VND5025LAK-E

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

Features

Max supply voltage	V_{CC}	41V
Operating voltage range	V_{CC}	4.5 to 36V
Max on-state resistance (per ch.)	R_{ON}	25mΩ
Current limitation (typ)	I_{LIMH}	60A
Off state supply current	I_S	2µA(1)

1. Typical value with all loads connected

- Features
  - In-rush current active management by power limitation
  - Very low stand-by current
  - 3.0V CMOS compatible input
  - Optimized electromagnetic emission
  - Very low electromagnetic susceptibility
  - In compliance with the 2002/95/EC European directive
  - Package: ECOPACK®
- Diagnostic functions
  - 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 shut-down
  - Overvoltage clamp
  - Load current limitation
  - Self-limiting of fast thermal transients
  - Protection against loss of ground and loss of V_{CC}

PowerSSO-24™

  - Thermal shut down
  - Reverse battery protection(a)
  - Electrostatic discharge protection

Description

The VND5025LAK-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_{CC} 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 shut-down intervention. Thermal shut-down with automatic restart allows the device to recover normal operation as soon as fault condition disappears.

Table 1. Order codes

Package	Tube	Tape and Reel
PowerSSO-24™	VND5025LAK-E	VND5025LAKTR-E

a. See *Figure 26: Application schematic*

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1 Block diagram and pin description

Figure 1. Block diagram

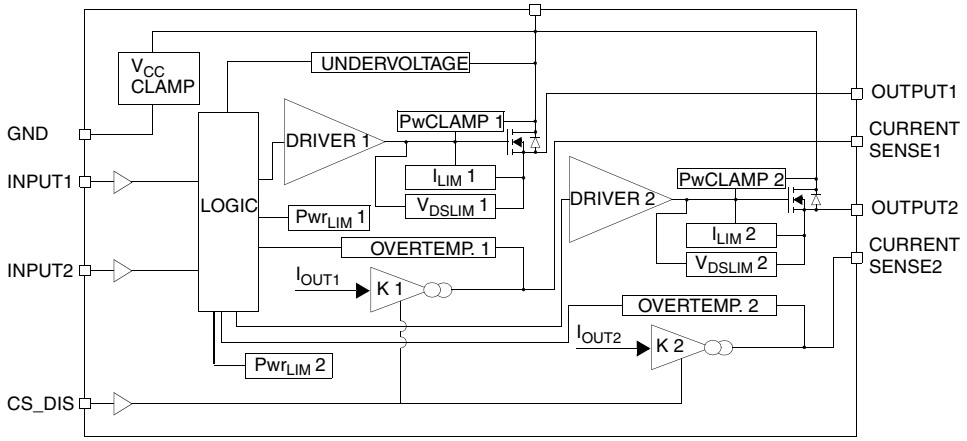
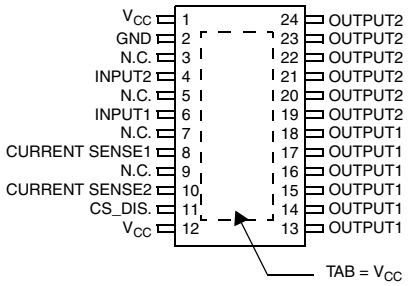


Table 2. Pin functions

Name	Function
V_{CC}	Battery connection
$OUTPUT_{1,2}$	Power output
GND	Ground connection; must be reverse battery protected by an external diode/resistor network
$INPUT_{1,2}$	Voltage controlled input pin with hysteresis, CMOS compatible; controls output switch state
CURRENT $SENSE_{1,2}$	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) and suggested connections for unused and N.C. pins

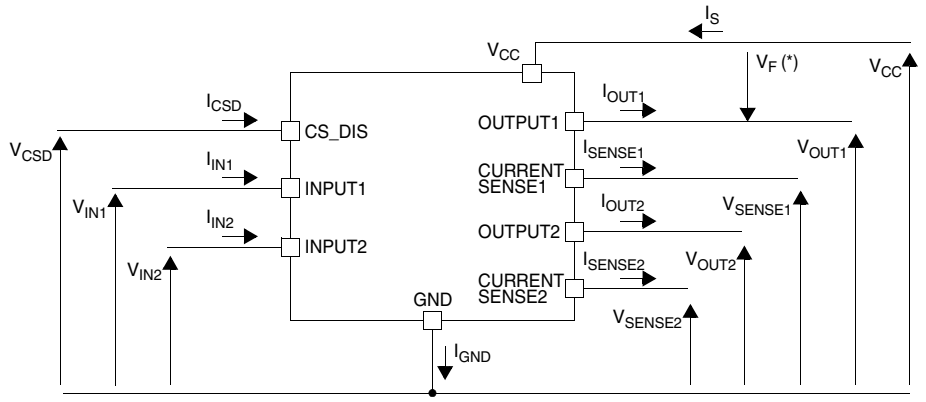


Connection / Pin	Current Sense	N.C.	Output	Input	CS_DIS
Floating	N.R.	X	X	X	X
To Ground	1kΩ resistor	X	N.R.	10kΩ resistor	10kΩ resistor

N.R. = Not recommended

2 Electrical characteristics

Figure 3. Current and voltage conventions



(*) $V_{Fn} = V_{OUTn} - V_{CC}$ during reverse battery condition

2.1 Absolute maximum ratings

Table 3. 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
E_{MAX}(1)	Maximum switching energy (single pulse) (L = 0.3mH; R_L = 0Ω; V_{bat} = 13.5V; T_{jstart} = 150°C; I_{OUT} = I_{limL}*(Typ.)*)	109	mJ
V_{ESD}	Electrostatic Discharge (Human Body Model: R = 1.5kΩ; C = 100pF) - Input - Current sense - CS_DIS - Output - V_{CC}	 4000 2000 4000 5000 5000	 V V V V 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 4. Thermal data

Symbol	Parameter	Max Value	Unit
$R_{thj\text{-}case}$	Thermal resistance junction-case (MAX) (with one channel ON)	1.35	°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient (MAX)	See *Figure 29*	

Table 5. Power section (8V < V_{CC} < 36V; -40°C < T_j < 150°C, unless otherwise specified)

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
V_{CC}	Operating supply voltage		4.5	13	36	V
V_{USD}	Undervoltage shutdown			3.5	4.5	
$V_{USDhyst}$	Undervoltage shut-down hysteresis			0.5		
R_{ON}	On state resistance(1)	I_{OUT} = 3A; T_j = 25°C			25	mΩ
		I_{OUT} = 3A; T_j = 150°C			50	
		I_{OUT} = 3A; V_{CC} = 5V; T_j = 25°C			35	
V_{clamp}	Clamp voltage	I_S = 20 mA	41	46	52	V
I_S	Supply current	Off State; V_{CC} = 13V; T_j = 25°C; V_{IN} = V_{OUT} = V_{SENSE} = V_{CSD} = 0V		2(2)	5(2)	µA
		On State; V_{CC} = 13V; V_{IN} = 5V; I_{OUT} = 0A		3	6	mA
$I_{L(off)}$	Off state output current(1)	V_{IN} = V_{OUT} = 0V; V_{CC} = 13V; T_j = 25°C	0	0.01	3	µA
		V_{IN} = V_{OUT} = 0V; V_{CC} = 13V; T_j = 125°C	0		5	
V_F	Output - V_{CC} diode voltage(1)	-I_{OUT} = 4A; T_j = 150°C			0.7	V

1. For each channel
2. PowerMOS leakage included

Table 6. Switching (V_{CC} = 13V; T_j = 25°C)

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
$t_{d(on)}$	Turn-on delay time	R_L = 4.3Ω (see *Figure 8*)		35		µs
$t_{d(off)}$	Turn-off delay time			50		
$(dV_{OUT}/dt)_{on}$	Turn-on voltage slope	R_L = 4.3Ω		(see *Figure 21*)		V/µs
$(dV_{OUT}/dt)_{off}$	Turn-off voltage slope			(see *Figure 22*)		
W_{ON}	Switching energy losses during t_{WON}	R_L = 4.3Ω (see *Figure 8*)		0.45		mJ
W_{OFF}	Switching energy losses during t_{WOFF}			0.35		

Table 7. Logic input

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

Table 8. Protection and diagnostics(1)

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
I_{LIMH}	DC short circuit current	V_{CC} = 13V	43	60	85	A
		5V < V_{CC} < 36V				
I_{LIML}	Short circuit current during thermal cycling	V_{CC} = 13V; $T_R < T_j < T_{TSD}$		24		
T_{TSD}	Shutdown temperature		150	175	200	°C
T_R	Reset temperature		T_{RS} + 1	T_{RS} + 5		
T_{RS}	Thermal reset of STATUS		135			
T_{HYST}	Thermal hysteresis (T_{TSD}-T_R)			7		
V_{DEMAG}	Turn-off output voltage clamp	I_{OUT} = 2A; V_{IN} = 0; L = 6mH	V_{CC} - 41	V_{CC} - 46	V_{CC} - 52	V
V_{ON}	Output voltage drop limitation	I_{OUT} = 0.2A; T_j = -40°C to +150°C (see *Figure 9*)		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 9. Current sense (8V < V_{CC} < 16V)

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
K_{LED}	I_{OUT}/I_{SENSE}	I_{OUT} = 0.05A; V_{SENSE} = 0.5V; V_{CSD} = 0V; T_j = -40°C to 150°C	1450	3300	5180	
K_0	I_{OUT}/I_{SENSE}	I_{OUT} = 0.5A; V_{SENSE} = 0.5V; V_{CSD} = 0V; T_j = -40°C to 150°C	1720	3020	4360	
K_1	I_{OUT}/I_{SENSE}	I_{OUT} = 2A; V_{SENSE} = 4V; V_{CSD} = 0V; T_j = -40°C T_j = 25°C to 150°C	 1940 2230	 2810 2810	 3740 3390	
dK_1/K_1 (1)	Current sense ratio drift	I_{OUT} = 2A; V_{SENSE} = 4V; V_{CSD} = 0V; T_j = -40°C to 150°C	-10		+10	%
K_2	I_{OUT}/I_{SENSE}	I_{OUT} = 3A; V_{SENSE} = 4V; V_{CSD} = 0V; T_j = -40°C T_j = 25°C to150°C	 2250 2400	 2790 2790	 3450 3180	
dK_2/K_2 (1)	Current sense ratio drift	I_{OUT} = 3A; V_{SENSE} = 4V; V_{CSD} = 0V; T_j = -40°C to 150°C	-7		+7	%
K_3	I_{OUT}/I_{SENSE}	I_{OUT} = 10A; V_{SENSE} = 4V; V_{CSD} = 0V; T_j = -40°C T_j = 25°C to 150°C	 2610 2650	 2760 2760	 2970 2870	
dK_3/K_3 (1)	Current sense ratio drift	I_{OUT} = 10A; V_{SENSE} = 4V; V_{CSD} = 0V; T_j = -40°C to 150°C	-3		+3	%
I_{SENSE0}	Analog sense leakage current	I_{OUT} = 0A; V_{SENSE} = 0V; V_{CSD} = 5V; V_{IN} = 0V; T_j = -40°C to 150°C V_{CSD} = 0V; V_{IN} = 5V; T_j = -40°C to 150°C I_{OUT} = 2A; V_{SENSE} = 0V; V_{CSD} = 5V; V_{IN} = 5V; T_j = -40°C to 150°C	 0 0 0	 	 1 2 1	 µA µA µA
V_{SENSE}	Max analog sense output voltage	I_{OUT} = 3A; V_{CSD} = 0V	5			V
V_{SENSEH}	Analog sense output voltage in overtemperature condition	V_{CC} = 13V; R_{SENSE} = 3.9kΩ		9		
I_{SENSEH}	Analog sense output current in overtemperature condition	V_{CC} = 13V; V_{SENSE} = 5V		8		mA

Table 9. Current sense (8V < V_{CC} < 16V) (continued)

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
$t_{DSENSE1H}$	Delay response time from falling edge of CS_DIS pin	V_{SENSE} < 4V, 0.5 < I_{OUT} < 10A I_{SENSE} = 90% of $I_{SENSEMAX}$ (see *Figure 4*)		50	100	µs
$t_{DSENSE1L}$	Delay response time from rising edge of CS_DIS pin	V_{SENSE} < 4V, 0.5 < I_{OUT} < 10A I_{SENSE} = 10% of $I_{SENSEMAX}$ (see *Figure 4*)		5	20	
$t_{DSENSE2H}$	Delay response time from rising edge of INPUT pin	V_{SENSE} < 4V, 0.5 < I_{OUT} < 10A I_{SENSE} = 90% of $I_{SENSEMAX}$ (see *Figure 4*)		70	300	
$\Delta t_{DSENSE2H}$	Delay response time between rising edge of output current and rising edge of current sense	V_{SENSE} < 4V, I_{SENSE} = 90% of $I_{SENSEMAX}$, I_{OUT} = 90% of I_{OUTMAX}, I_{OUTMAX} = 3A (see *Figure 5*)			110	
$t_{DSENSE2L}$	Delay response time from falling edge of INPUT pin	V_{SENSE} < 4V, 0.5 < I_{OUT} < 10A I_{SENSE} = 10% of $I_{SENSEMAX}$ (see *Figure 4*)		100	250	

1. Parameter guaranteed by design; it is not tested.

Figure 4. Current sense delay characteristics

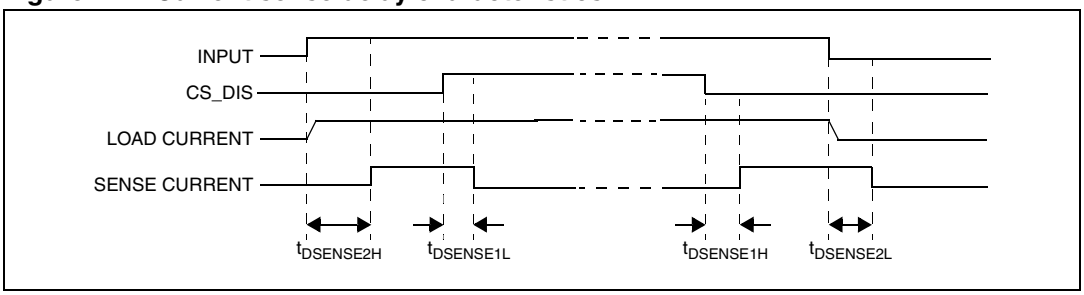


Figure 5. Delay response time between rising edge of ouput current and rising edge of current sense (CS enabled)

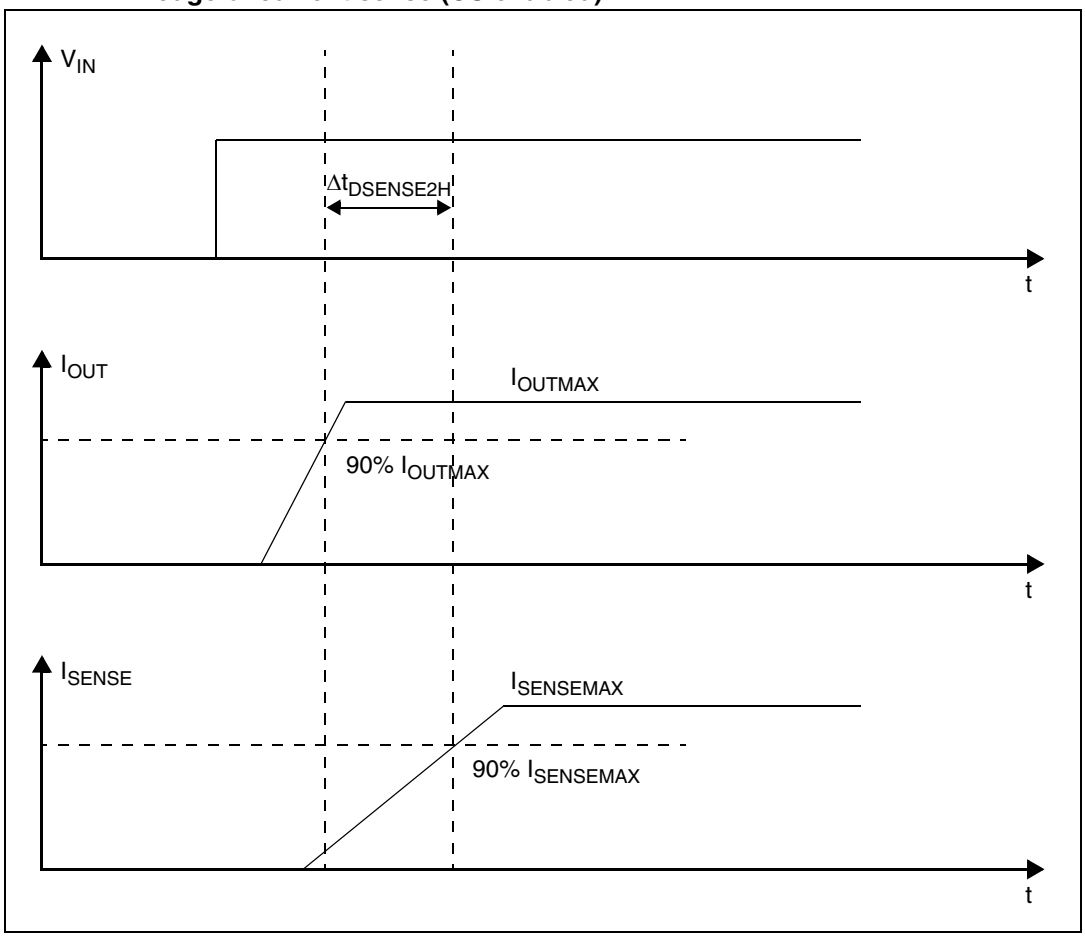


Figure 6. I_{OUT}/I_{SENSE} **vs** I_{OUT} (see *Table 9* for details)

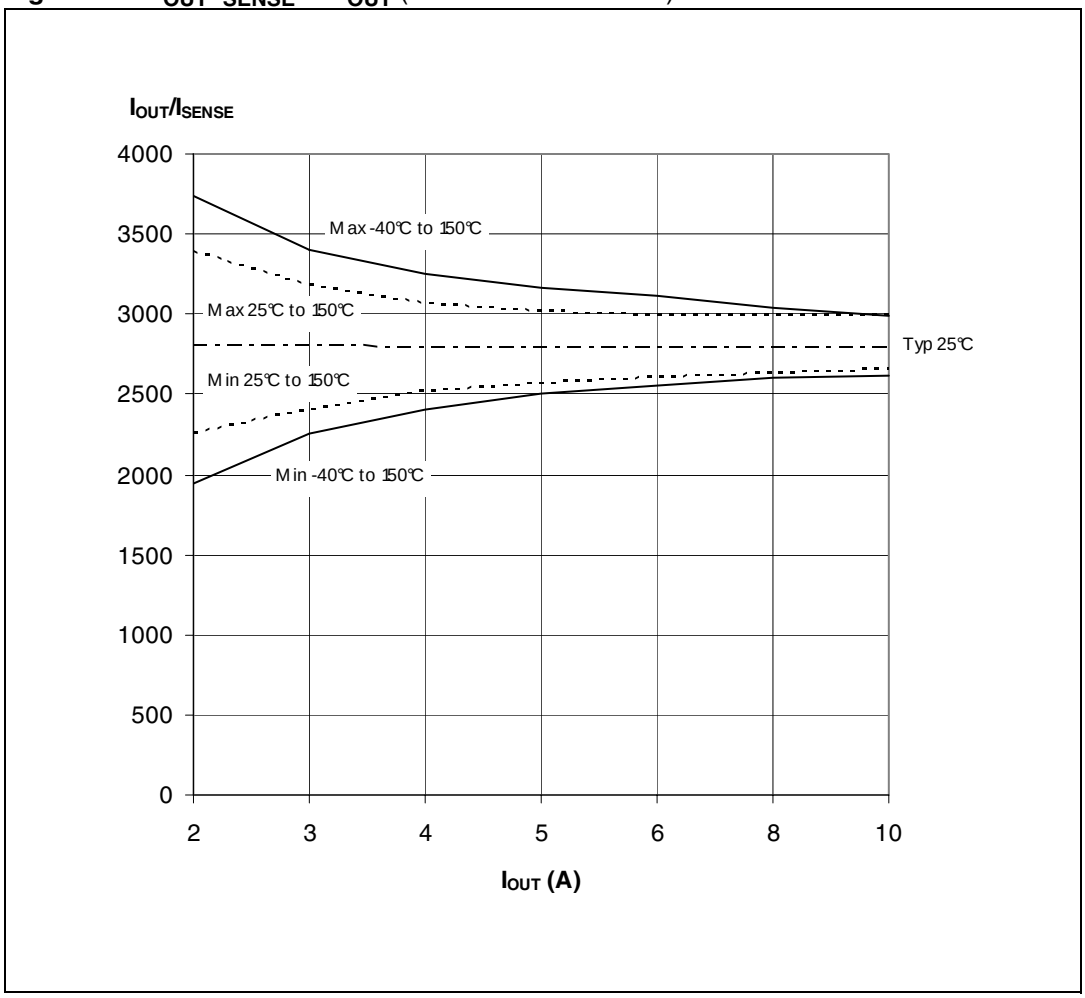
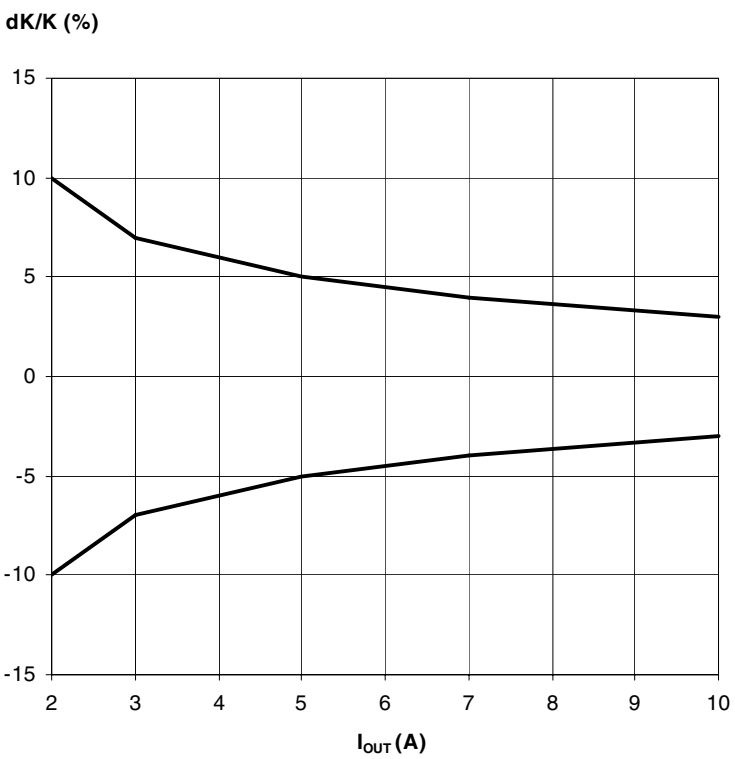


Figure 7. Maximum current sense ratio drift vs load current



Note: Parameter guaranteed by design; it is not tested.

Table 10. Truth table

Conditions	Input	Output	Sense (V_{CSD} = 0V)(1)
Normal operation	L	L	0
	H	H	Nominal
Overtemperature	L	L	0
	H		V_{SENSEH}
Undervoltage	L	L	0
	H		
Short circuit to GND ($R_{SC} \leq 10m\Omega$)	L	L	0
	H		0 if $T_j < T_{TSD}$
			V_{SENSEH} if $T_j > T_{TSD}$
Short circuit to V_{CC}	L	H	0
	H		< Nominal
Negative output voltage clamp	L	L	0

1. If the V_{CSD} is high, the SENSE output is at a high impedance; its potential depends on leakage currents and external circuit.

Figure 8. Switching characteristics

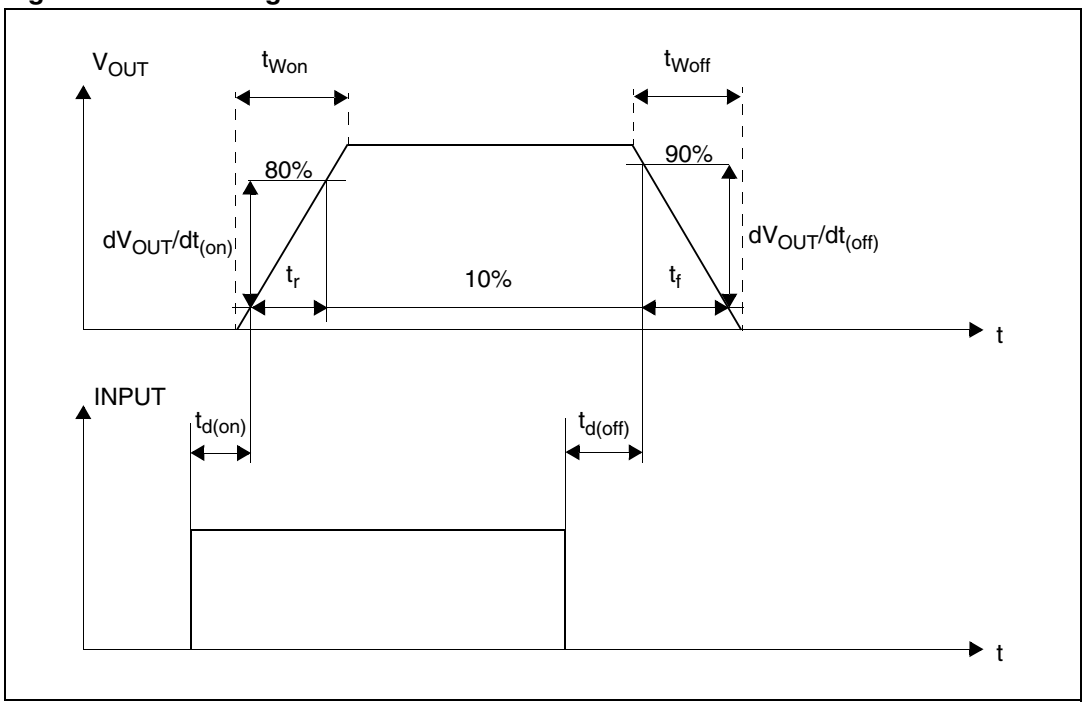


Figure 9. Output voltage drop limitation

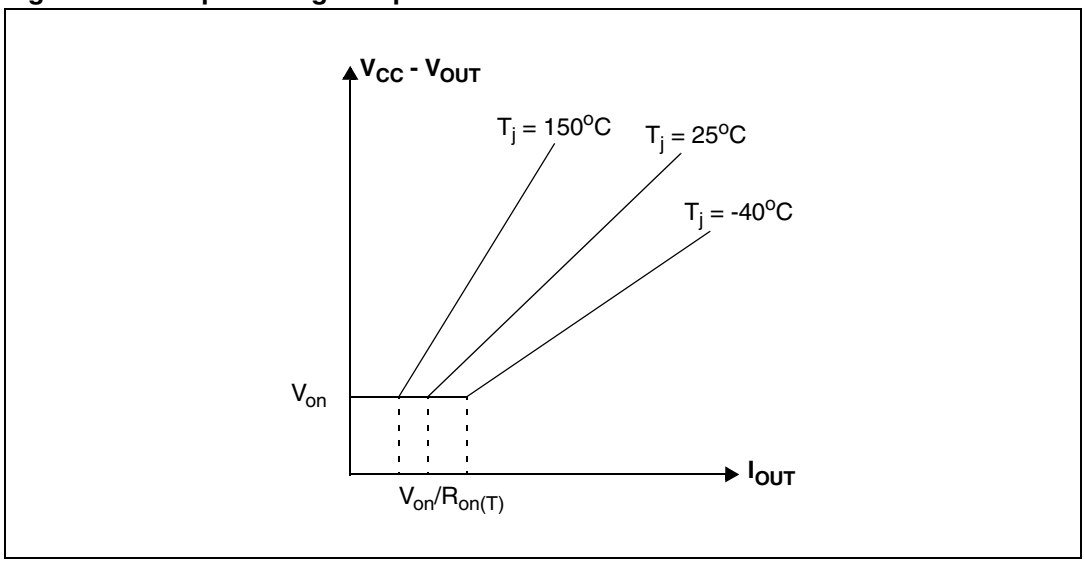


Table 11. Electrical transient requirements

ISO 7637-2: 2004(E) Test pulse	Test levels(1)		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	0.1µs, 50Ω
3b	+75V	+100V	1h	90ms	100ms	0.1µs, 50Ω
4	-6V	-7V	1 pulse			100ms, 0.01Ω
5b(2)	+65V	+87V	1 pulse			400ms, 2Ω

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(2)	C	C

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

1. The above test levels must be considered referred to V_{CC} = 13.5V except for pulse 5b.
2. Valid in case of external load dump clamp: 40V maximum referred to ground.

Figure 10. Waveforms

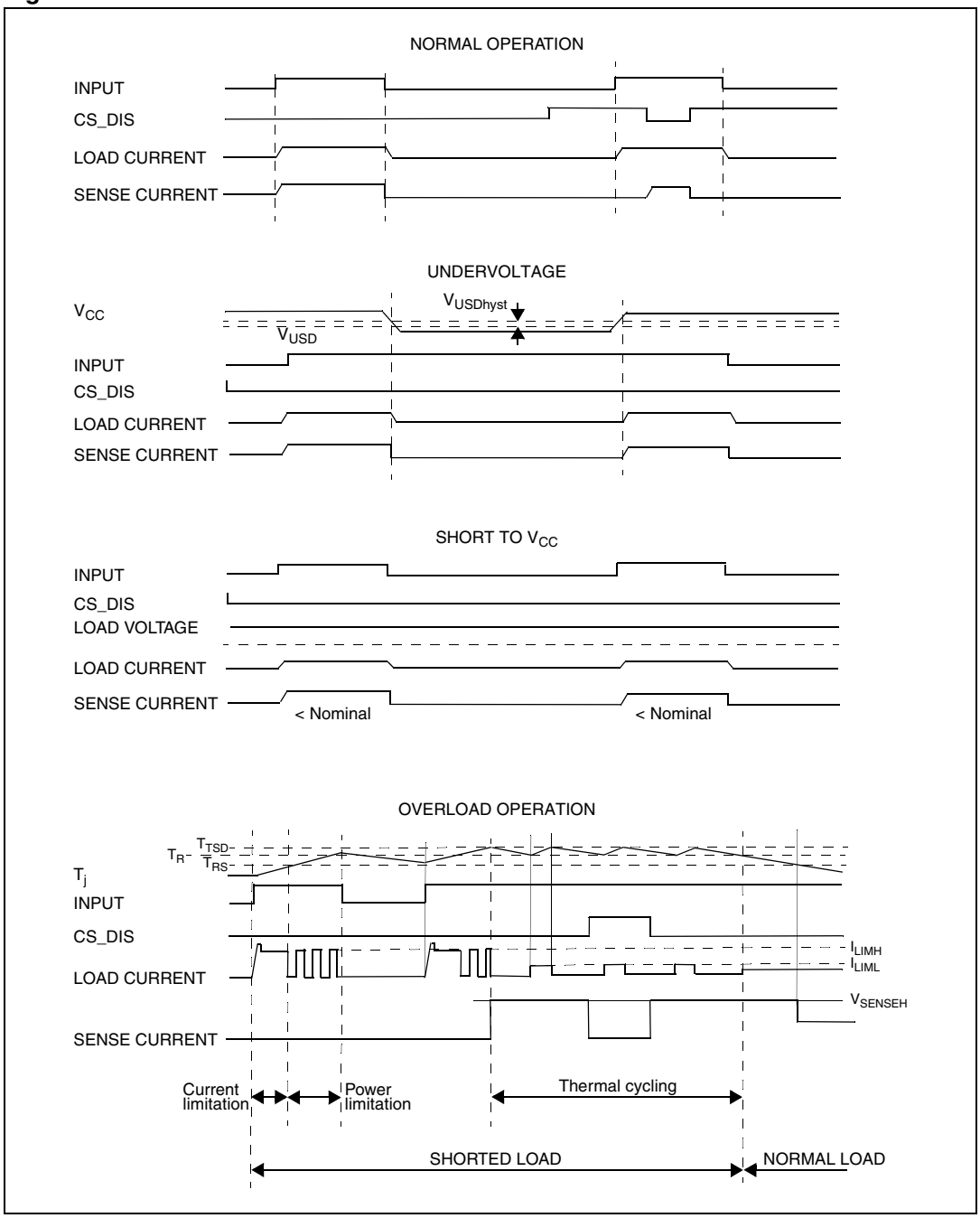


Figure 11. Off state output current

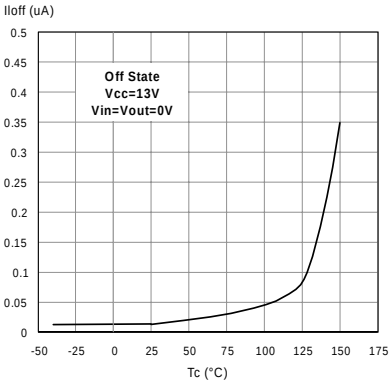


Figure 12. High level input current

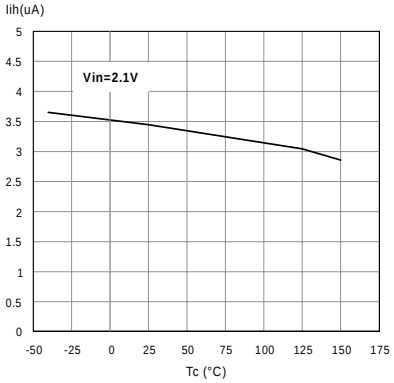


Figure 13. Input clamp voltage

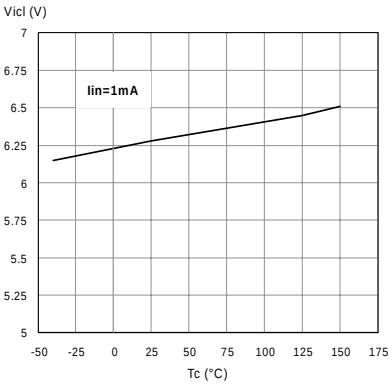


Figure 14. Input high level

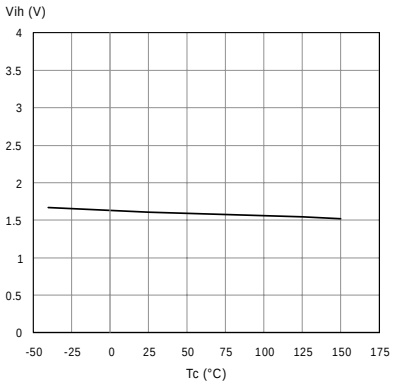


Figure 15. Input low level

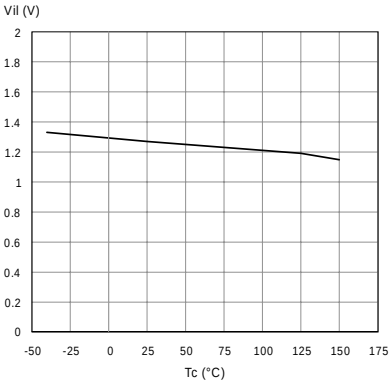


Figure 16. Input hysteresis voltage

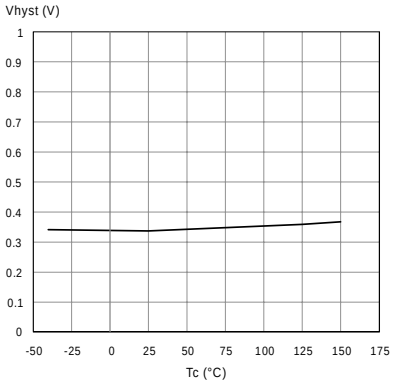


Figure 17. On state resistance vs T_{case}

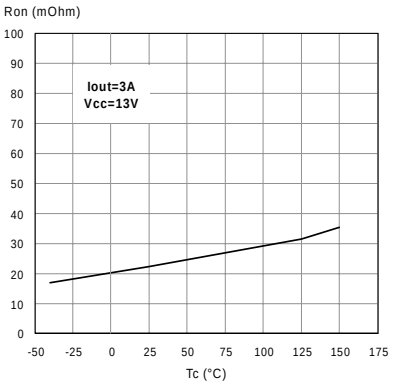


Figure 18. On state resistance vs V_{CC}

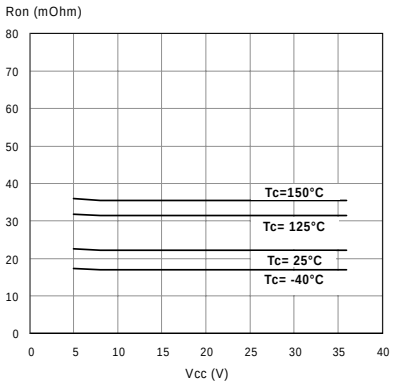


Figure 19. Undervoltage shutdown

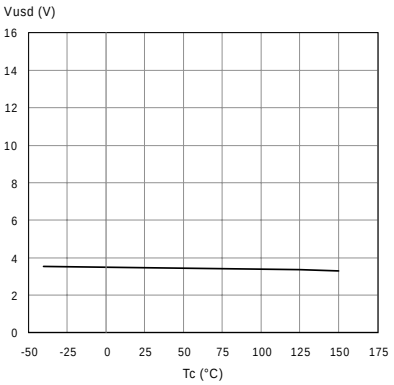


Figure 20. I_{LIMH} vs T_{case}

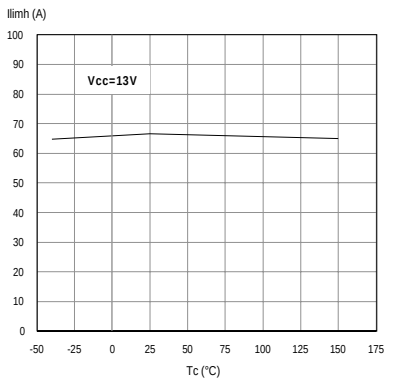


Figure 21. Turn-on voltage slope

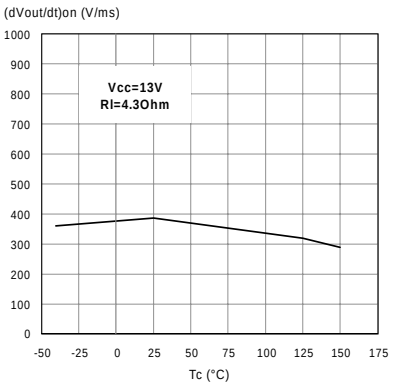


Figure 22. Turn-off voltage slope

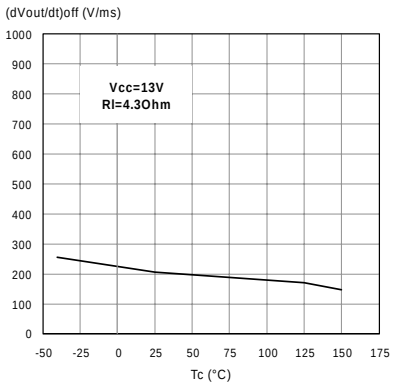


Figure 23. CS_DIS high level voltage

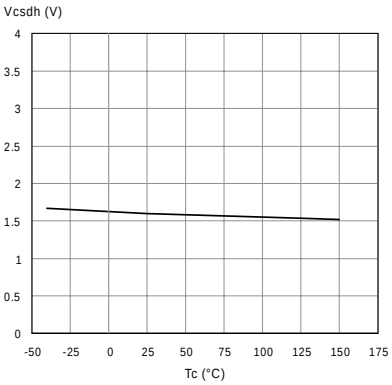


Figure 24. CS_DIS low level voltage

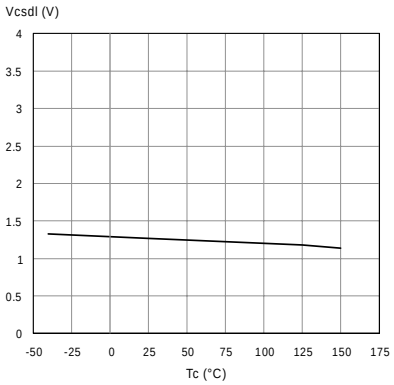
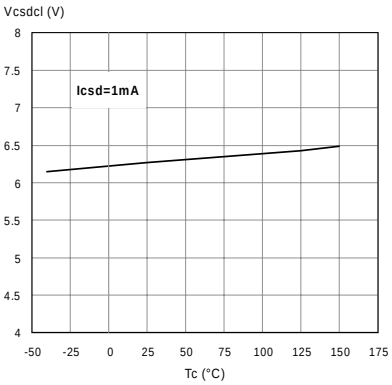
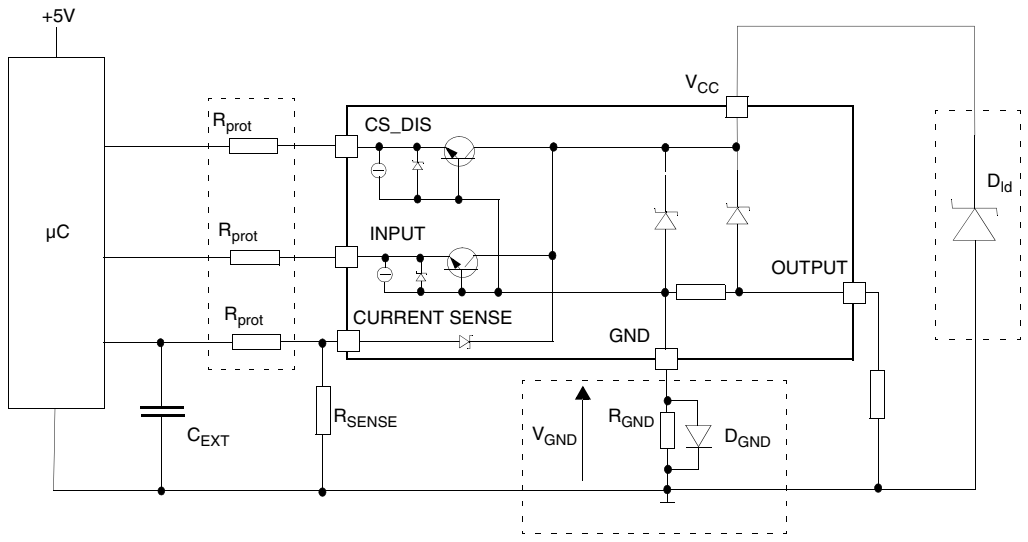


Figure 25. CS_DIS clamp voltage



3 Application information

Figure 26. Application schematic



Note: Channel 2 has the same internal circuit as channel 1.

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_{GND} only)

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

The following formulas indicate how to dimension the R_{GND} resistor:

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

where $-I_{GND}$ 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_{GND} (when $V_{CC} < 0$ 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 $I_{S(on)max}$ 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_{GND} produces a shift ($I_{S(on)max} * R_{GND}$) 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_{GND}.

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} = 1kΩ) 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 (j600mV) 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 µC 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 µC I/Os pins from latch-up.

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

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

Calculation example:

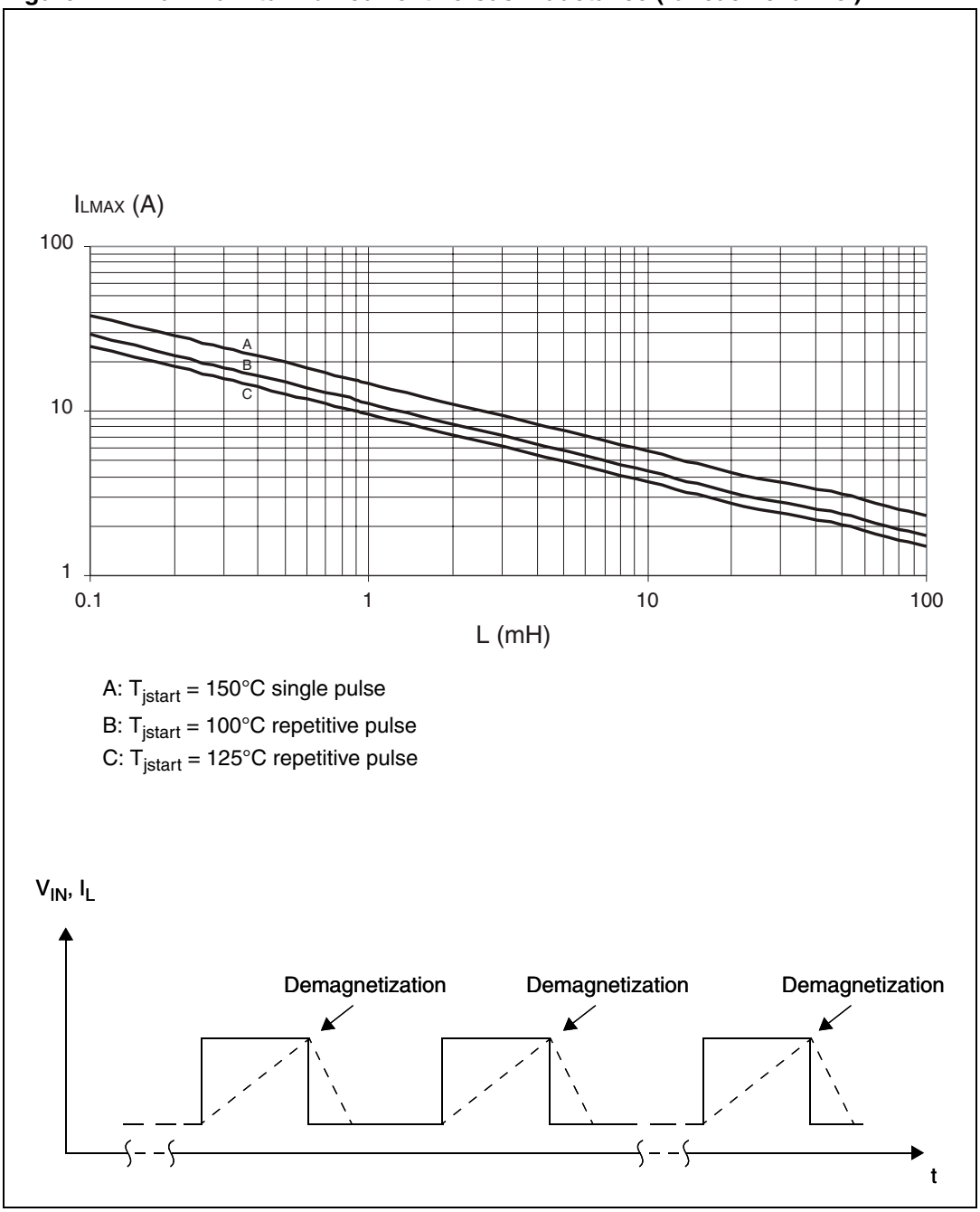
For V_{CCpeak} = -100V and $I_{latchup} \geq$ 20mA; $V_{OH\mu C} \geq$ 4.5V

5kΩ ≤ R_{prot} ≤ 65kΩ

Recommended values: R_{prot} = 10kΩ, C_{EXT} = 10nF

3.4 Maximum demagnetization energy (V_{CC} = 13.5V)

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



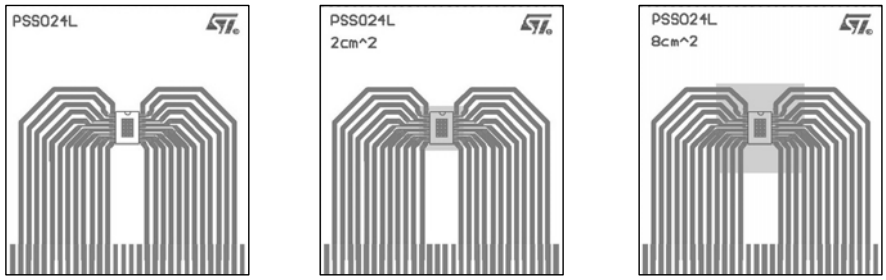
Note: Values are generated with R_L = 0Ω

In case of repetitive pulses, T_{jstart} (at beginning of each demagnetization) of every pulse must not exceed the temperature specified above for curves A and B.

4 Package and thermal data

4.1 PowerSSO-24™ thermal data

Figure 28. PowerSSO-24™ PC board



Layout condition of R_{th} and Z_{th} measurements (PCB: Double layer, Thermal Vias, FR4 area = 77mm x 86mm, PCB thickness = 1.6mm, Cu thickness = 70µm (front and back side), Copper areas: from minimum pad layout to 8cm^2).

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

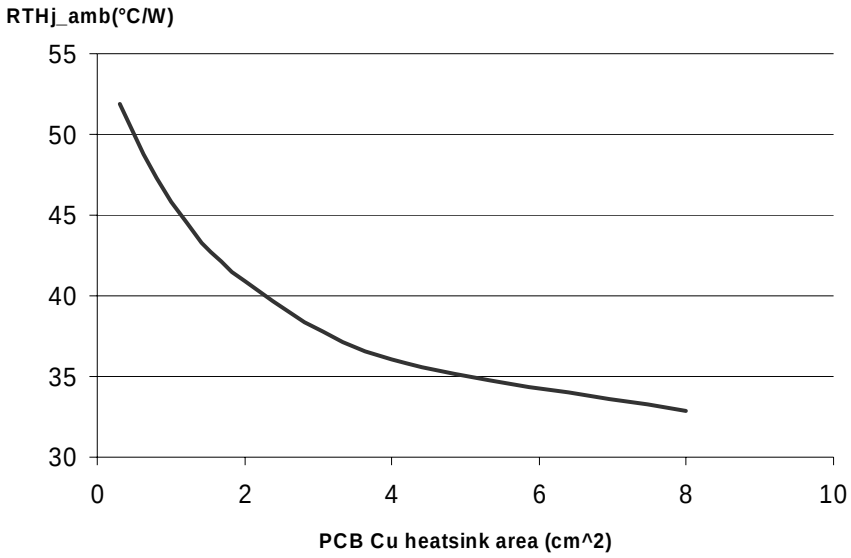


Figure 30. PowerSSO-24™ thermal impedance junction to ambient single pulse (with one channel ON)

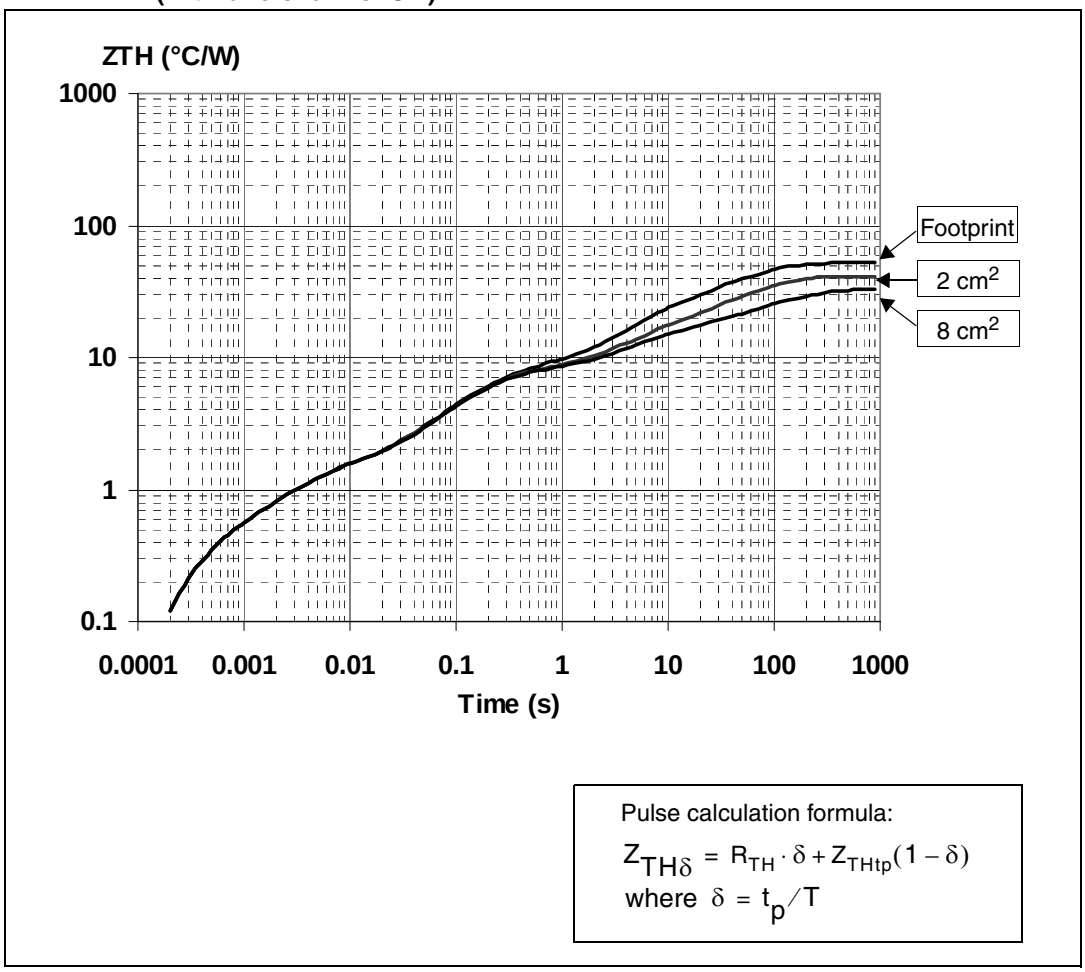
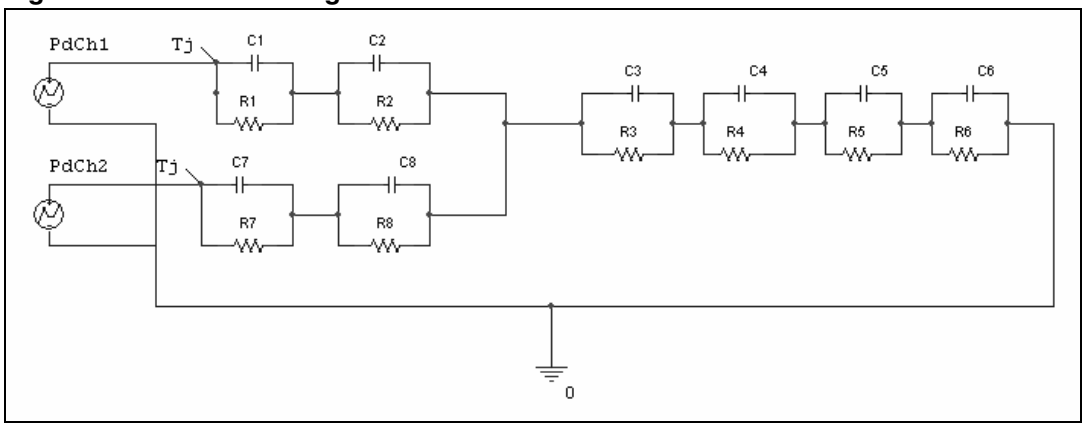


Figure 31. Thermal fitting model of a double channel HSD in PowerSSO-24™(1)



1. Values are given in *Table 12*

Table 12. Thermal parameters

Area/Island (cm^2)	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® packages

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. ECOPACK® packages are lead-free. The category of Second Level Interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label.

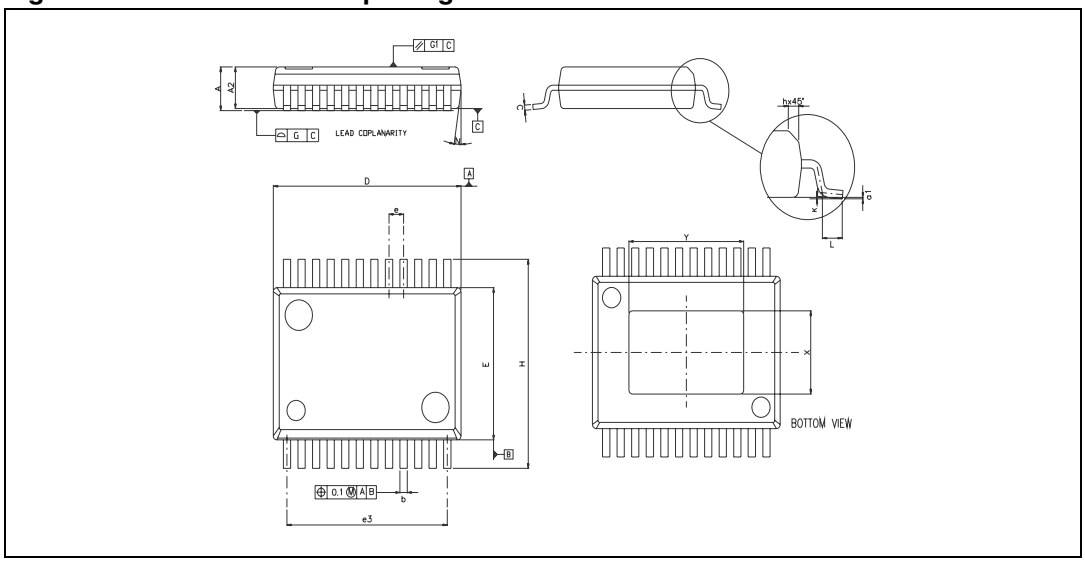
ECOPACK is an ST trademark. ECOPACK specifications are available at www.st.com.

5.2 Package mechanical

Table 13. PowerSSO-24™ mechanical data

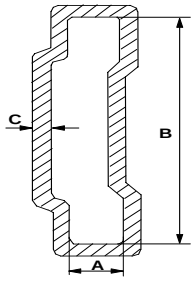
Symbol	Millimeters		
	Min	Typ	Max
A	1.9		2.22
A2	1.9		2.15
a1	0		0.07
b	0.34	0.4	0.46
c	0.23		0.32
D	10.2		10.4
E	7.4		7.6
e		0.8	
e3		8.8	
G			0.1
G1			0.06
H	10.1		10.5
h			0.4
L	0.55		0.85
N			10°
X	3.9		4.3
Y	6.1		6.5

Figure 32. PowerSSO-24™ package dimensions



5.3 Packing information

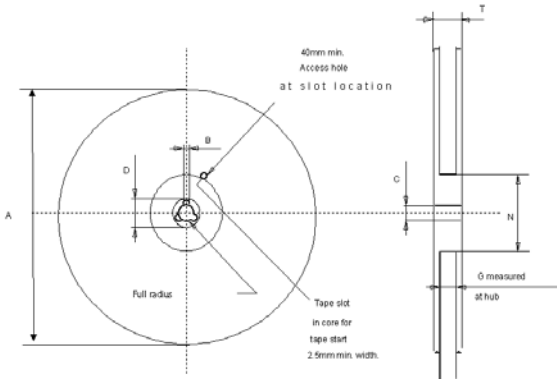
Figure 33. PowerSSO-24™ tube shipment (no suffix)



Base Qty	49
Bulk Qty	1225
Tube length (±0.5)	532
A	3.5
B	13.8
C (±0.1)	0.6

All dimensions are in mm.

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



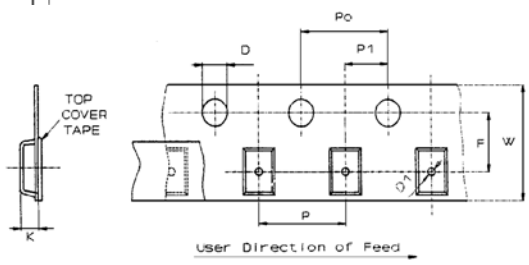
REEL DIMENSIONS

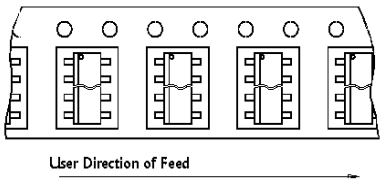
Base Qty	1000
Bulk Qty	1000
A (max)	330
B (min)	1.5
C (±0.2)	13
F	20.2
G (+2 / -0)	24.4
N (min)	100
T (max)	30.4

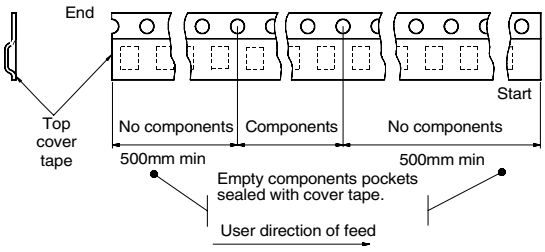
TAPE DIMENSIONS

According to Electronic Industries Association (EIA) Standard 481 rev. A, Feb. 1986

Tape width	**W**	24
Tape Hole Spacing	**P0 (±0.1)**	4
Component Spacing	**P**	12
Hole Diameter	**D (±0.05)**	1.55
Hole Diameter	**D1 (min)**	1.5
Hole Position	**F (±0.1)**	11.5
Compartment Depth	**K (max)**	2.85
Hole Spacing	**P1 (±0.1)**	2







6 Revision history

Table 14. Document revision history

Date	Revision	Changes
16-Feb-2007	1	Initial release
23-Feb-2007	2	*Table 9: Current sense (8V < VCC < 16V)*: Error in dK_3/K_3 current sense ratio drift row corrected.
28-Mar-2007	3	*Protection* section updated to correct editing error.

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