>GND</sub> resistor:

1.  $R_{GND} \leq 600 \text{ mV} / (I_{S(on)max})$
2.  $R_{GND} \geq (-V_{CC}) / (-I_{GND})$

where -I<sub>GND</sub> is the DC reverse ground pin current and can be found in the absolute maximum rating section of the device datasheet.

Power Dissipation in R<sub>GND</sub> (when V<sub>CC</sub> < 0 during reverse battery situations) is:

$$P_D = (-V_{CC})^2 / R_{GND}$$

This resistor can be shared among several different HSDs. Please note that the value of this resistor is calculated with formula (1), where I<sub>S(on)max</sub> becomes the sum of the maximum on-state currents of the different devices.

Please note that if the microprocessor ground is not shared by the device ground, the R<sub>GND</sub> produces a shift (I<sub>S(on)max</sub> \* R<sub>GND</sub>) in the input thresholds and the status output values. This shift varies depending on how many devices are ON in the case of several high-side drivers sharing the same R<sub>GND</sub>.

If the calculated power dissipation leads to a large resistor or several devices have to share the same resistor, then ST suggests to utilize the following Solution 2.

### 3.1.2 Solution 2: diode ( $D_{GND}$ ) in the ground line

If the device drives an inductive load, insert a resistor ( $R_{GND} = 1 \text{ k}\Omega$ ) in parallel to  $D_{GND}$ .

This small signal diode can be safely shared among several different HSDs. Also in this case, the presence of the ground network produces a shift ( $\approx 600 \text{ mV}$ ) in the input threshold and in the status output values if the microprocessor ground is not common to the device ground. This shift does not vary if more than one HSD shares the same diode/resistor network.

## 3.2 Load dump protection

$D_{ld}$  is necessary (Voltage Transient Suppressor) if the load dump peak voltage exceeds the  $V_{CC}$  maximum DC rating. The same applies if the device is subject to transients on the  $V_{CC}$  line that are greater than the ones shown in the ISO 7637-2:2004E table.

## 3.3 MCU I/Os protection

If a ground protection network is used and negative transients are present on the  $V_{CC}$  line, the control pins are pulled negative. ST suggests to insert an in-line resistor ( $R_{prot}$ ) to prevent the microcontroller I/O pins from latch-up.

The value of these resistors is a compromise between the leakage current of microcontroller and the current required by the HSD I/Os (input levels compatibility) with the latch-up limit of microcontroller I/Os.

$$-V_{CCpeak}/I_{latchup} \leq R_{prot} \leq (V_{OH\mu C} - V_{IH} - V_{GND}) / I_{IHmax}$$

Calculation example:

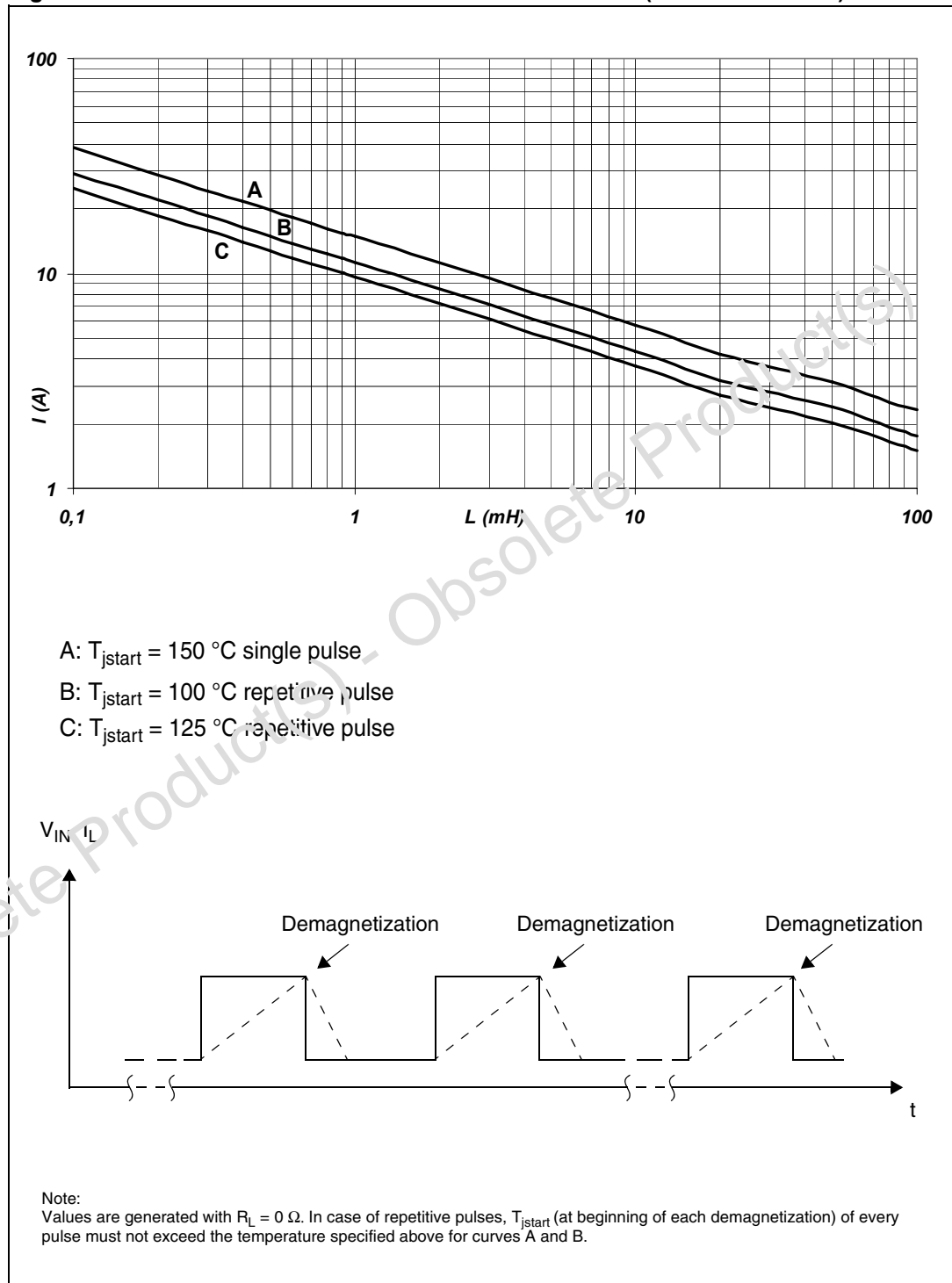
$$\text{For } V_{CCpeak} = -100 \text{ V and } I_{latchup} \geq 20 \text{ mA; } V_{OH\mu C} \geq 4.5 \text{ V}$$

$$5 \text{ k}\Omega \leq R_{prot} \leq 65 \text{ k}\Omega$$

Recommended values:  $R_{prot} = 10 \text{ k}\Omega$ ,  $C_{EXT} = 10 \text{ nF}$ .

### 3.4 Maximum demagnetization energy ( $V_{CC} = 13.5\text{ V}$ )

Figure 27. Maximum turn-off current versus inductance (for each channel)





## 4 Package and thermal data

### 4.1 PowerSSO-24™ thermal data

Figure 28. PowerSSO-24™ PC board

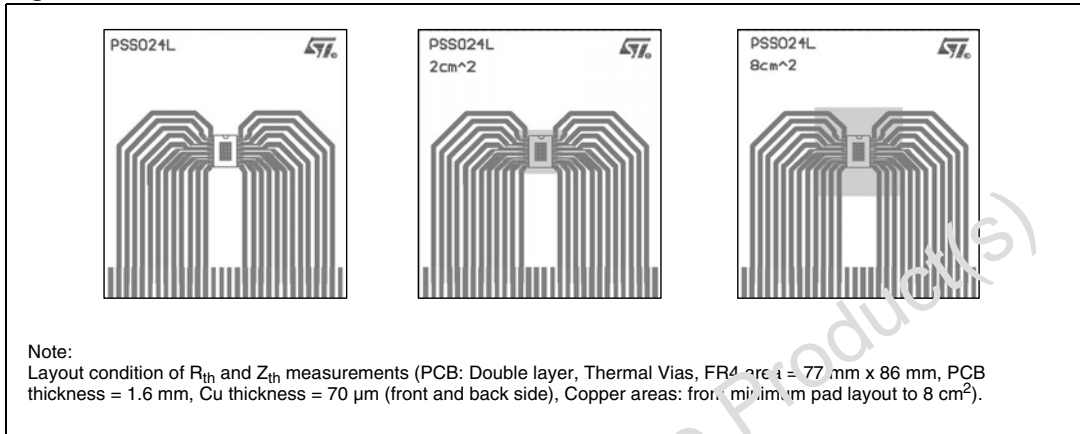


Figure 29.  $R_{thj-amb}$  vs PCB copper area in open box free air condition (one channel ON)

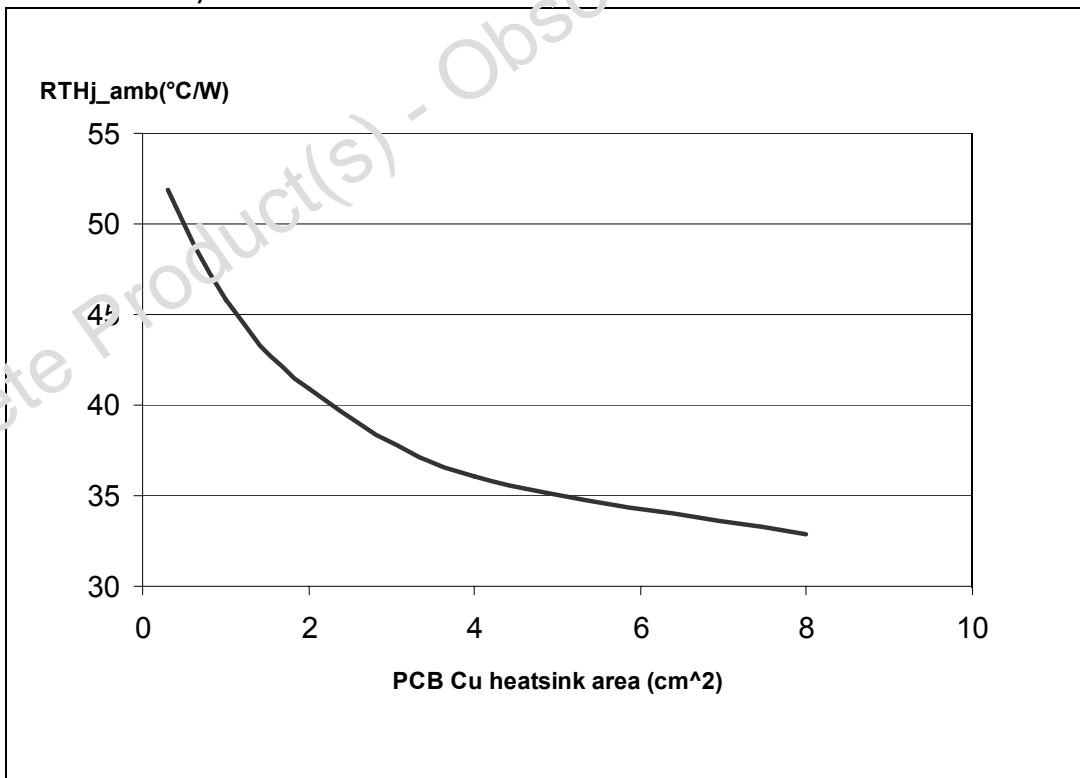
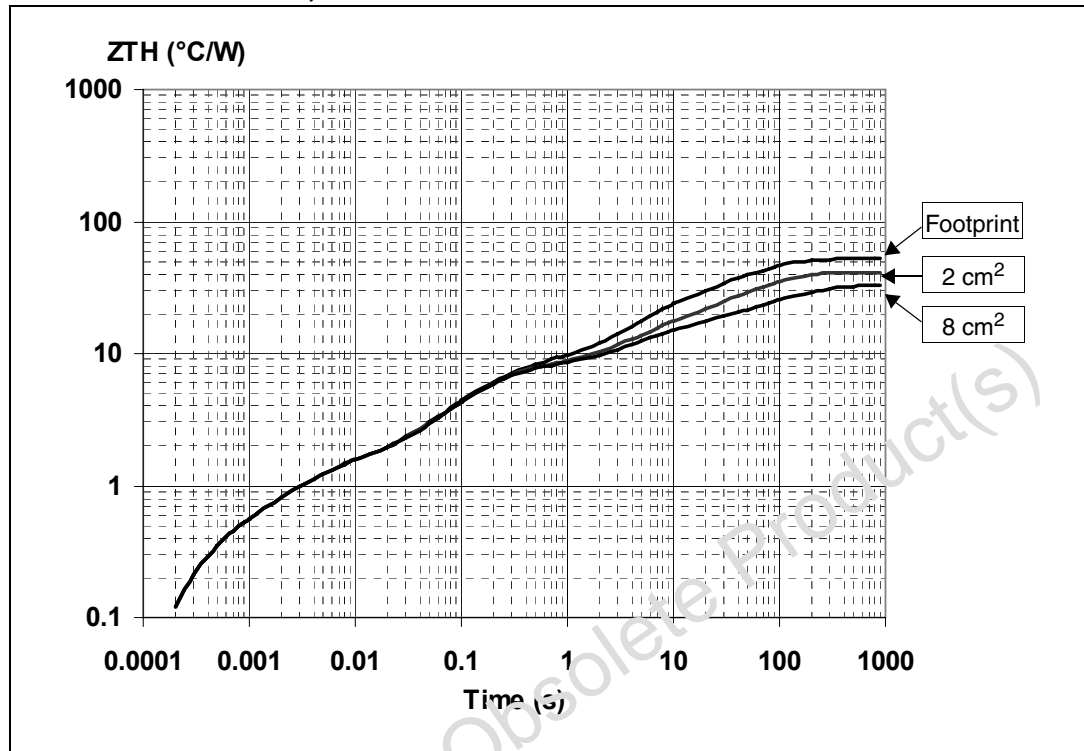


Figure 30. PowerSSO-24™ thermal impedance junction to ambient single pulse (one channel ON)

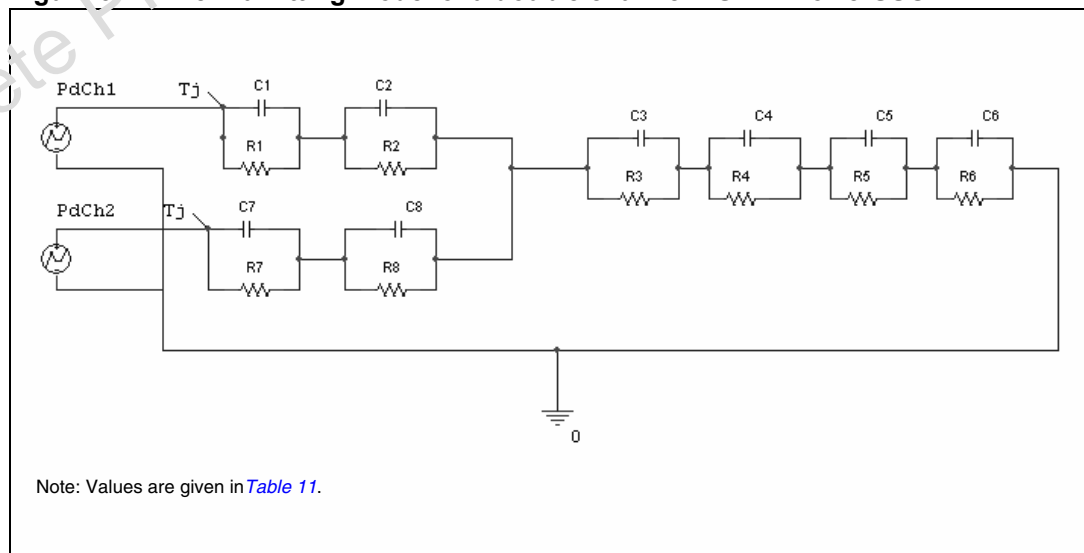


Equation 1: pulse calculation formula

$$Z_{TH\delta} = R_{TH} \cdot \delta + Z_{THt_c} (1 - \delta)$$

where  $\delta = t_p/T$

Figure 31. Thermal fitting model of a double channel HSD in PowerSSO-24™



Note: Values are given in Table 11.

Table 15. Thermal parameters

Area/Island (cm <sup>2</sup> )	Footprint	2	8
R1 (°C/W)	0.28		
R2 (°C/W)	0.9		
R3 (°C/W)	6		
R4 (°C/W)	7.7		
R5 (°C/W)	9	9	8
R6 (°C/W)	28	17	10
R7 (°C/W)	0.28		
R8 (°C/W)	0.9		
C1 (W.s/°C)	0.001		
C2 (W.s/°C)	0.003		
C3 (W.s/°C)	0.025		
C4 (W.s/°C)	0.75		
C5 (W.s/°C)	1	4	9
C6 (W.s/°C)	2.2	5	17
C7 (W.s/°C)	0.001		
C8 (W.s/°C)	0.003		

## 5 Package and packing information

### 5.1 ECOPACK<sup>®</sup> packages

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com).

ECOPACK<sup>®</sup> is an ST trademark.

### 5.2 Package mechanical data

Figure 32. PowerSSO-24™ package dimensions

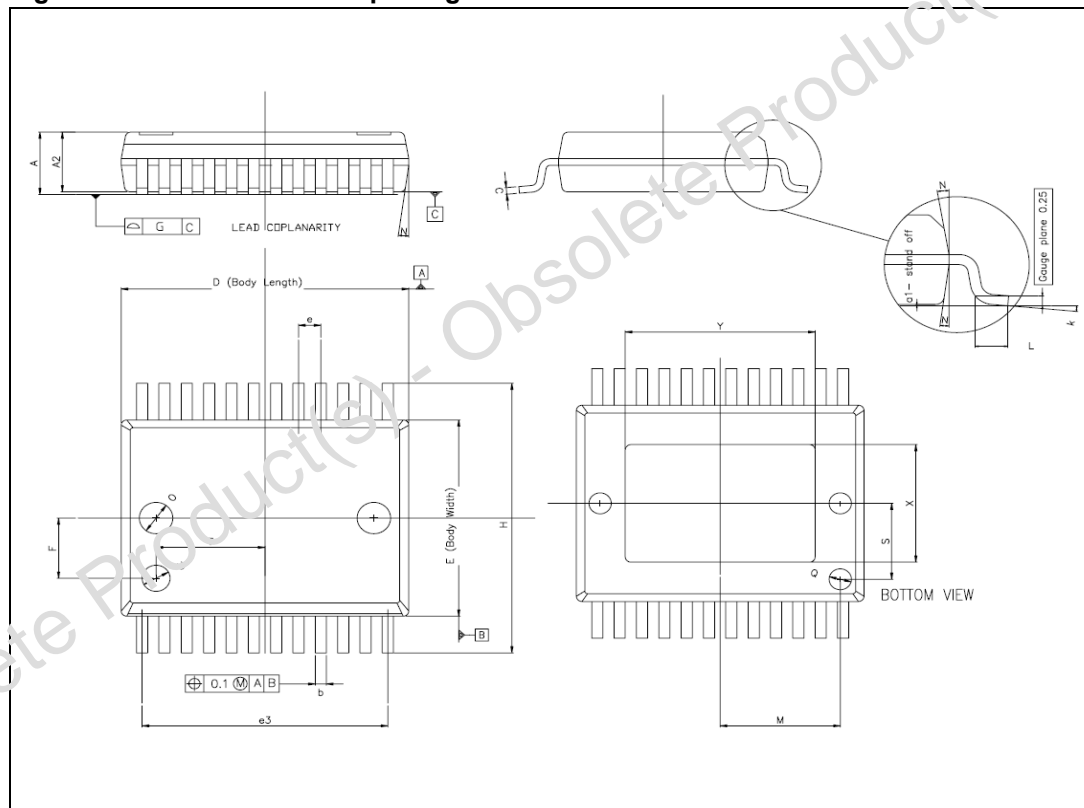


Table 16. PowerSSO-24™ mechanical data

Symbol	Millimeters		
	Min	Typ	Max
A			2.45
A2	2.15		2.35
a1	0		0.1
b	0.33		0.51
c	0.23		0.32
D	10.10		10.50
E	7.4		7.9
e		0.8	
e3		8.8	
F		2.3	
G			0.1
H	10.1		10.5
h			0.4
k	0°		8°
L	0.55		0.85
O		1.2	
Q		0.8	
S		2.9	
T		3.65	
U		1.0	
N			10°
X	4.1		4.7
Y	6.5		7.1

### 5.3 Packing information

Figure 33. PowerSSO-24™ tube shipment (no suffix)

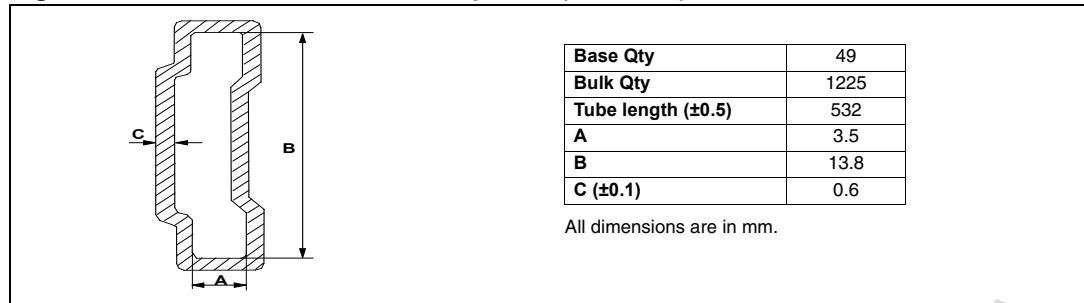
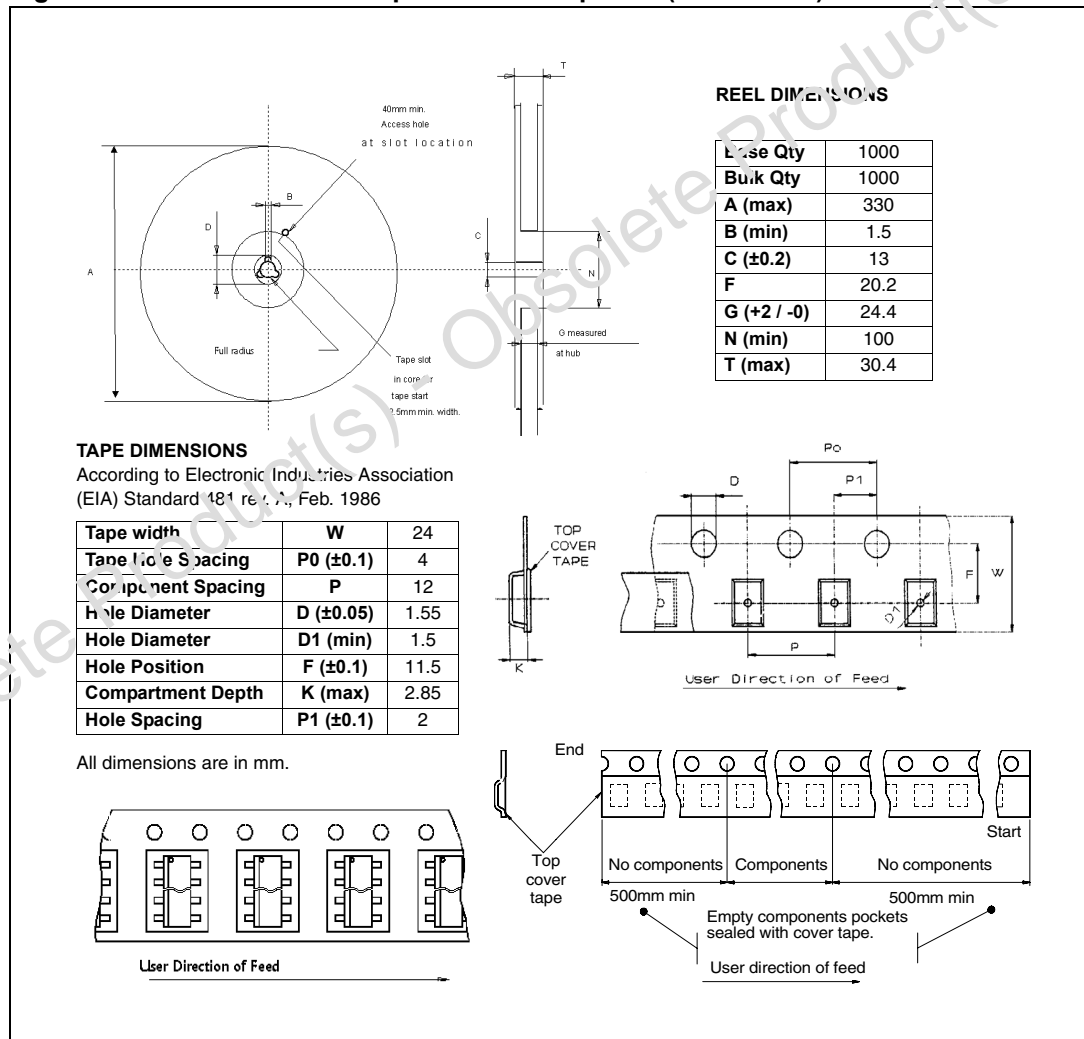


Figure 34. PowerSSO-24™ tape and reel shipment (suffix “TR”)



## 6 Revision history

**Table 17. Document revision history**

Date	Revision	Changes
28-Mar-2007	1	Initial release
02-Jul-2009	2	Updated <a href="#">Table 16: PowerSSO-24™ mechanical data</a>
23-Jul-2009	3	Updated <a href="#">Figure 32: PowerSSO-24™ package dimensions</a> . Updated <a href="#">Table 16: PowerSSO-24™ mechanical data</a> : – Deleted G1 row – Added O, Q, S, T and U rows
08-Feb-2010	4	Updated $I_{LIMH}$ value from 41 A to 60 A
22-Jul-2010	5	Updated <a href="#">Table 1: Device summary</a> . <a href="#">Table 10: Current sense (8 V &lt; <math>V_{CC}</math> &lt; 16 V)</a> : – Updated $K_2$ values and test conditions Updated <a href="#">Figure 6: <math>I_{OUT}/I_{SENSE}</math> vs <math>I_{OUT}</math></a>
05-Aug-2010	6	<a href="#">Table 10: Current sense (8 V &lt; <math>V_{CC}</math> &lt; 16 V)</a> : – Updated $K_1$ minimum value at $T_j = 25\text{ °C}$ to 150 °C

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