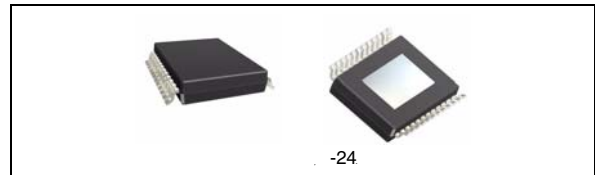


h... h... h... h...  
t... t... t... t...

## Features

Number of channels	4	41
Supply voltage	3.0 V	4.5 V - 36 V
Input impedance (typical)	25 Ω	25 Ω
Input capacitance (typical)	60 pF	60 pF
Input leakage current	2 μA	2 μA (1)

1. Input impedance is measured at 100 kHz.
- Input impedance: The input impedance is 25 Ω typical at 100 kHz. The input capacitance is 60 pF typical. The input leakage current is 2 μA typical. The input impedance is measured at 100 kHz. The input capacitance is 60 pF typical. The input leakage current is 2 μA typical.
  - Input capacitance: The input capacitance is 60 pF typical. The input impedance is 25 Ω typical at 100 kHz. The input leakage current is 2 μA typical.
  - Input leakage current: The input leakage current is 2 μA typical. The input impedance is 25 Ω typical at 100 kHz. The input capacitance is 60 pF typical.



h... h... h... h...  
t... t... t... t...

## Description

The VND5025 is a 4-channel, low-power, high-precision, 0-5 V input range, 10-bit ADC. It is designed for applications requiring high accuracy and low power consumption. The device is available in a 24-pin package. The input impedance is 25 Ω typical at 100 kHz. The input capacitance is 60 pF typical. The input leakage current is 2 μA typical. The device is designed for applications requiring high accuracy and low power consumption. The input impedance is 25 Ω typical at 100 kHz. The input capacitance is 60 pF typical. The input leakage current is 2 μA typical.

Table 1. Order codes

Package	Tube	Tape and Reel
-24	5025 -	5025 -

Figure 26: Application schematic

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17.	.....	1
18.	.....	1
19.	.....	1
20.	.....	1
21.	.....	1
22.	.....	1
23.	.....	20
24.	.....	20
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29.	..... ( ..... ) .....	24
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33.	..... -24 ..... ( ..... ) .....	2
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# 1 Block diagram and pin description

Figure 1. Block diagram

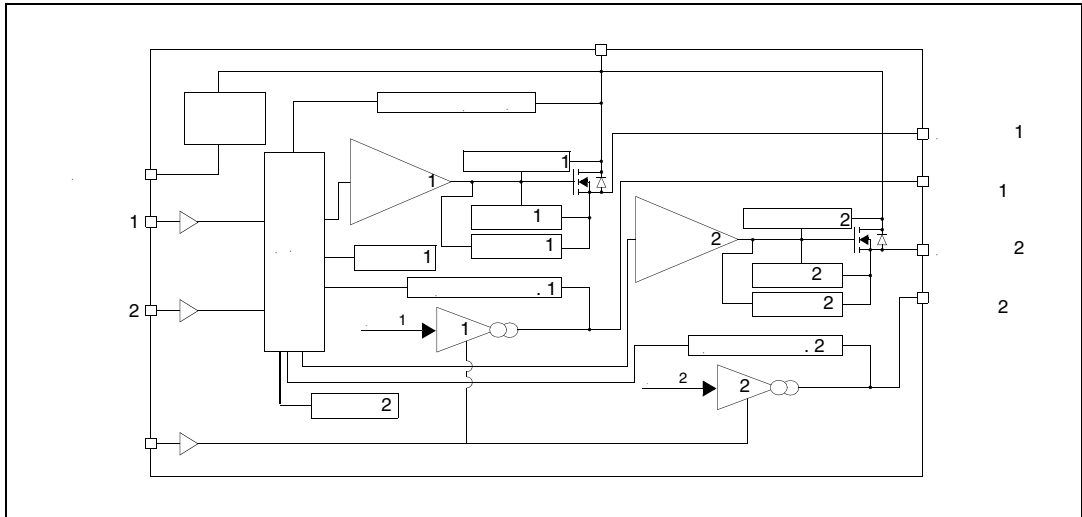
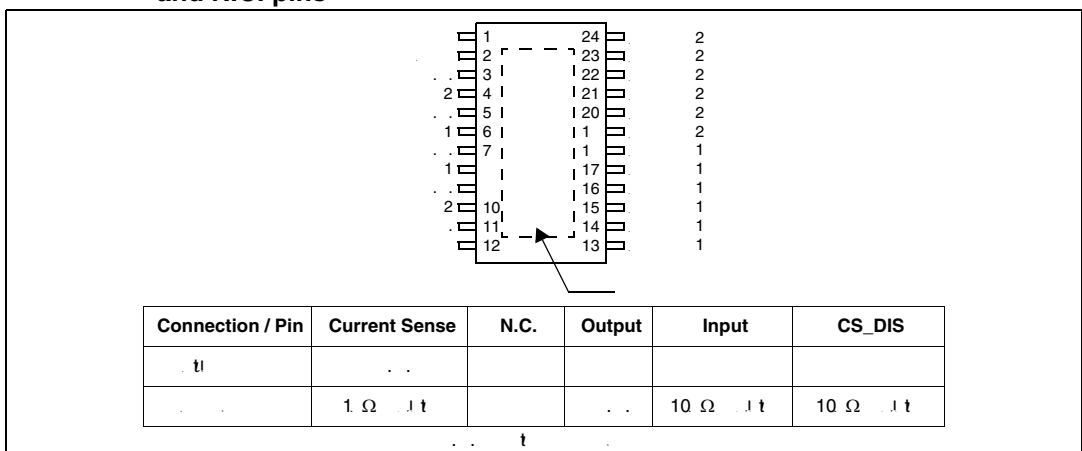


Table 2. Pin functions

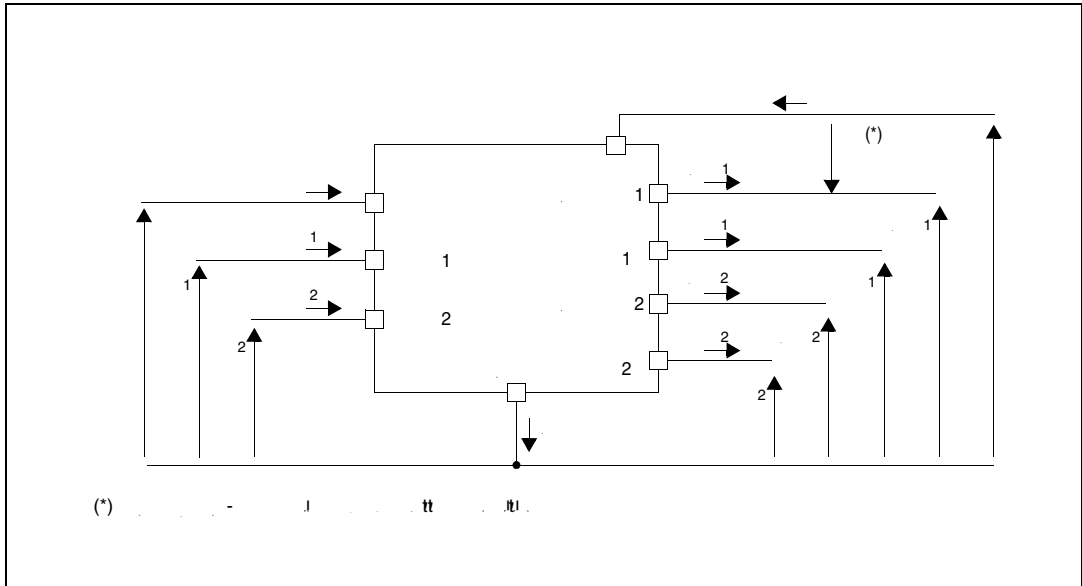
Name	Function
1,2	...
1,2	...
1,2	...
1,2	...
1,2	...

Figure 2. Configuration diagram (top view) and suggested connections for unused and N.C. pins



## 2 Electrical characteristics

Figure 3. Current and voltage conventions



## 2.1 Absolute maximum ratings

Table 3. Absolute maximum ratings

Symbol	Parameter	Value	Unit
	Operating temperature	41	
-	Storage temperature	0.3	
-	Maximum current	200	
	Operating temperature	-41 to +	
-	Storage temperature	24	
	Operating temperature	-1 to 10	
-	Storage temperature	200	
	Operating temperature	-41 to +	
(1)	Operating temperature (typical) (0.3, 0Ω, 13.5, 150, (Typ.))	10	
	Operating temperature (1.5Ω, 100)	4000 2000 4000 5000 5000	
	Operating temperature (100-011)	750	
J	Operating temperature	-40 to 150	
t	Operating temperature	-55 to 150	

1. Section 3.4

## 2.2 Thermal data

Table 4. Thermal data

Symbol	Parameter	Max Value	Unit
t <sub>J-amb</sub>	Operating temperature (junction to ambient)	1.35	/
t <sub>J-amb</sub>	Operating temperature (junction to ambient)	Figure 29	

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

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
			4.5	13	36	
				3.5	4.5	
				0.5		
	(1)	3, j 25			25	Ω
		3, j 150			50	
		3, 5, j 25			35	
		20	41	46	52	
		tt, 13, j 25, 0		2(2)	5(2)	μ
		tt, 13, 5, 0		3	6	
( )	tt tt t(1)	0, 13, j 25	0	0.01	3	μ
		0, 13, j 125	0		5	
	tt-t t(1)	4, j 150			0.7	

1. ...
2. ...

**Table 6. Switching ( $V_{CC} = 13V$ ;  $T_j = 25^{\circ}C$ )**

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
t( )		4.3Ω		35		μ
t( )		( Figure 8)		50		
( / t)		4.3Ω		( Figure 21)		/μ
( / t)			( Figure 22)			
	tt t	4.3Ω ( Figure 8)		0.45		
	tt t			0.35		



**Table 7. Logic input**

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
	$t_{\text{setup}}$				0.	
	$t_{\text{hold}}$	0.	1			$\mu$
	$t_{\text{rth}}$		2.1			
	$t_{\text{fth}}$	2.1			10	$\mu$
$t_{\text{tr}}$	$t_{\text{tr}}$		0.25			
	$t_{\text{tr}}$	1	5.5		7	
	$t_{\text{tr}}$	-1		-0.7		
	$t_{\text{tr}}$				0.	
	$t_{\text{tr}}$	0.	1			$\mu$
	$t_{\text{tr}}$		2.1			
	$t_{\text{tr}}$	2.1			10	$\mu$
$t_{\text{tr}}$	$t_{\text{tr}}$		0.25			
	$t_{\text{tr}}$	1	5.5		7	
	$t_{\text{tr}}$	-1		-0.7		

**Table 8. Protection and diagnostics<sup>(1)</sup>**

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
	$t_{\text{tr}}$	13	43	60	5	
	$t_{\text{tr}}$	5, 36				
	$t_{\text{tr}}$	13, 36		24		
	$t_{\text{tr}}$		150	175	200	
	$t_{\text{tr}}$		+1	+5		
	$t_{\text{tr}}$		135			
	$t_{\text{tr}}$			7		
	$t_{\text{tr}}$	2, 0, 6	-41	-46	-52	
	$t_{\text{tr}}$	0.2, -40, +150 ( <i>Figure 9</i> )		40		

1.  $t_{\text{tr}}$  is the time interval between the rising edge of the input signal and the rising edge of the output signal.  $t_{\text{tr}}$  is the time interval between the falling edge of the input signal and the falling edge of the output signal.  $t_{\text{tr}}$  is the time interval between the rising edge of the input signal and the falling edge of the output signal.  $t_{\text{tr}}$  is the time interval between the falling edge of the input signal and the rising edge of the output signal.

Table 9. Current sense (8V < V<sub>CC</sub> < 16V)

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
	/	0.05, 0.5, 0, -40 t 150	1450	3300	510	
0	/	0.5, 0.5, 0, -40 t 150	1720	3020	4360	
1	/	2, 4, 0, -40 25 t 150	140 2230	210 210	3740 330	
1/ 1 <sup>(1)</sup>	t t	2, 4, 0, -40 t 150	-10		+10	%
2	/	3, 4, 0, -40 25 t 150	2250 2400	270 270	3450 310	
2/ 2 <sup>(1)</sup>	t t	3, 4, 0, -40 t 150	-7		+7	%
3	/	10, 4, 0, -40 25 t 150	2610 2650	2760 2760	270 270	
3/ 3 <sup>(1)</sup>	t t	10, 4, 0, -40 t 150	-3		+3	%
0	t	0, 0, 5, 0, -40 t 150 0, 5, -40 t 150 2, 0, 5, 5, -40 t 150	0 0 0		1 2 1	μ μ μ
	t t	3, 0	5			
	t t t J t t t	13, 3. Ω				
	t t t t t t t	13, 5				

Table 9. Current sense (8V < V<sub>CC</sub> < 16V) (continued)

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
t <sub>1</sub>	t <sub>1</sub>	4, 0.5, 10 0% ( <i>Figure 4)</i>		50	100	μ
t <sub>1</sub>	t <sub>1</sub>	4, 0.5, 10 10% ( <i>Figure 4)</i>		5	20	
t <sub>2</sub>	t <sub>2</sub>	4, 0.5, 10 0% ( <i>Figure 4)</i>		70	300	
Δt	t <sub>1</sub> - t <sub>2</sub> t <sub>1</sub> - t <sub>2</sub> t <sub>1</sub> - t <sub>2</sub> ( <i>Figure 5)</i>	4, 0.5, 10 0% 0% ( 3 <i>Figure 5)</i>			110	
t <sub>2</sub>	t <sub>2</sub>	4, 0.5, 10 10% ( <i>Figure 4)</i>		100	250	

1. t<sub>1</sub> is the delay time from the rising edge of the current to the rising edge of the sense signal.

Figure 4. Current sense delay characteristics

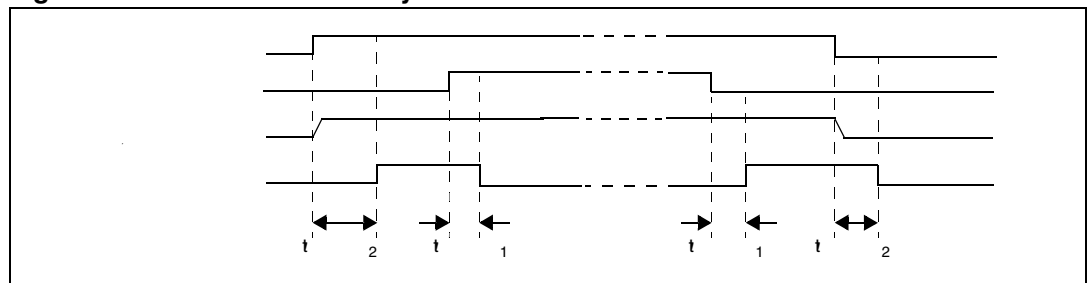


Figure 5. Delay response time between rising edge of output current and rising edge of current sense (CS enabled)

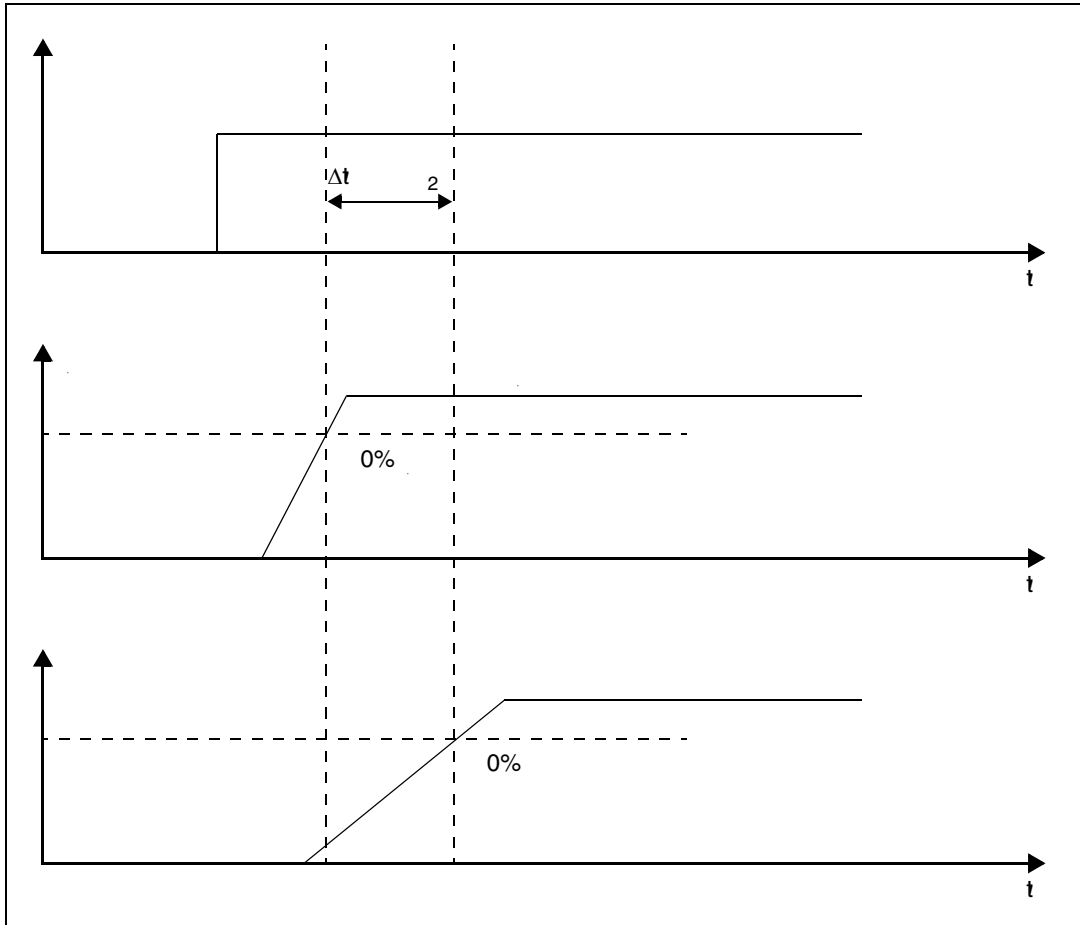


Figure 6.  $I_{OUT}/I_{SENSE}$  vs  $I_{OUT}$  ( [Table 9](#) t J. )

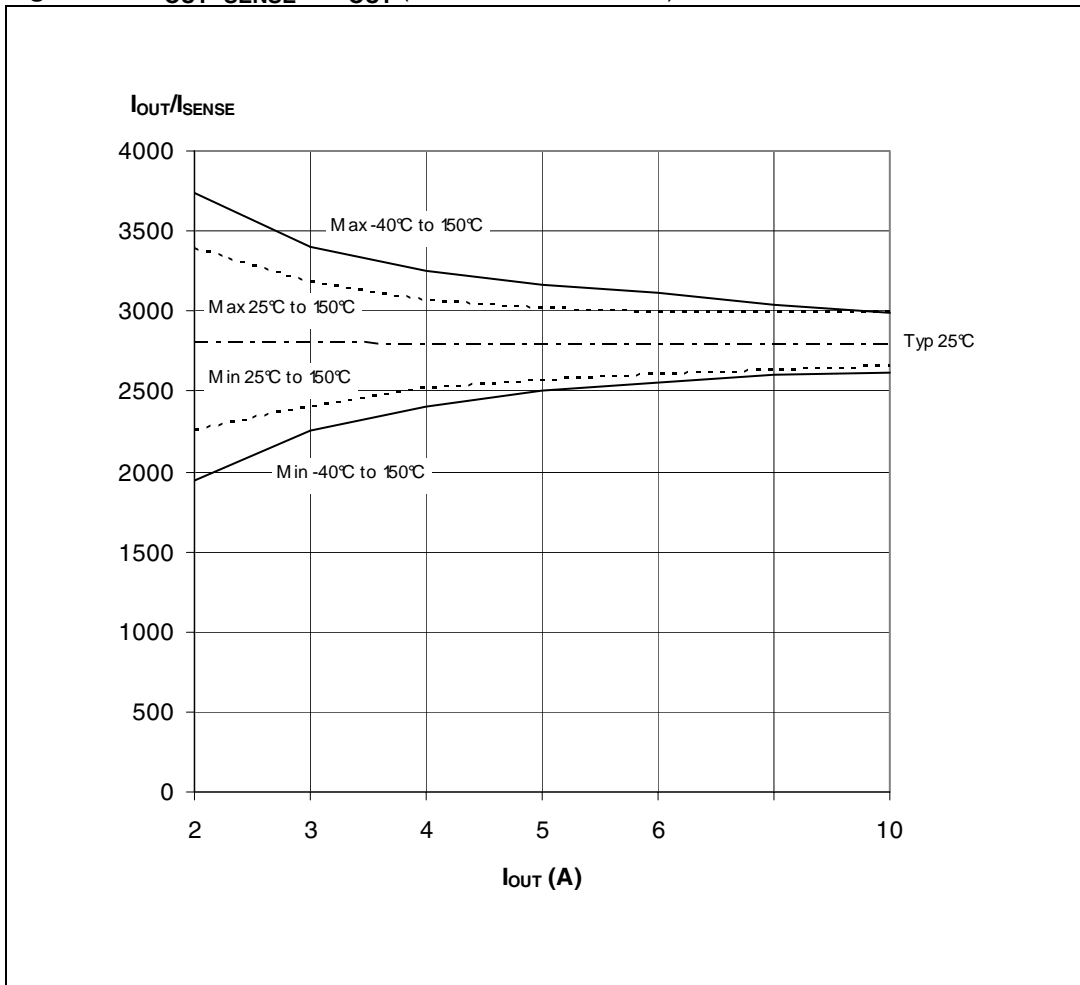


Figure 7. Maximum current sense ratio drift vs load current

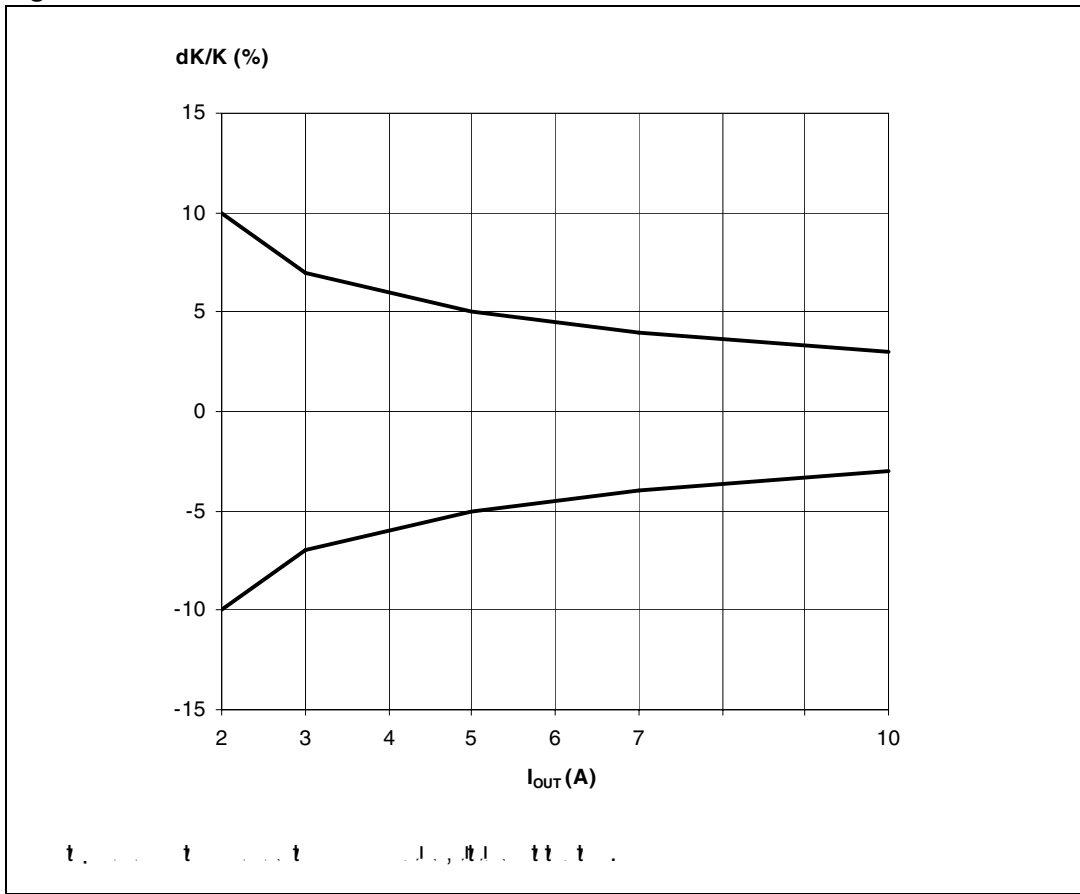


Table 10. Truth table

Conditions	Input	Output	Sense ( $V_{CSD} = 0V$ ) <sup>(1)</sup>
...	...	...	0
	...	...	...
...	...	...	0
	...	...	...
...	...	...	0
	...	...	...
... ( $\leq 10 \Omega$ )	...	...	0
	...	...	0.1
	...	...	...
...	...	...	0
	...	...	...
...	...	...	0

Figure 8. Switching characteristics

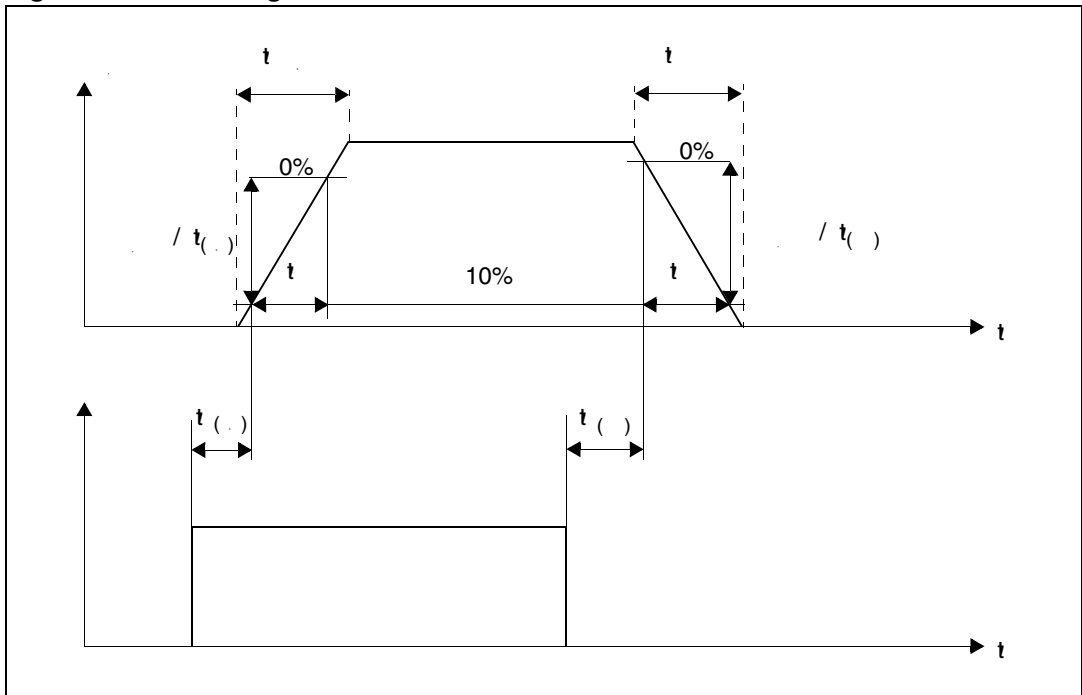


Figure 9. Output voltage drop limitation

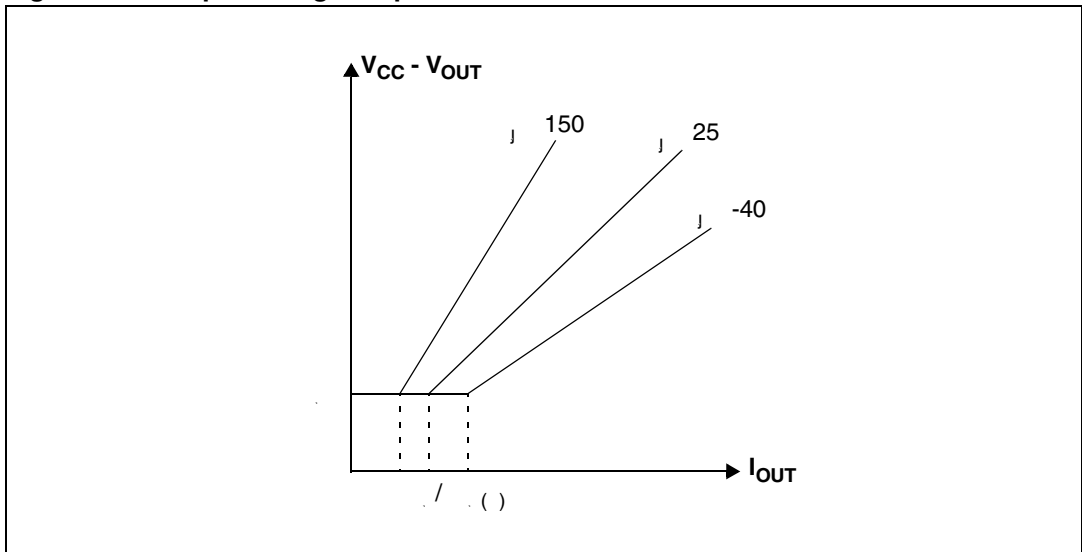


Table 11. Electrical transient requirements

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	-75	-100	5000	0.5	5	2 , 10Ω
2	+37	+50	5000	0.2	5	50μ , 2Ω
3	-100	-150	↑	0	100	0.1μ , 50Ω
3	+75	+100	↑	0	100	0.1μ , 50Ω
4	-6	-7	1			100 , 0.01Ω
5 <sup>(2)</sup>	+65	+ 7	1			400 , 2Ω

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

Class	Contents

1. ... t t ... t ... t 13.5 t ... 5 .
2. ... t ... t ... 40 ... t ...



Figure 10. Waveforms

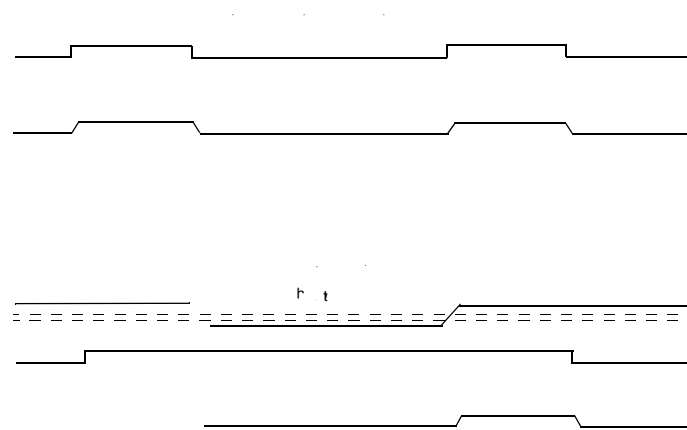


Figure 11. Off state output current

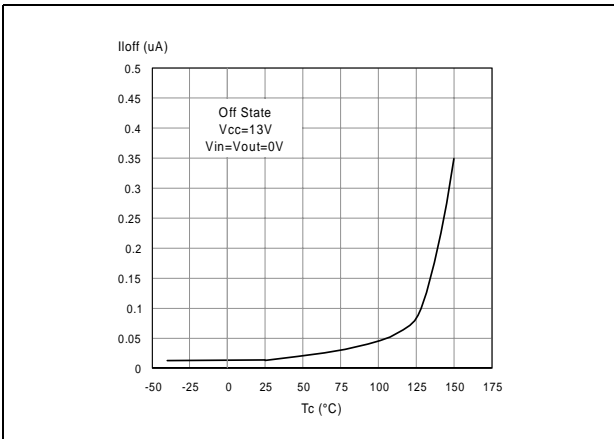


Figure 12. High level input current

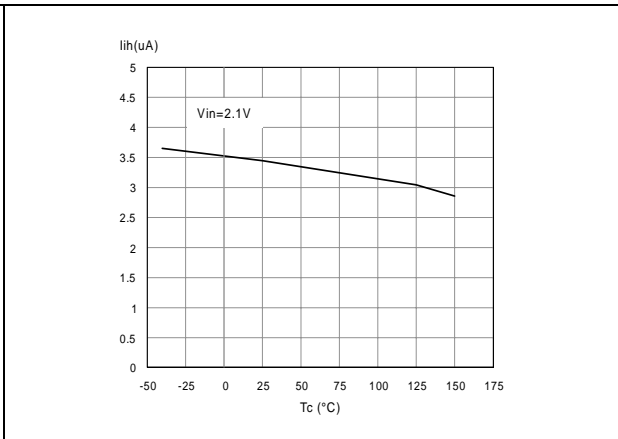


Figure 13. Input clamp voltage

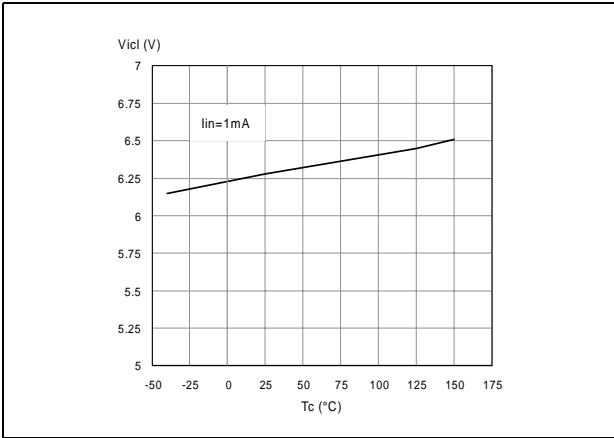


Figure 14. Input high level

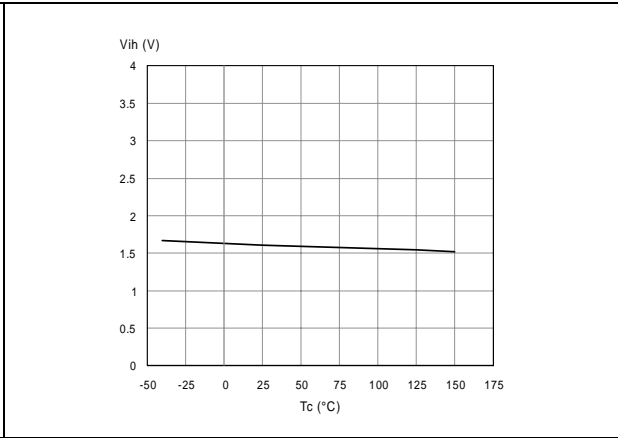


Figure 15. Input low level

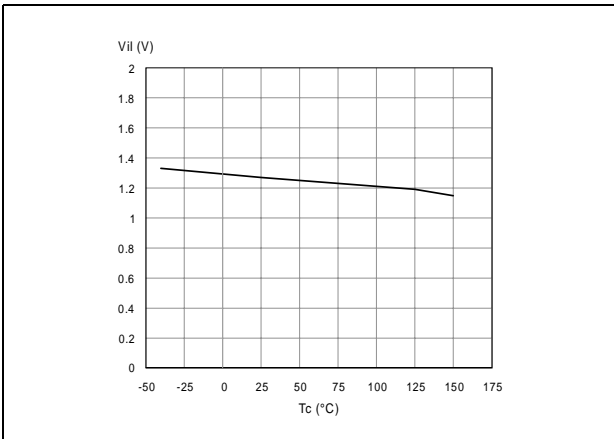


Figure 16. Input hysteresis voltage

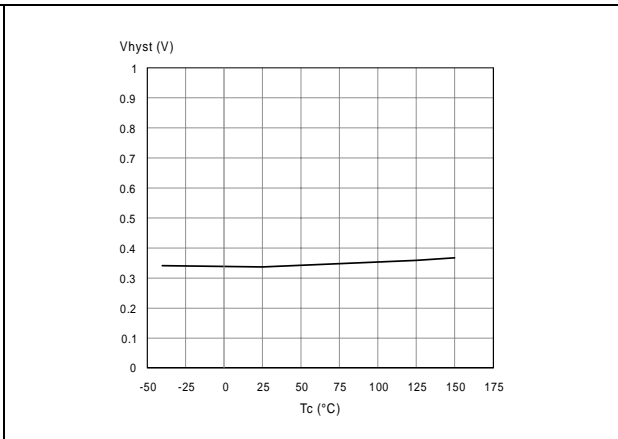


Figure 17. On state resistance vs  $T_{case}$

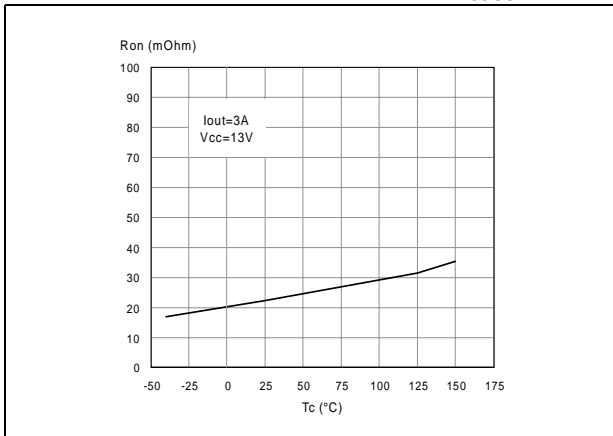


Figure 18. On state resistance vs  $V_{CC}$

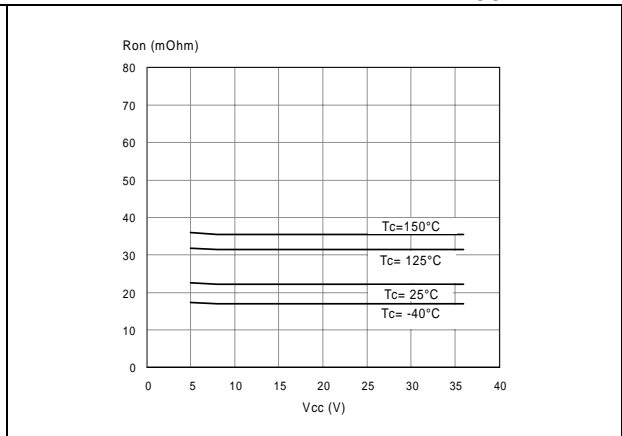


Figure 19. Undervoltage shutdown

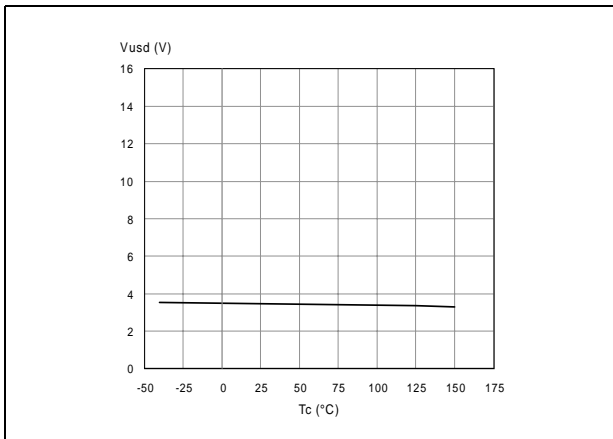


Figure 20.  $I_{LIMH}$  vs  $T_{case}$

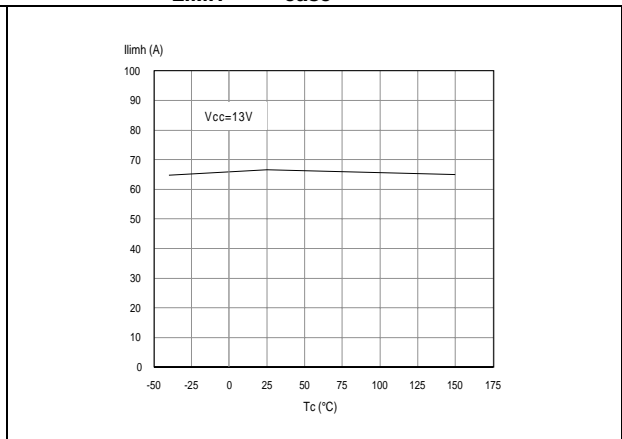


Figure 21. Turn-on voltage slope

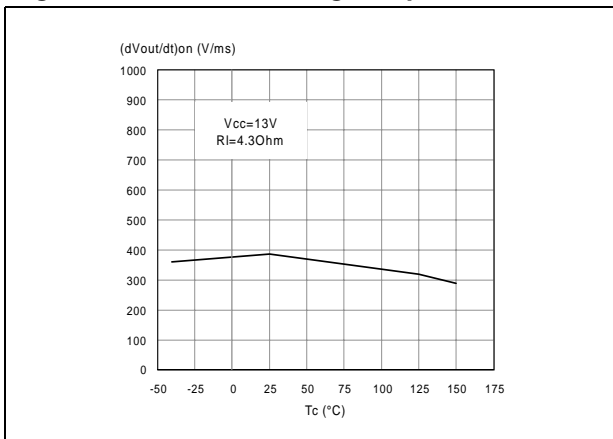
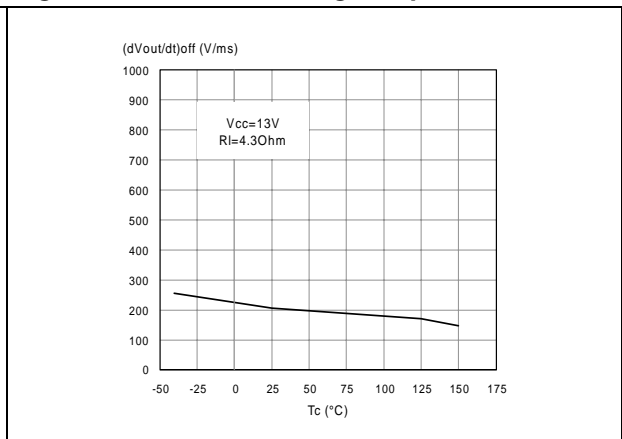
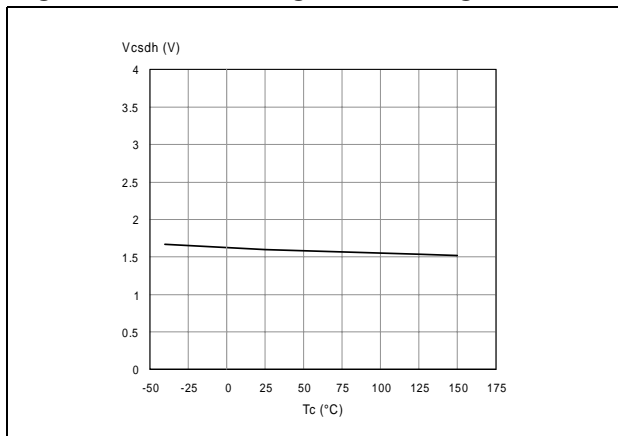


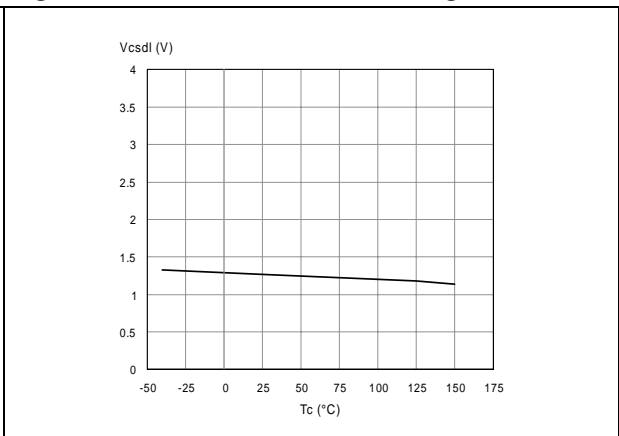
Figure 22. Turn-off voltage slope



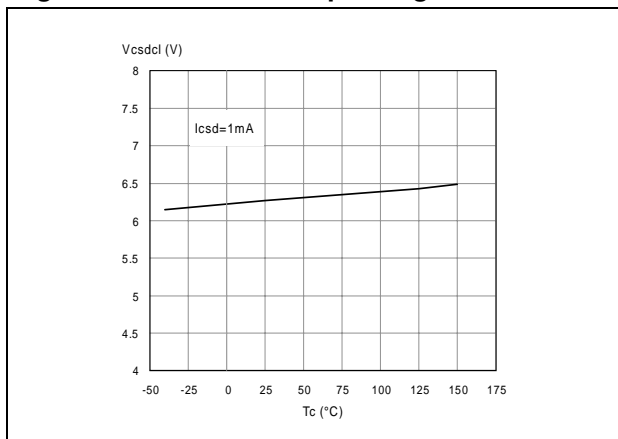
**Figure 23. CS\_DIS high level voltage**



**Figure 24. CS\_DIS low level voltage**

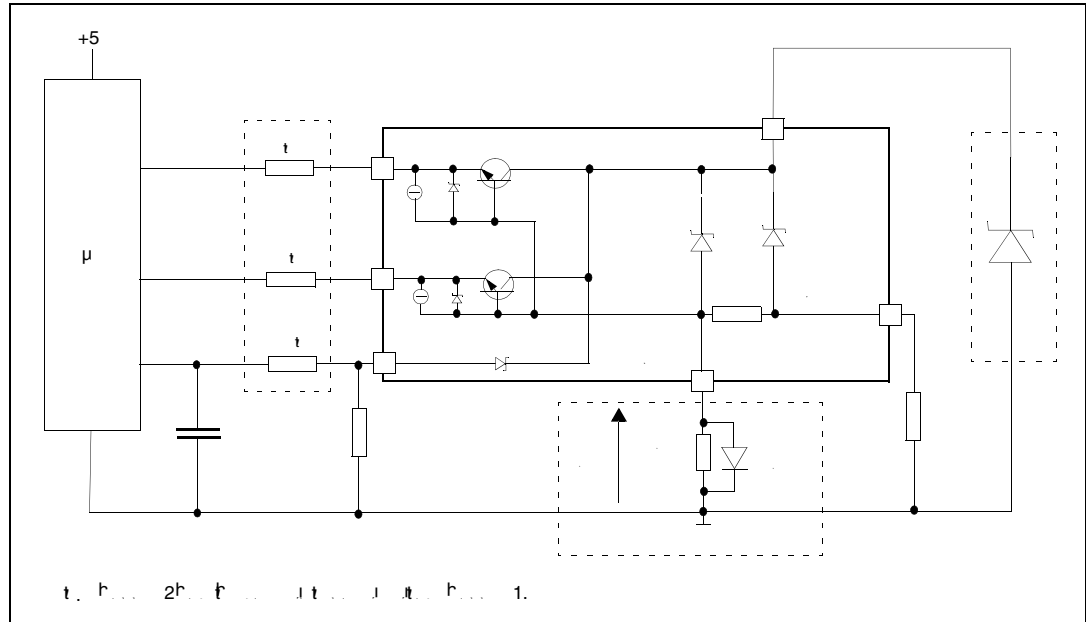


**Figure 25. CS\_DIS clamp voltage**



### 3 Application information

Figure 26. Application schematic



#### 3.1 GND protection network against reverse battery

When the battery is connected in reverse, the current flows from the load back to the microcontroller. This current can damage the microcontroller if it is not protected.

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

When the battery is connected in reverse, the current flows from the load back to the microcontroller.

The current through the resistor is given by the following equation:

1.  $I_{R_{GND}} \leq 600 \text{ mA} / (V_{DD} - V_{GS})$
2.  $R_{GND} \geq (-V_{GS}) / (-I_{R_{GND}})$

When the battery is connected in reverse, the current flows from the load back to the microcontroller. The current through the resistor is given by the following equation:

$$I_{R_{GND}} = \frac{V_{GS}}{R_{GND} + R_{load}} \quad (R_{load} = 0 \text{ } \Omega \text{ (short circuit))}$$

$$R_{GND} \geq \frac{(-V_{GS})^2}{I_{R_{GND}}}$$

When the battery is connected in reverse, the current flows from the load back to the microcontroller. The current through the resistor is given by the following equation:

When the battery is connected in reverse, the current flows from the load back to the microcontroller. The current through the resistor is given by the following equation:

... ..  
... .. 2.

### 3.1.2 Solution 2: Diode (D<sub>GND</sub>) in the ground line

... .. (1 Ω) ... ..  
... ..  
... .. (j600 Ω) ... ..  
... ..  
... .. / ... ..

### 3.2 Load dump protection

... ..  
... ..  
... .. 7637-2, 2004 ... ..

### 3.3 μC I/Os protection

... ..  
... .. ( ) ... ..  
... .. μ / ... ..

... .. μ ... ..  
... .. ( ... .. ) ... .. μ  
... ..

... .. / ... .. ≤ ... .. t ≤ ( ... .. μ - ... .. ) / ... ..

... ..

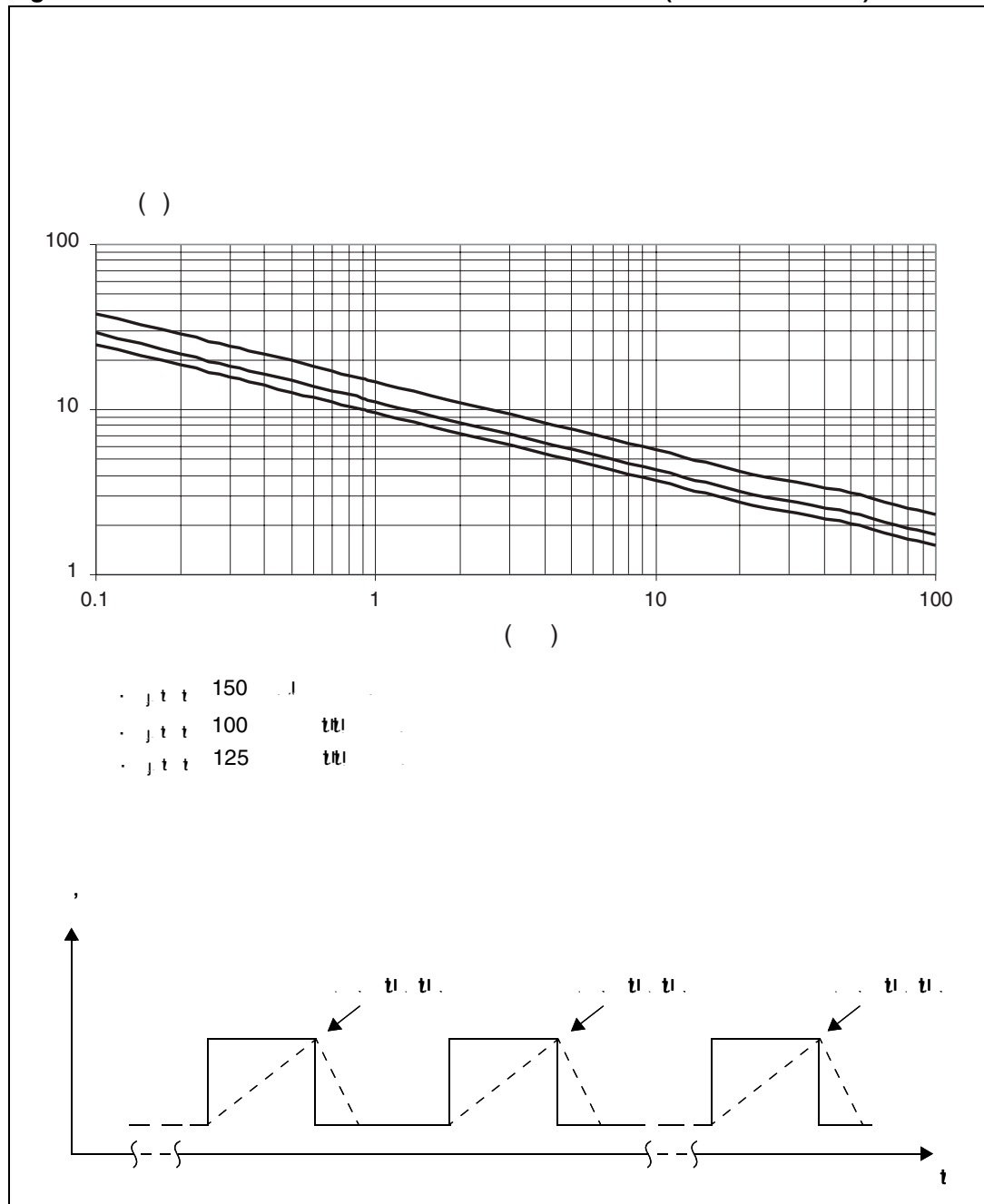
... .. -100 ... .. t<sub>th</sub> ≥ 20 ... .. μ ≥ 4.5

5 Ω ≤ ... .. t ≤ 65 Ω

... .. t 10 Ω, ... .. 10

### 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  $R_L = 0\Omega$   
 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

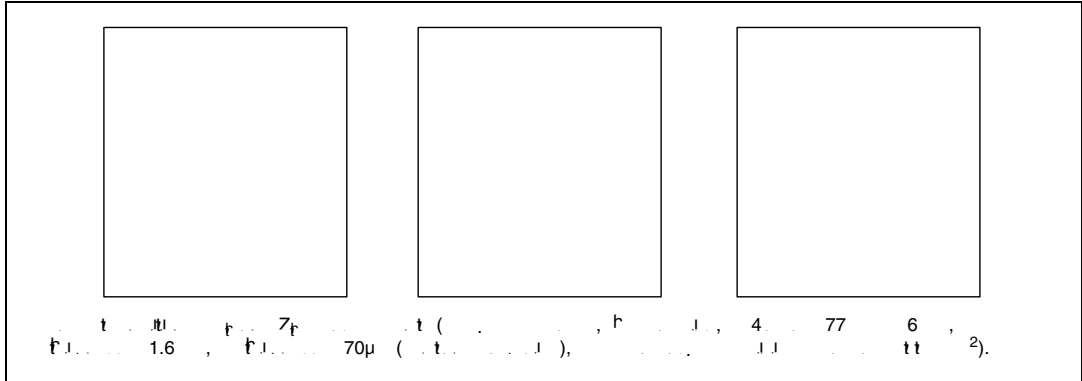


Figure 29.  $R_{thj-amb}$  vs PCB copper area in open box free air condition (with one channel ON)

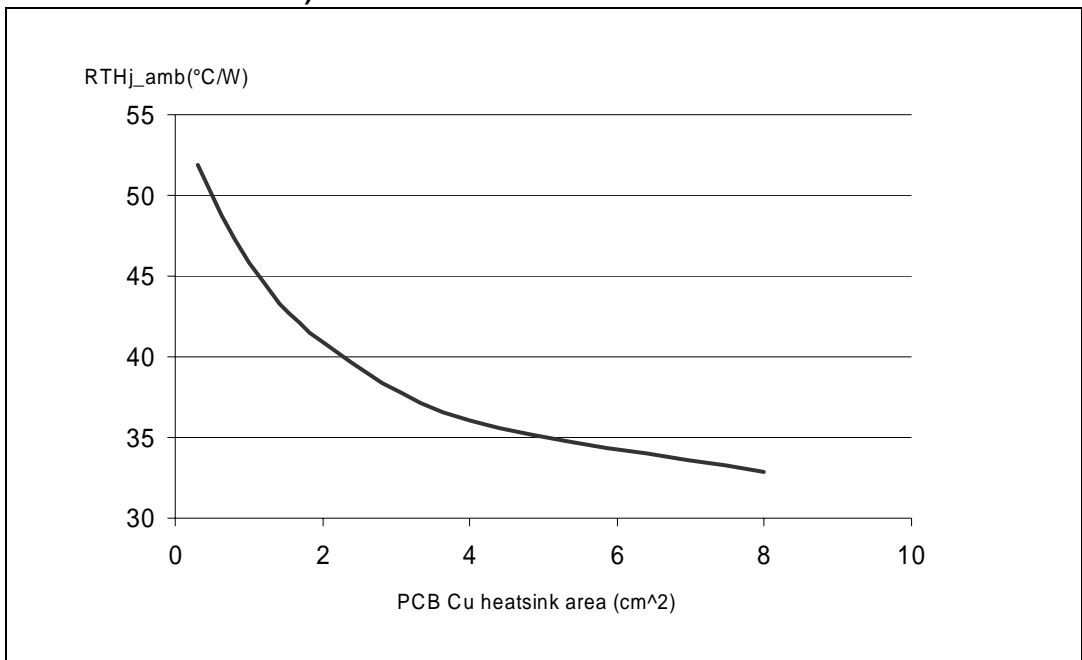




Figure 30. PowerSSO-24™ thermal impedance junction to ambient single pulse (with one channel ON)

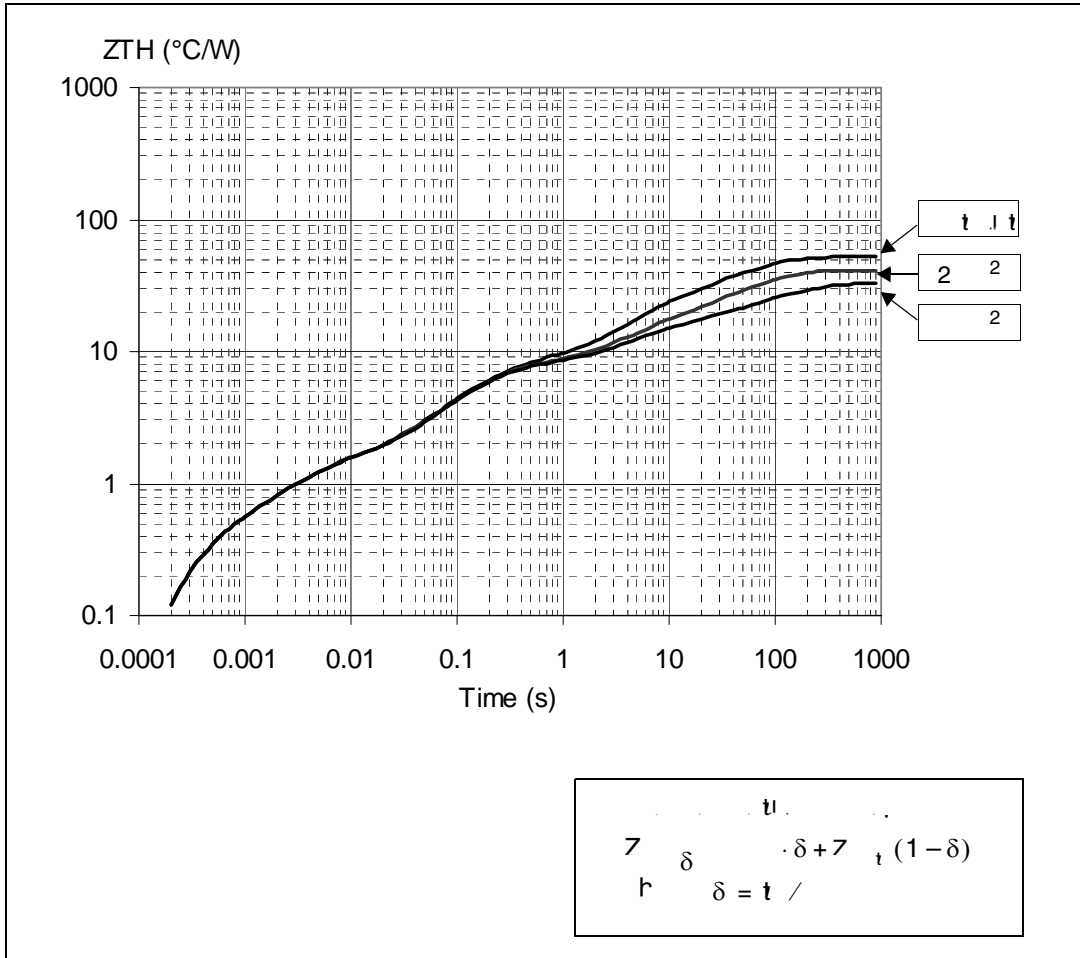
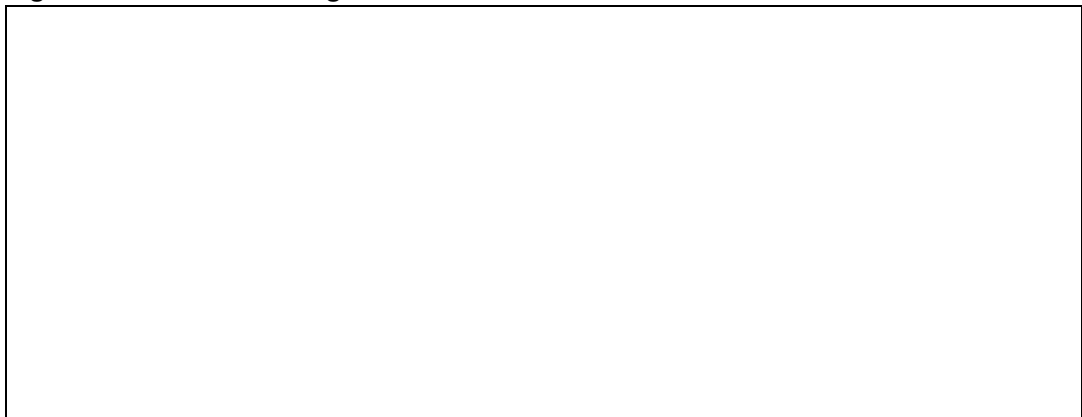


Figure 31. Thermal fitting model of a double channel HSD in PowerSSO-24™(1)



1. See also Table 12.

Table 12. Thermal parameters

Area/Island (cm <sup>2</sup> )	Footprint	2	8
1 ( / )	0.2		
2 ( / )	0.		
3 ( / )	6		
4 ( / )	7.7		
5 ( / )			
6 ( / )	2	17	10
7 ( / )	0.2		
( / )	0.		
1 ( . / )	0.001		
2 ( . / )	0.003		
3 ( . / )	0.025		
4 ( . / )	0.75		
5 ( . / )	1	4	
6 ( . / )	2.2	5	17
7 ( . / )	0.001		
( . / )	0.003		

## 5 Package and packing information

### 5.1 ECOPACK® packages

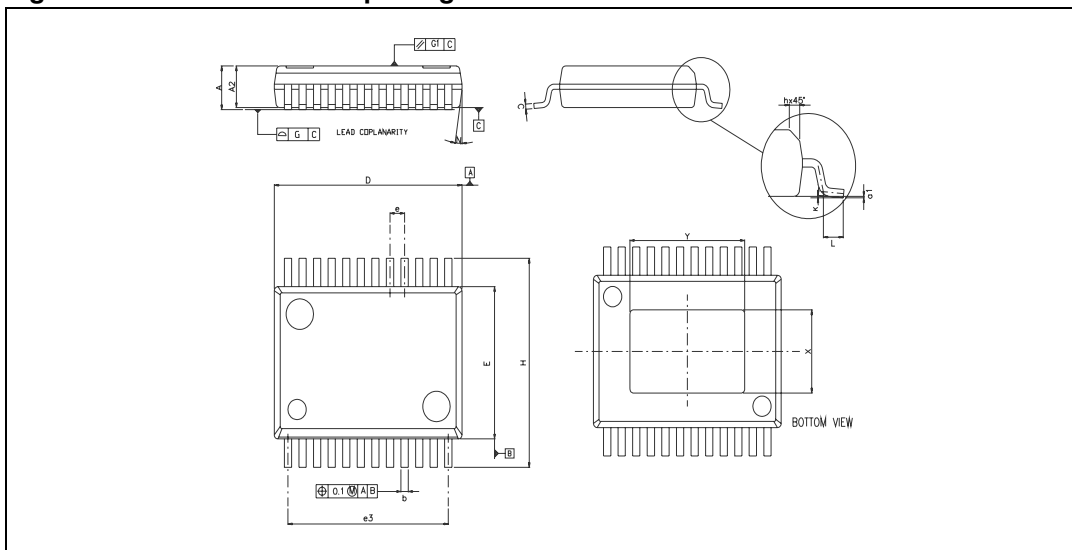
For more information on the mechanical characteristics of the PowerSSO-24™ package, please refer to the PowerSSO-24™ package mechanical drawing (see Figure 13). The dimensions are given in millimeters.

### 5.2 Package mechanical

Table 13. PowerSSO-24™ mechanical data

Symbol	Millimeters		
	Min	Typ	Max
	1.		2.22
2	1.		2.15
1	0		0.07
	0.34	0.4	0.46
	0.23		0.32
	10.2		10.4
	7.4		7.6
		0.	
3			0.1
1			0.06
	10.1		10.5
h			0.4
	0.55		0.5
			10
	3.		4.3
	6.1		6.5

Figure 32. PowerSSO-24™ package dimensions



### 5.3 Packing information

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

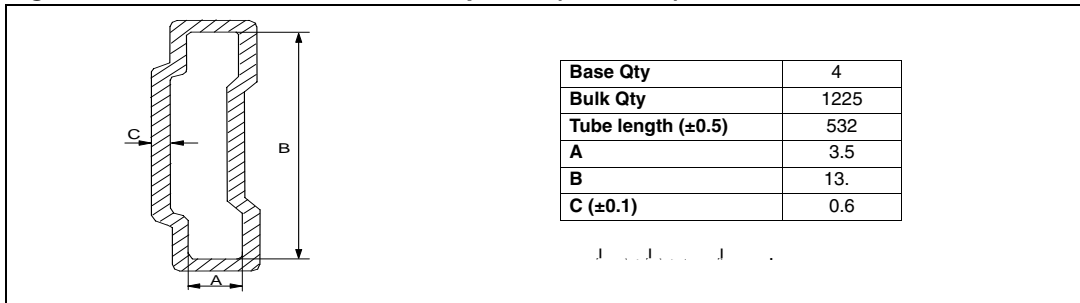
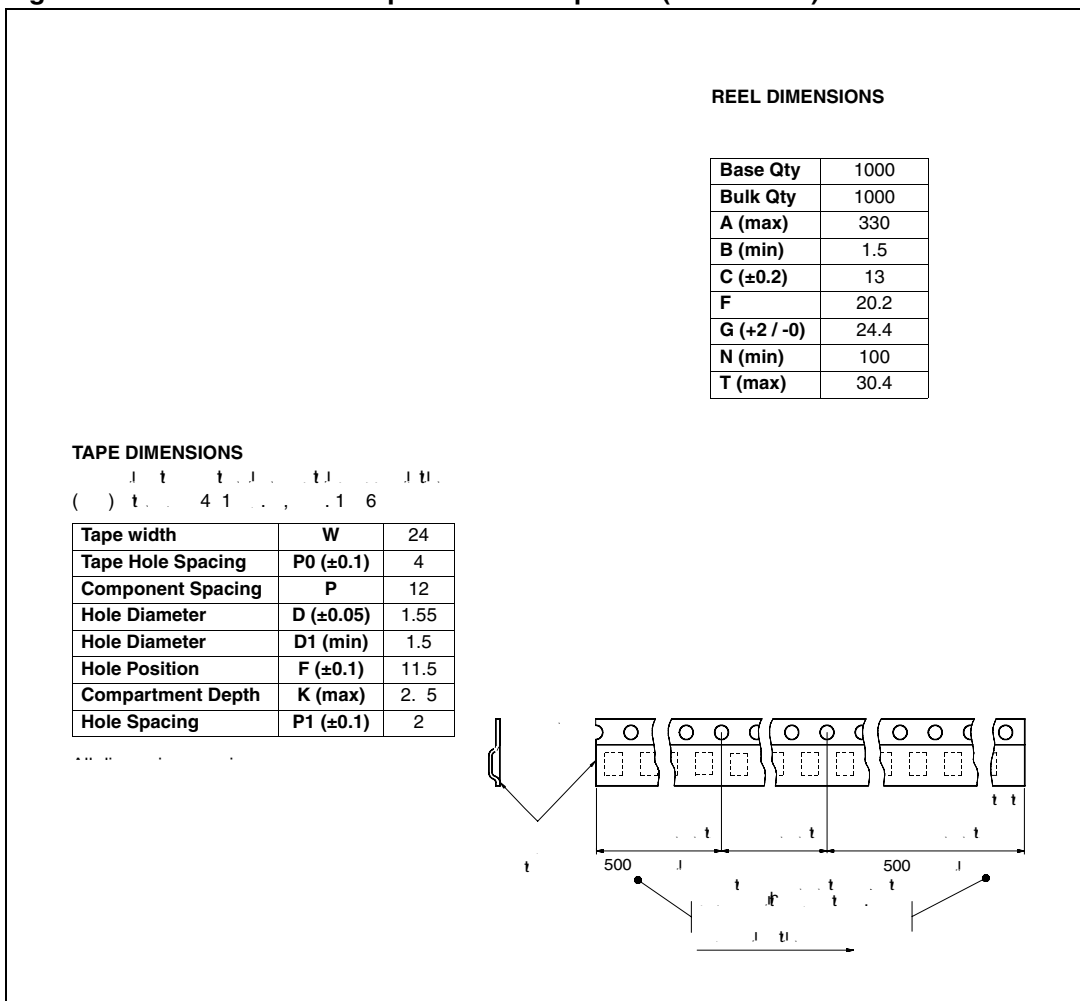


Figure 34. PowerSSO-24™ tape and reel shipment (suffix “TR”)



## 6 Revision history

Table 14. Document revision history

Date	Revision	Changes
16- -2007	1	
23- -2007	2	<i>Table 9: Current sense (8V &lt; VCC &lt; 16V)</i>
2 - -2007	3	<i>Protection</i>

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