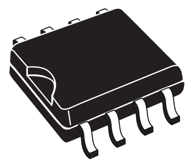
VN800PS-E

High-side driver

Features

Type	$R_{DS(on)}$	I_{OUT}	V_{CC}
VN800PS-E	135 mΩ	0.7 A	36 V

- ECOPACK®: lead free and RoHS compliant
- Automotive Grade: compliance with AEC guidelines
- Very low standby current
- CMOS compatible input
- Thermal shutdown protection and diagnosis
- Undervoltage shutdown
- Overvoltage clamp
- Load current limitation
- Reverse battery protection
- Electrostatic discharge protection



SO-8

Description

The VN800PS-E is monolithic device made by using STMicroelectronics™ VIPower™ M0-3 technology, intended for driving any kind of load with one side connected to ground.

Active V_{CC} pin voltage clamp protects the device against low energy spikes. Active current limitation combined with thermal shutdown and automatic restart protect the device against overload. Device automatically turns off in case of ground pin disconnection.

This device is especially suitable for industrial applications in norms conformity with IEC1131 (Programmable Controllers International Standard).

Table 1. Device summary

Package	Order codes	
	Tube	Tape and reel
SO-8	VN800PS-E	VN800PSTR-E

Contents

List of tables

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1 Block diagram and pin description

Figure 1. Block diagram

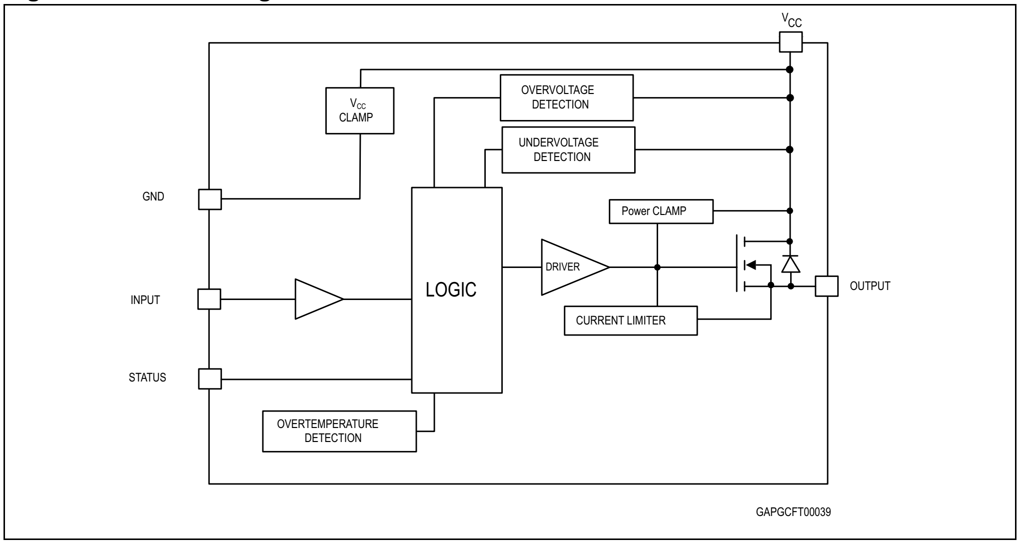


Figure 2. Configuration diagram (top view)

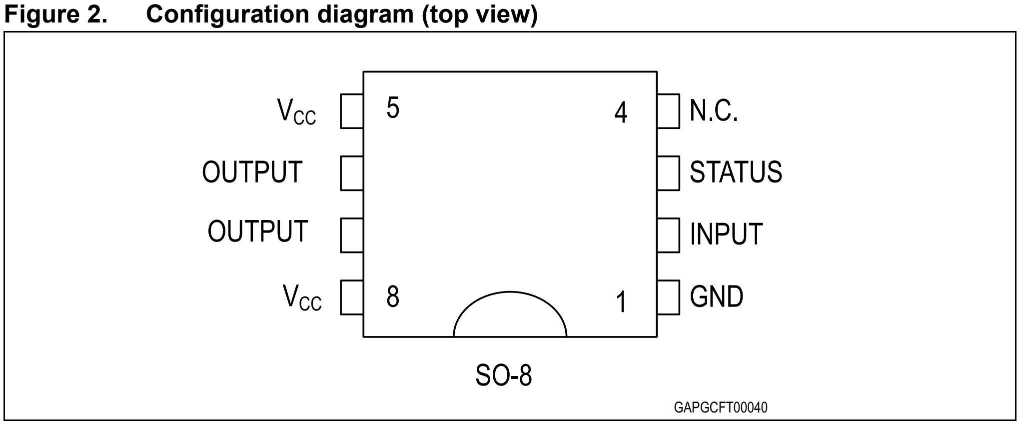
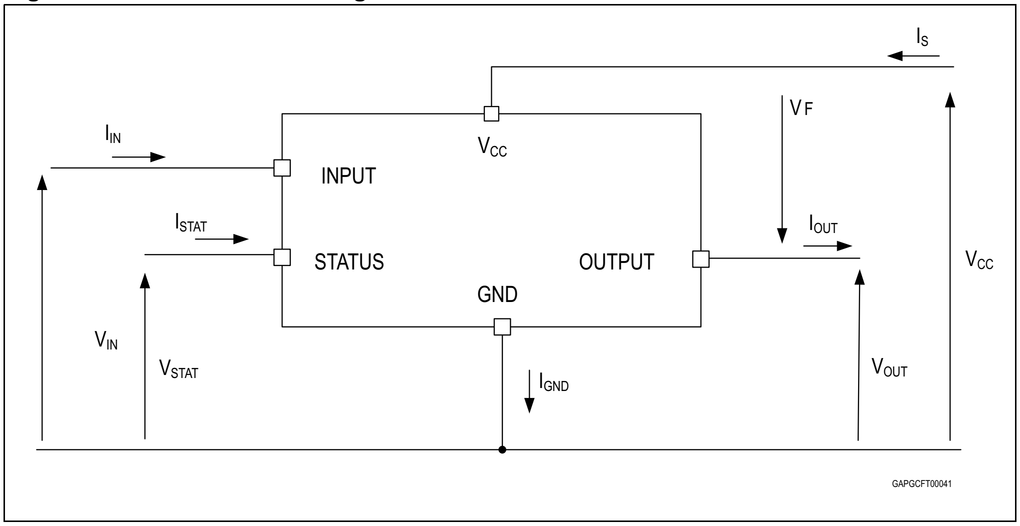


Table 2. Suggested connections for unused and not connected pins

Connection/pin	Status	N.C.	Output	Input
Floating	X	X	X	X
To ground		X		Through 10 KΩ resistor

2 Electrical specifications

Figure 3. Current and voltage conventions



2.1 Absolute maximum ratings

Table 3. Absolute maximum ratings

Symbol	Parameter	Value	Unit
		SO-8	
V_{CC}	DC supply voltage	41	V
$-V_{CC}$	Reverse DC supply voltage	-0.3	V
$-I_{GND}$	DC reverse ground pin current	-200	mA
I_{OUT}	DC output current	Internally limited	A
$-I_{OUT}$	Reverse DC output current	-6	A
I_{IN}	DC input current	+/- 10	mA
V_{IN}	Input voltage range	$-3/+V_{CC}$	V
V_{STAT}	DC status voltage	$+V_{CC}$	V
V_{ESD}	Electrostatic discharge (human body model: R = 1.5 KΩ; C = 100 pF) - Input - Status - Output - V_{CC}	 4000 4000 5000 5000	 V V V V
P_{tot}	Power dissipation $T_C = 25$ °C	4.2	W
E_{MAX}	Maximum switching energy ($L = 77.5$ mH; $R_L = 0$ Ω; $V_{bat} = 13.5$ V; $T_{jstart} = 150$ °C; $I_L = 1.5$ A)	121	mJ

Table 3. Absolute maximum ratings (continued)

Symbol	Parameter	Value	Unit
		SO-8	
T_j	Junction operating temperature	Internally limited	°C
T_c	Case operating temperature	-40 to 150	°C
T_{stg}	Storage temperature	-55 to 150	°C

2.2 Thermal data

Table 4. Thermal data

Symbol	Parameter	Value	Unit
		SO-8	
$R_{thj\text{-}lead}$	Thermal resistance junction-lead max	30	°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient max	93 (1)	°C/W
		82 (2)	°C/W

1. When mounted on FR4 printed circuit board with 0.5 cm^2 of copper area (at least 35 µm thick) connected to all V_{CC} pins.
2. When mounted on FR4 printed circuit board with 2 cm^2 of copper area (at least 35 µm thick).

2.3 Electrical characteristics

Values specified in this section are for 8 V< V_{CC} < 36 V; -40 °C < T_j < 150 °C, unless otherwise stated.

Table 5. Power

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{CC}	Operating supply voltage		5.5		36	V
V_{USD}	Undervoltage shutdown		3	4	5.5	V
V_{OV}	Overvoltage shutdown		36	42		V
R_{ON}	On-state resistance	I_{OUT} = 0.5 A; T_j = 25 °C I_{OUT} = 0.5 A			135 270	mΩ mΩ
I_S	Supply current	Off-state; V_{CC} = 24 V; T_{case} = 25 °C On-state; V_{CC} = 24 V On-state; V_{CC} = 24 V; T_{case} = 100 °C		10 1.5	20 3.5 2.6	µA mA mA
I_{LGND}	Output current at turn-off	V_{CC} = V_{STAT} = V_{IN} = V_{GND} = 24 V; V_{OUT} = 0 V			1	mA
$I_{L(off1)}$	Off-state output current	V_{IN} = V_{OUT} = 0 V	0		50	µA
$I_{L(off2)}$	Off-state output current	V_{IN} = V_{OUT} = 0 V; V_{CC} = 13 V; T_j = 125 °C			5	µA
$I_{L(off3)}$	Off-state output current	V_{IN} = V_{OUT} = 0 V; V_{CC} = 13 V; T_j = 25 °C			3	µA

Table 6. Switching (V_{CC} = 24 V)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	R_L = 48 Ω from V_{IN} rising edge to V_{OUT} = 2.4 V	-	10	-	µs
$t_{d(off)}$	Turn-off delay time	R_L = 48 Ω from V_{IN} falling edge to V_{OUT} = 21.6 V	-	40	-	µs
$dV_{OUT}/dt_{(on)}$	Turn-on voltage slope	R_L = 48 Ω from V_{OUT} = 2.4 V to V_{OUT} = 19.2 V	-	See relative diagram	-	V/µs
$dV_{OUT}/dt_{(off)}$	Turn-off voltage slope	R_L = 48 Ω from V_{OUT} = 21.6 V to V_{OUT} = 2.4 V	-	See relative diagram	-	V/µs

Table 7. Input pin

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{INL}	Input low level			-	1.25	V
I_{INL}	Low level input current	V_{IN} = 1.25 V	1	-		µA
V_{INH}	Input high level		3.25	-		V

Table 7. Input pin (continued)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{INH}	High level input current	V_{IN}=3.25 V		-	10	µA
$V_{I(hyst)}$	Input hysteresis voltage		0.5	-		V
I_{IN}	Input current	$V_{IN} = V_{CC} = 36$ V		-	200	µA

Table 8. V_{CC} - output diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_F	Forward on voltage	$-I_{OUT} = 0.6$ A; $T_j = 150$ °C	-	-	0.6	V

Table 9. Status pin

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{STAT}	Status low output voltage	$I_{STAT} = 1.6$ mA	-	-	0.5	V
I_{LSTAT}	Status leakage current	Normal operation; $V_{STAT} = V_{CC} = 36$ V	-	-	10	µA
C_{STAT}	Status pin input capacitance	Normal operation; $V_{STAT} = 5$ V	-	-	30	pF

Table 10. Protections[(1)]

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
T_{TSD}	Shutdown temperature		150	175	200	°C
T_R	Reset temperature		135			°C
T_{hyst}	Thermal hysteresis		7	15		°C
T_{SDL}	Status delay in overload condition	T_j>T_{jsh}			20	µs
I_{lim}	DC short circuit current	$V_{CC} = 24$ V; $R_{LOAD} = 10$ mΩ	0.7		2	A
V_{demag}	Turn-off output clamp voltage	$I_{OUT} = 0.5$ A; L = 6 mH	V_{CC} - 47	V_{CC} - 52	V_{CC} - 57	V

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.

Figure 4. Status timing

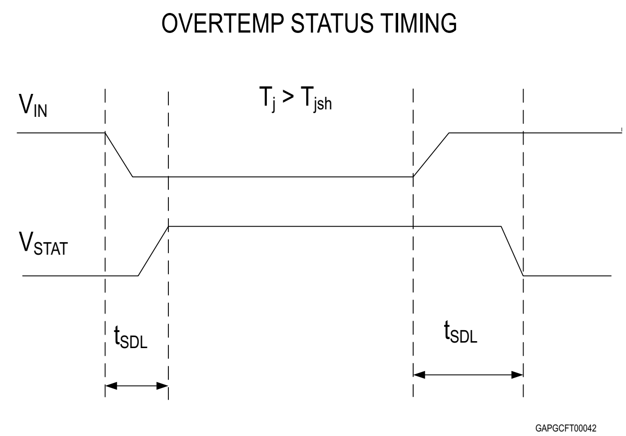


Table 11. Truth table

Conditions	Input	Output	Status
Normal operation	L H	L H	H H
Current limitation	L H H	L X X	H ($T_j < T_{TSD}$) H ($T_j > T_{TSD}$) L
Over temperature	L H	L L	H L
Undervoltage	L H	L L	X X
Overvoltage	L H	L L	H H

Figure 5. Switching time waveforms

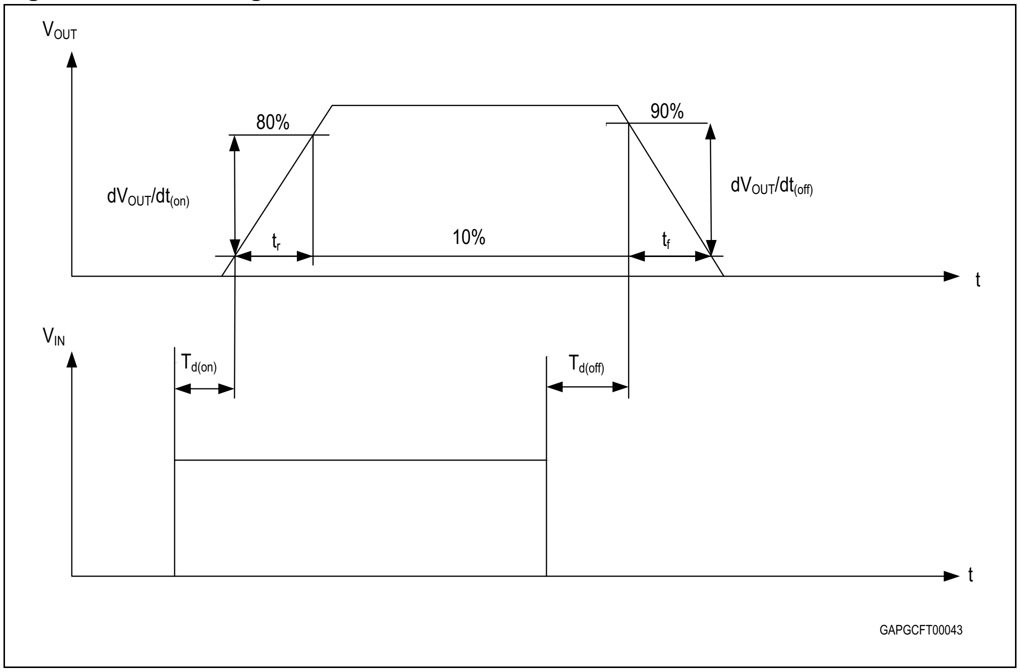


Table 12. Electrical transient requirements on V_{CC} pin (part 1/3)

ISO T/R 7637/1 test pulse	Test levels				
	I	II	III	IV	Delays and impedance
1	-25 V	-50 V	-75 V	-100 V	2 ms, 10 Ω
2	+25 V	+50 V	+75 V	+100 V	0.2 ms, 10 Ω
3a	-25 V	-50 V	-100 V	-150 V	0.1 µs, 50 Ω
3b	+25 V	+50 V	+75 V	+100 V	0.1 µs, 50 Ω
4	-4 V	-5 V	-6 V	-7 V	100 ms, 0.01 Ω
5	+26.5 V	+46.5 V	+66.5 V	+86.5 V	400 ms, 2 Ω

Table 13. Electrical transient requirements on V_{CC} pin (part 2/3)

ISO T/R 7637/1 Test pulse	Test levels results			
	I	II	III	IV
1	C	C	C	C
2	C	C	C	C
3a	C	C	C	C
3b	C	C	C	C
4	C	C	C	C
5	C	E	E	E

Table 14. Electrical transient requirements on V_{CC} pin (part 3/3)

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

Figure 6. Peak short circuit current test circuit

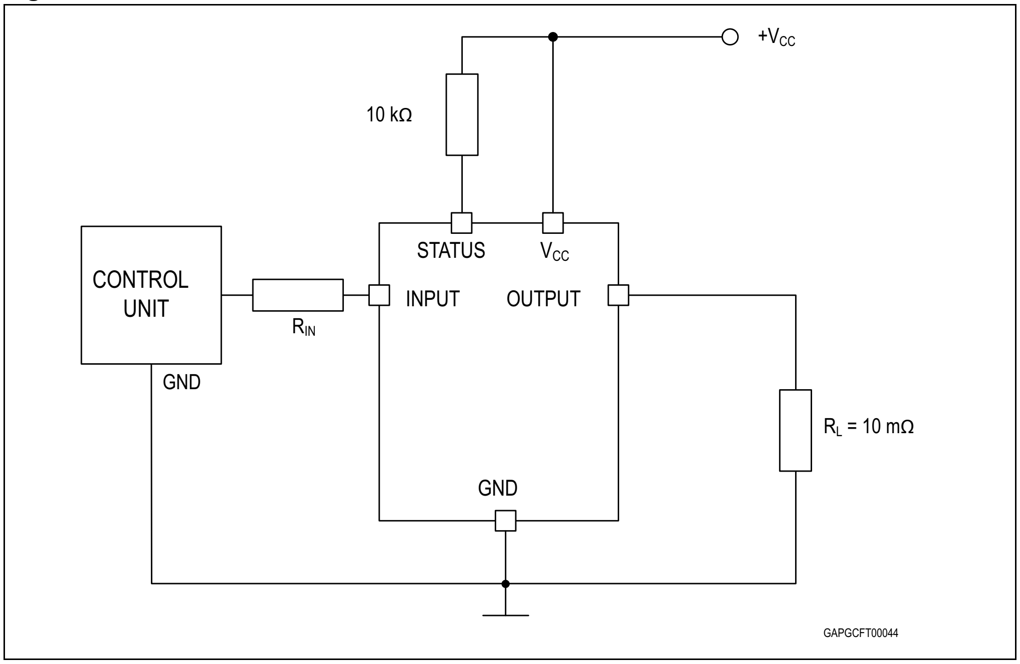


Figure 7. Avalanche energy test circuit

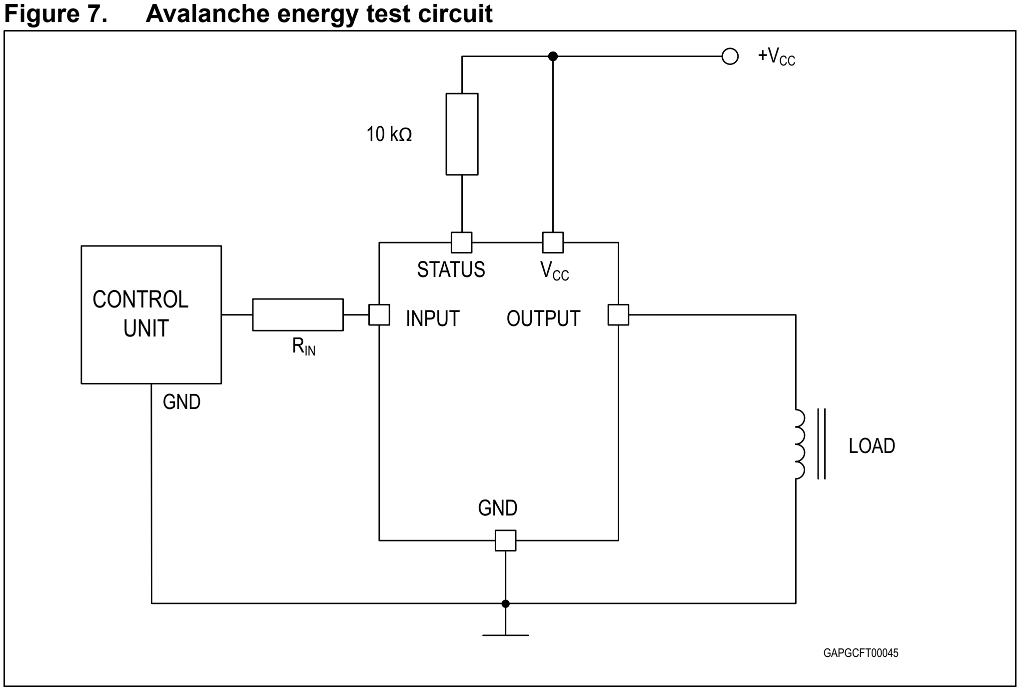
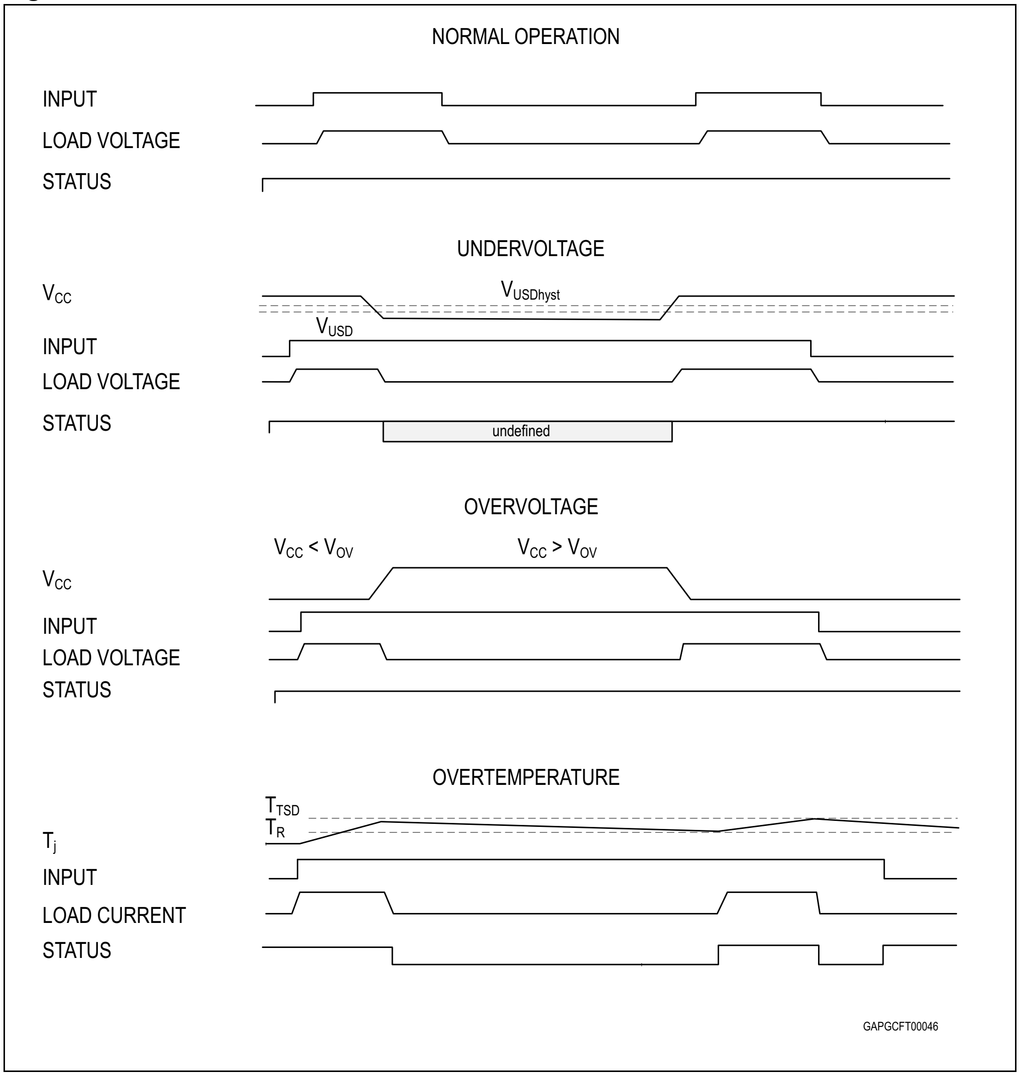
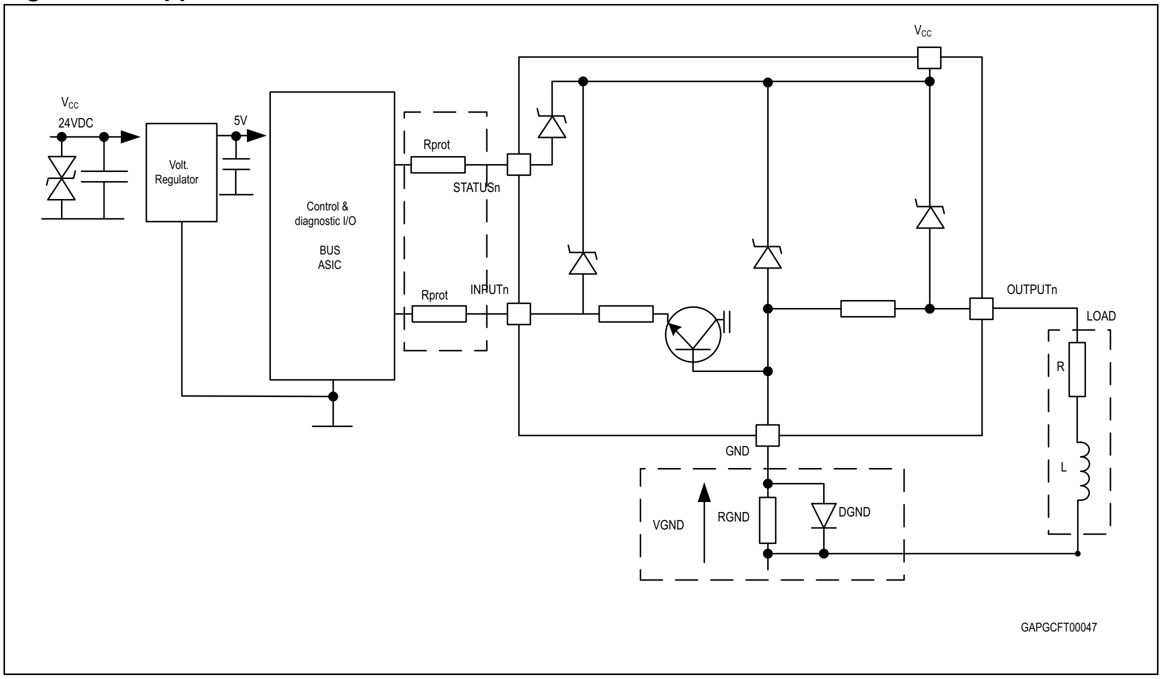


Figure 8. Waveforms



3 Application information

Figure 9. Application schematic



3.1 GND protection network against reverse battery

3.1.1 Solution 1: resistor in the ground line (R_{GND} only)

This can be used with any type of load.

The following is an indication on how to dimension the R_{GND} resistor.

1) $R_{GND} \leq 600\ mV / (I_{S(on)max})$

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's 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 amongst several different HSD. Please note that the value of this resistor should be 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 common with the device ground then 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 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 the ST suggests to utilize Solution 2 (see *Section 3.1.2*).

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

A resistor (R_{GND} = 1 kΩ) should be inserted in parallel to D_{GND} if the device is driving an inductive load.

This small signal diode can be safely shared amongst several different HSD. Also in this case, the presence of the ground network produces a shift (≈600 mV) in the input threshold and the status output values if the microprocessor ground is not common with the device ground. This shift not varies if more than one HSD shares the same diode/resistor network.

Series resistor in input and status lines are also required to prevent that, during battery voltage transient, the current exceeds the absolute maximum rating.

Safest configuration for unused input and status pin is to leave them unconnected.

3.2 Microcontroller 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 a resistor (R_{prot}) in line to prevent the microcontroller I/Os pins to 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:

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

5k Ω ≤ R_{prot} ≤ 65 kΩ.

Recommended R_{prot} value is 10 kΩ.

3.3 Electrical characteristics curves

Figure 10. Off-state output current

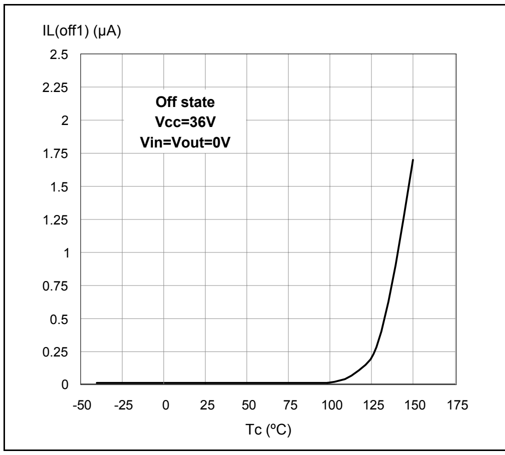


Figure 11. High level input current

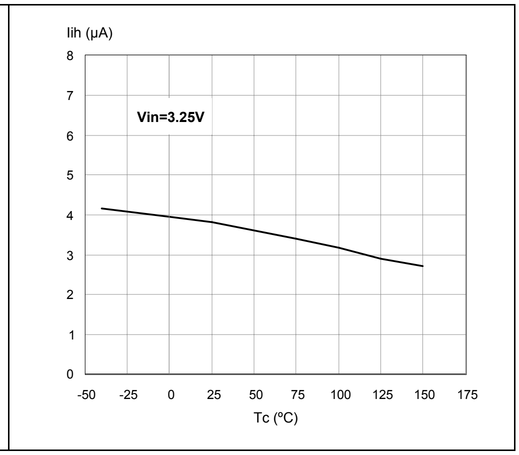


Figure 12. Status leakage current

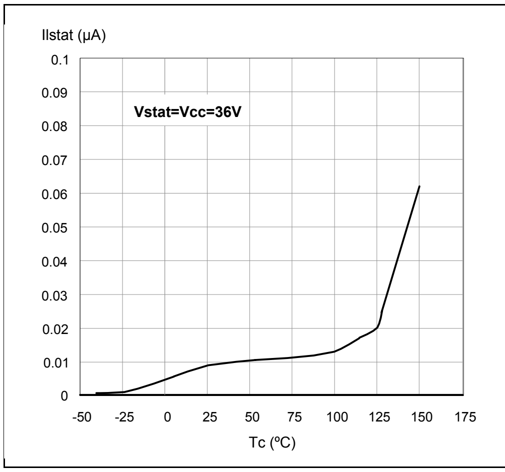


Figure 13. On-state resistance vs T_{case}

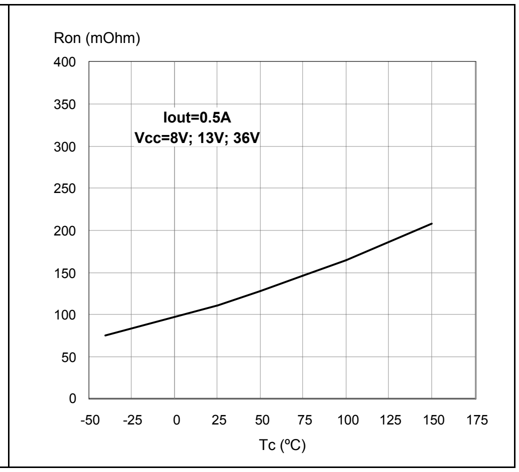


Figure 14. On-state resistance vs V_{CC}

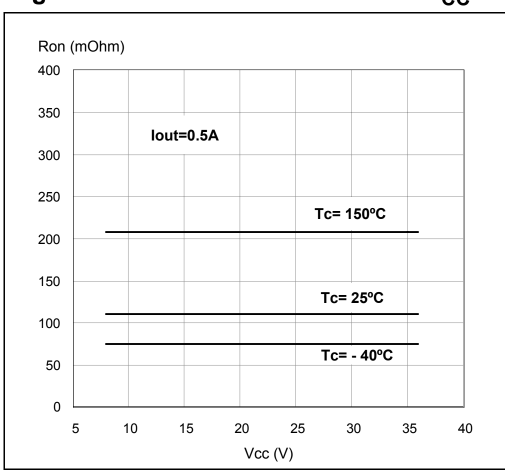


Figure 15. Input high level

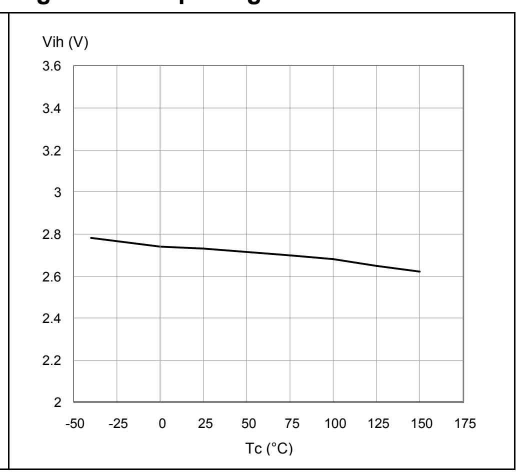


Figure 16. Input low level

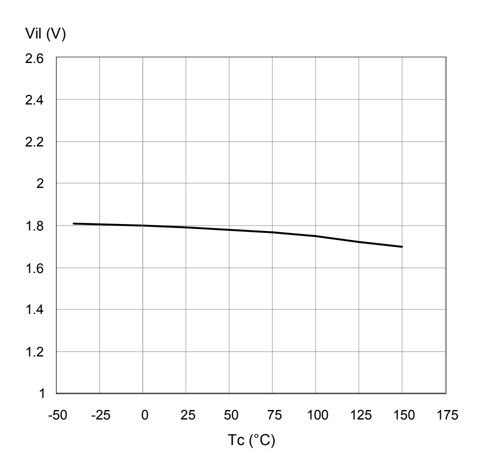


Figure 17. Turn-on voltage slope

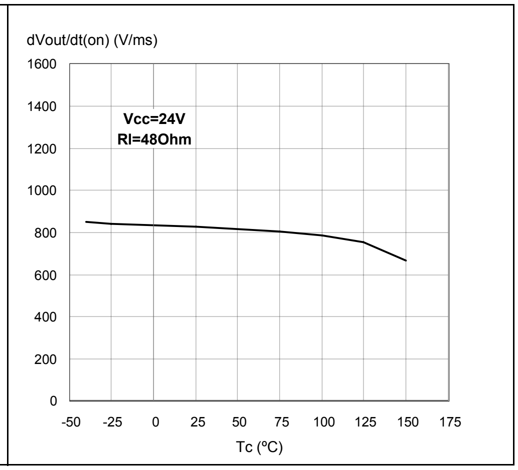


Figure 18. Overvoltage shutdown

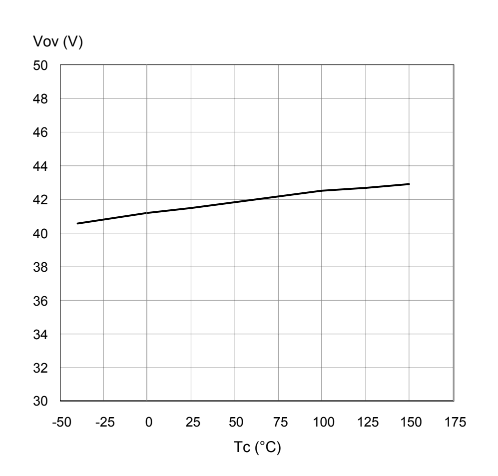


Figure 19. Input hysteresis voltage

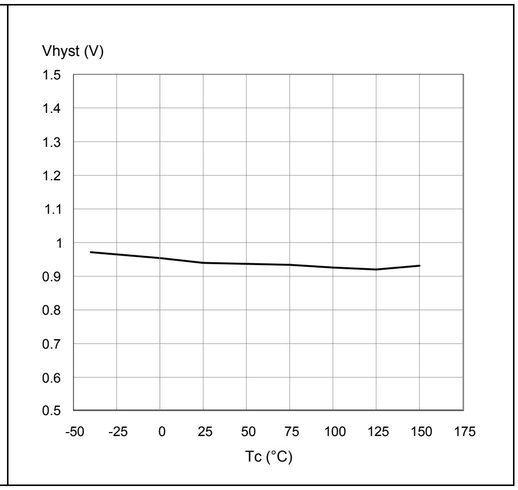


Figure 20. Turn-off voltage slope

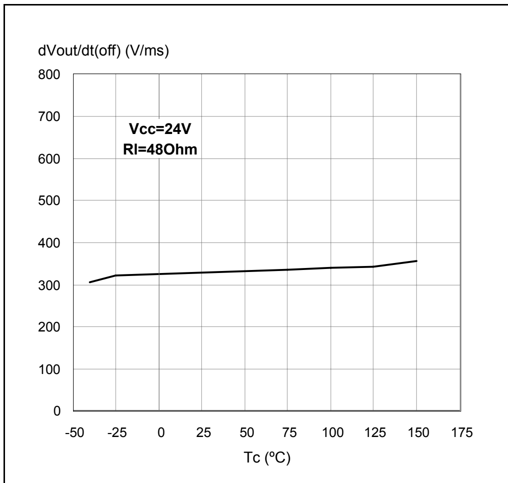
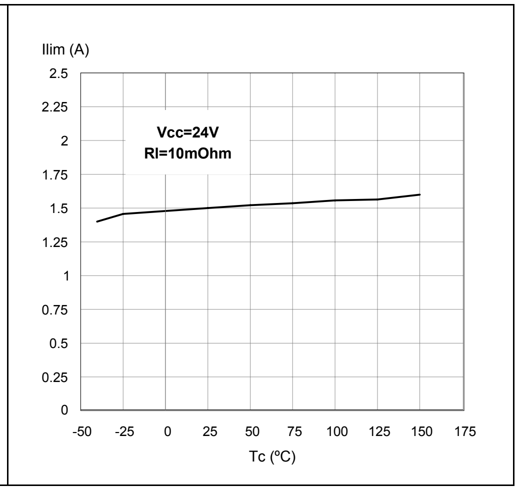
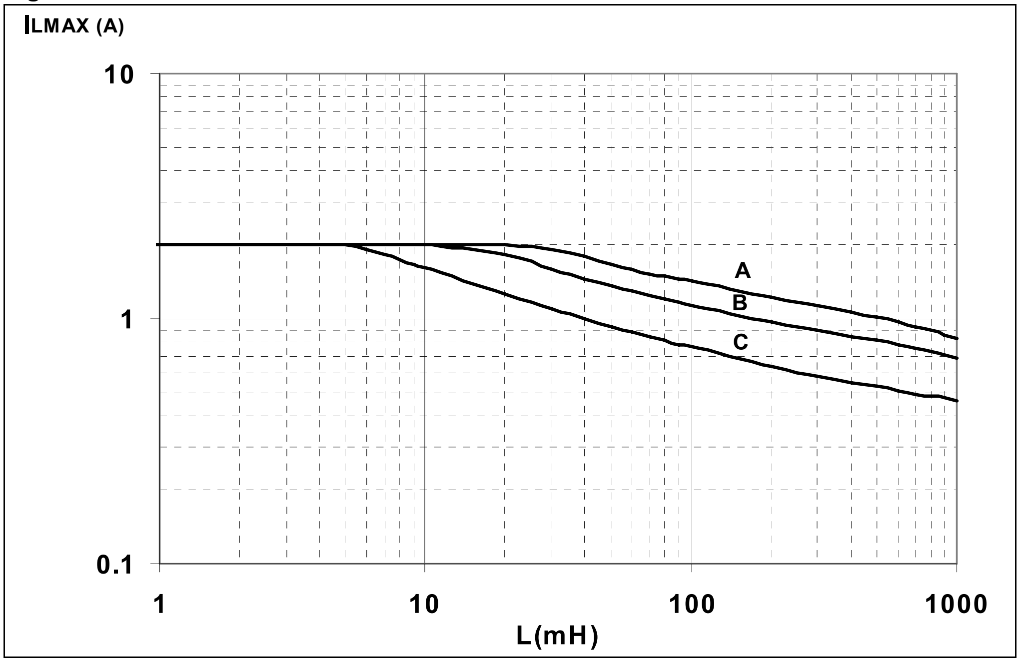


Figure 21. I_{LIM} vs T_{case}



3.4 SO-8 maximum demagnetization energy

Figure 22. SO-8 maximum turn off current versus load inductance



Note: *Legend*

A = Single pulse at T_{Jstart} = 150 ºC

B = Repetitive pulse at T_{Jstart} = 100 ºC

C = Repetitive Pulse at T_{Jstart} = 125 ºC

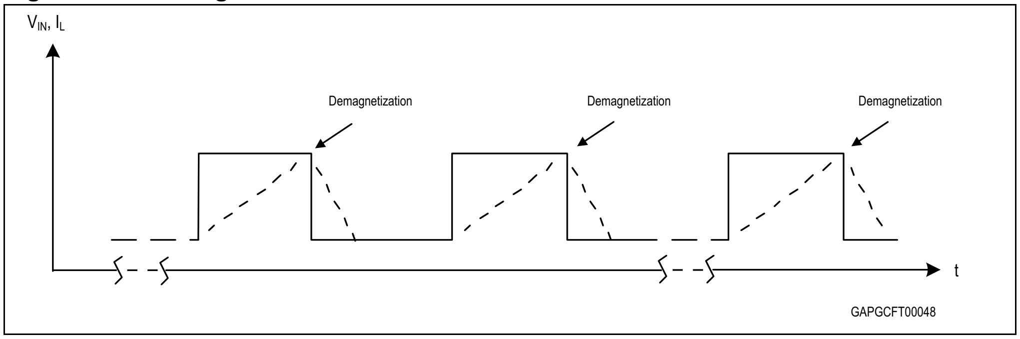
Conditions:

V_{CC} = 13.5 V

Values are generated with R_L = 0 Ω

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

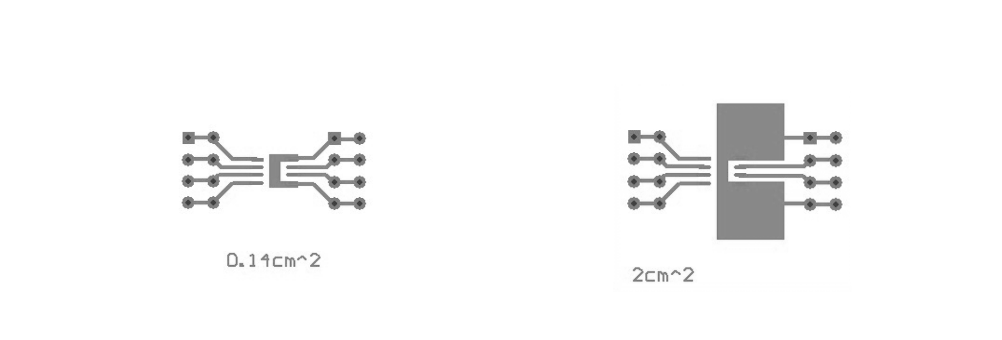
Figure 23. Demagnetization



4 Package and PCB thermal data

4.1 SO-8 thermal data

Figure 24. SO-8 PC board(1)



1. Layout condition of R_{th} and Z_{th} measurements (PCB FR4 area = 58 mm x 58 mm, PCB thickness = 2 mm, Cu thickness = 35 µm, Copper areas: 0.14 cm^2, 2 cm^2).

Figure 25. SO-8 $R_{thj-amb}$ vs PCB copper area in open box free air condition

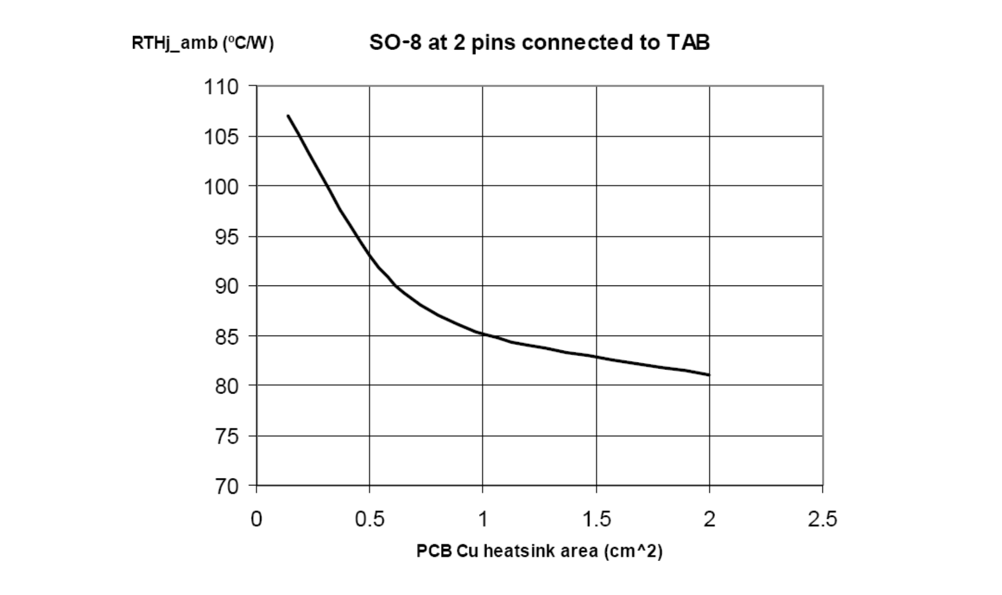


Figure 26. SO-8 thermal impedance junction ambient single pulse

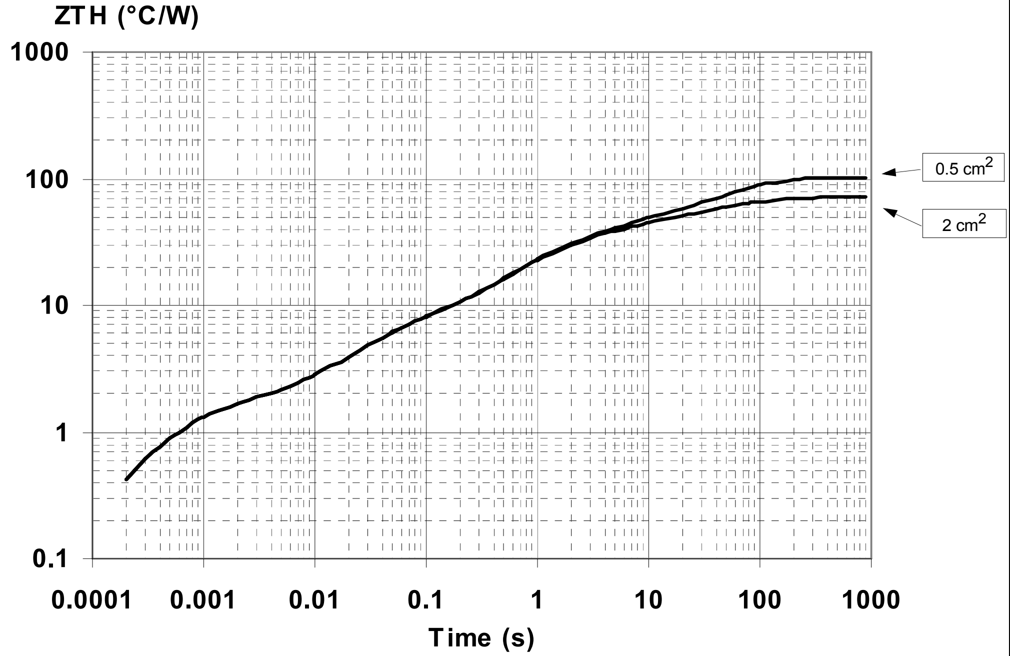
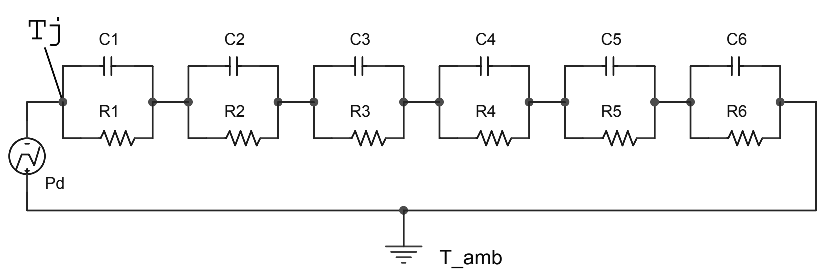


Figure 27. Thermal fitting model of a single channel HSD in SO-8



Equation 1 Pulse calculation formula

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

where

$$\delta = t_p / T$$

Table 15. Thermal parameter

Area/island (cm^2)	0.14	2
R1 (°C/W)	0.24	
R2 (°C/W)	1.2	
R3 (°C/W)	4.5	
R4 (°C/W)	21	
R5 (°C/W)	16	
R6 (°C/W)	58	28
C1 (W.s/°C)	0.00015	
C2 (W.s/°C)	0.0005	
C3 (W.s/°C)	7.50E-03	
C4 (W.s/°C)	0.045	
C5 (W.s/°C)	0.35	
C6 (W.s/°C)	1.05	2

5 Package and packing information

5.1 ECOPACK®

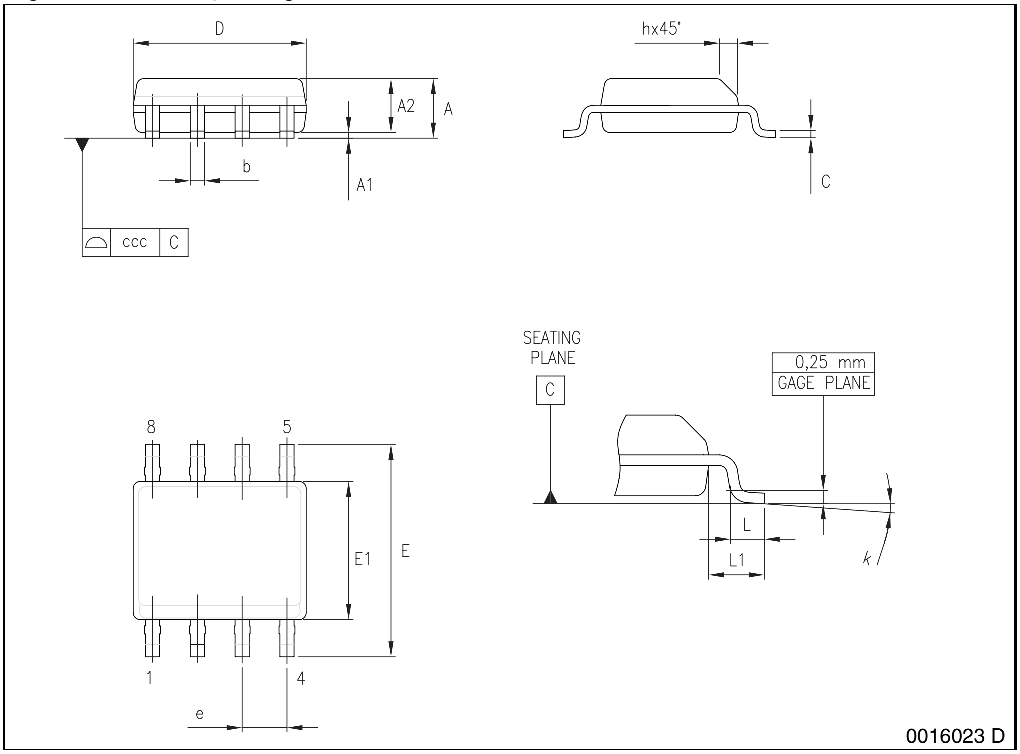
In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: *www.st.com*. ECOPACK® is an ST trademark.

5.2 SO-8 package information

Table 16. SO-8 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A			1.75
a1	0.1		0.25
a2			1.65
a3	0.65		0.85
b	0.35		0.48
b1	0.19		0.25
C	0.25		0.5
c1		45	
D	4.8		5
E	5.8		6.2
e		1.27	
e3		3.81	
F	3.8		4
L	0.4		1.27
M			0.6
S			8
L1	0.8		1.2

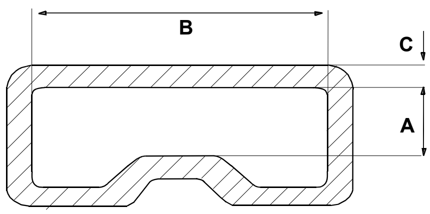
Figure 28. SO-8 package dimensions



5.3 SO-8 packing information

The devices can be packed in tube or tape and reel shipments (see the *Device summary on page 1*).

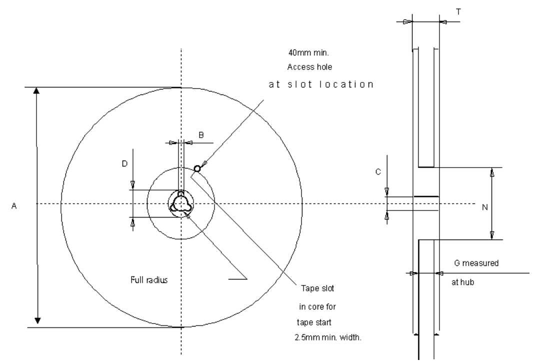
Figure 29. SO-8 tube shipment (no suffix)



Base Q.ty	100
Bulk Q.ty	2000
Tube length (± 0.5)	532
A	3.2
B	6
C (± 0.1)	0.6

All dimensions are in mm.

Figure 30. SO-8 tape and reel shipment (suffix "TR")



REEL DIMENSIONS

Base Q.ty	2500
Bulk Q.ty	2500
A (max)	330
B (min)	1.5
C (± 0.2)	13
F	20.2
G (+ 2 / -0)	12.4
N (min)	60
T (max)	18.4

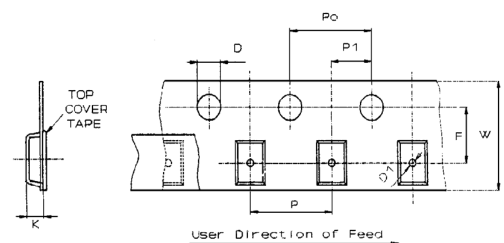
All dimensions are in mm.

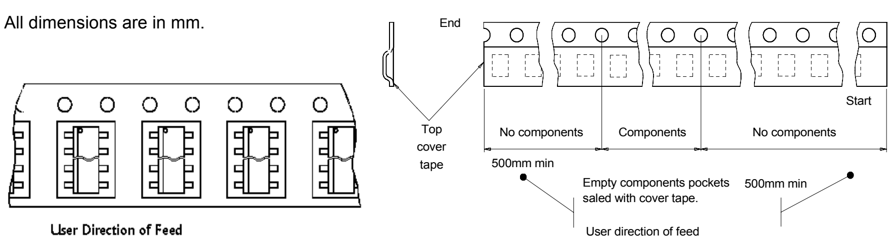
TAPE DIMENSIONS

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

Tape width	**W**	12
Tape Hole Spacing	**P0 (± 0.1)**	4
Component Spacing	**P**	8
Hole Diameter	**D (± 0.1/-0)**	1.5
Hole Diameter	**D1 (min)**	1.5
Hole Position	**F (± 0.05)**	5.5
Compartment Depth	**K (max)**	4.5
Hole Spacing	**P1 (± 0.1)**	2

All dimensions are in mm.





6 Revision history

Table 17. Document revision history

Date	Revision	Changes
21-Apr-2009	1	Initial release
31-May-2010	2	Updated *Features* list. Updated *Table 3: Absolute maximum ratings*. Reformatted entire document.
07-Feb-2011	3	Updated *Features* list. Updated following tables: – *Table 4: Thermal data* – *Table 16: SO-8 mechanical data*