



# VND5004A-E VND5004ASP30-E

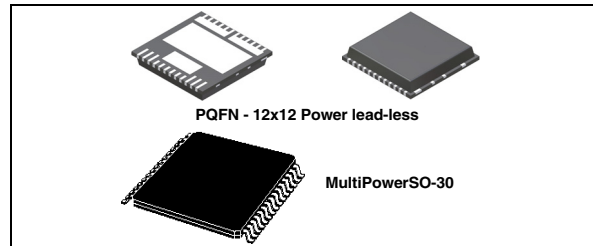
Double 4mΩ high side driver with analog current sense  
for automotive applications

## Features

Max transient supply voltage	V <sub>CC</sub>	41V
Operating voltage range	V <sub>CC</sub>	4.5 to 27V
Max On-State resistance (per ch.)	R <sub>ON</sub>	4 mΩ
Current limitation (typ)	I <sub>LIMH</sub>	100A
Off state supply current	I <sub>S</sub>	2 μA <sup>(1)</sup>

1. Typical value with all loads connected

- General
  - Inrush 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
- Diagnostic functions
  - Proportional load current sense
  - Current sense disable
  - Thermal shutdown indication
- Protection
  - Undervoltage shut-down
  - Overvoltage clamp
  - Load current limitation
  - Thermal shut down
  - Self limiting of fast thermal transients
  - Protection against loss of ground and loss of V<sub>CC</sub>
  - Reverse battery protection with self switch on of the PowerMOS (see [Application schematic on page 18](#))
  - Electrostatic discharge protection



## Application

- All types of resistive, inductive and capacitive loads
- Suitable for power management applications

## Description

The VND5004ATR-E and VND5004ASP30-E are devices made using STMicroelectronics VIPower technology. They are intended for driving resistive or inductive loads with one side connected to ground. Active V<sub>CC</sub> pin voltage clamp and load dump protection circuit protect the devices against transients on the V<sub>CC</sub> pin (see ISO7637 transient compatibility table). These devices integrate 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 high impedance. Output current limitation protects the devices in overload condition. In case of long duration overload, the devices limit the dissipated power to a safe level up to thermal shut-down intervention. Thermal shut-down with automatic restart allows the device to recover normal operation as soon as a fault condition disappears.

Table 1. Devices summary

Package	Order codes		
	Tube	Tape and Reel	Tray
PQFN-12x12 Power lead-less	-	VND5004ATR-E	VND5004A-E
MultiPowerSO-30	VND5004ASP30-E	VND5004ASP30TR-E	-

# Contents

<b>1</b>	<b>Block diagram and pin configurations</b>	<b>5</b>
<b>2</b>	<b>Electrical specifications</b>	<b>7</b>
2.1	Absolute maximum ratings	7
2.2	Thermal data	8
2.3	Electrical characteristics	9
2.4	Electrical characteristics curves	15
<b>3</b>	<b>Application information</b>	<b>18</b>
3.1	MCU I/Os protection	18
3.2	Load dump protection	18
3.3	Maximum demagnetization energy (VCC = 13.5V)	19
<b>4</b>	<b>Package and PC board thermal data</b>	<b>20</b>
4.1	MultiPowerSO-30 thermal data	20
4.2	PQFN - 12x12 Power lead-less thermal data	23
<b>5</b>	<b>Package and packing information</b>	<b>26</b>
5.1	ECOPACK <sup>®</sup> packages	26
5.2	MultiPowerSO-30 mechanical data	26
5.3	PQFN - 12x12 Power lead-less mechanical data	28
5.4	MultiPowerSO-30 packing information	30
5.5	PQFN - 12x12 Power lead-less packing information	31
<b>6</b>	<b>Revision history</b>	<b>33</b>

## List of tables

Table 1.	Devices summary . . . . .	1
Table 2.	Pin functions . . . . .	5
Table 3.	Suggested connections for unused and n.c. pins . . . . .	6
Table 4.	Absolute maximum ratings . . . . .	7
Table 5.	Thermal data . . . . .	8
Table 6.	Power section . . . . .	9
Table 7.	Switching (VCC = 13V; Tj = 25°C) . . . . .	9
Table 8.	Logic input . . . . .	10
Table 9.	Protection and diagnostics . . . . .	10
Table 10.	Current sense (8V<VCC<16V) . . . . .	11
Table 11.	Truth table. . . . .	12
Table 12.	Electrical transient requirements . . . . .	13
Table 13.	Thermal parameters for MultiPowerSO-30 . . . . .	22
Table 14.	Thermal parameters for PQFN - 12x12 Power lead-less . . . . .	25
Table 15.	MultiPowerSO-30 mechanical data . . . . .	27
Table 16.	PQFN - 12x12 Power lead-less mechanical data . . . . .	29
Table 17.	Document revision history . . . . .	33

## List of figures

Figure 1.	Block diagram . . . . .	5
Figure 2.	Configuration diagram (not in scale) . . . . .	6
Figure 3.	Current and voltage conventions . . . . .	7
Figure 4.	Current sense delay characteristics . . . . .	11
Figure 5.	Switching characteristics . . . . .	12
Figure 6.	Waveforms . . . . .	14
Figure 7.	Off state output current . . . . .	15
Figure 8.	High level input current . . . . .	15
Figure 9.	Input clamp voltage . . . . .	15
Figure 10.	Input low level . . . . .	15
Figure 11.	Input high level . . . . .	15
Figure 12.	Input hysteresis voltage . . . . .	15
Figure 13.	On state resistance vs. $T_{case}$ . . . . .	16
Figure 14.	On state resistance vs. $V_{CC}$ . . . . .	16
Figure 15.	Undervoltage shutdown . . . . .	16
Figure 16.	Turn-On voltage slope . . . . .	16
Figure 17.	$I_{LIMH}$ vs. $T_{case}$ . . . . .	16
Figure 18.	Turn-Off voltage slope . . . . .	16
Figure 19.	CS_DIS high level voltage . . . . .	17
Figure 20.	CS_DIS clamp voltage . . . . .	17
Figure 21.	CS_DIS low level voltage . . . . .	17
Figure 22.	Application schematic . . . . .	18
Figure 23.	Maximum turn off current versus inductance . . . . .	19
Figure 24.	MultiPowerSO-30 PC board . . . . .	20
Figure 25.	$R_{thj-amb}$ Vs. PCB copper area in open box free air condition (one channel ON) . . . . .	20
Figure 26.	MultiPowerSO-30 thermal impedance junction ambient single pulse (one channel ON) . . . . .	21
Figure 27.	Thermal fitting model of a double channel HSD in MultiPowerSO-30 . . . . .	21
Figure 28.	12x12 Power lead-less package PC board . . . . .	23
Figure 29.	$R_{thj-amb}$ Vs. PCB copper area in open box free air condition (one channel ON) . . . . .	23
Figure 30.	PQFN - 12x12 Power lead-less package thermal impedance junction ambient single pulse (one channel ON) . . . . .	24
Figure 31.	Thermal fitting model of a double channel HSD in PQFN - 12x12 Power lead-less . . . . .	24
Figure 32.	MultiPowerSO-30 outline . . . . .	26
Figure 33.	PQFN - 12x12 Power lead-less outline . . . . .	28
Figure 34.	MultiPowerSO-30 tube shipment (no suffix) . . . . .	30
Figure 35.	MultiPowerSO-30 tape and reel shipment (suffix "TR") . . . . .	30
Figure 36.	PQFN - 12x12 Power lead-less tray shipment (no suffix) . . . . .	31
Figure 37.	PQFN - 12x12 Power lead-less tape and reel shipment (suffix "TR") . . . . .	32

# 1 Block diagram and pin configurations

Figure 1. Block diagram

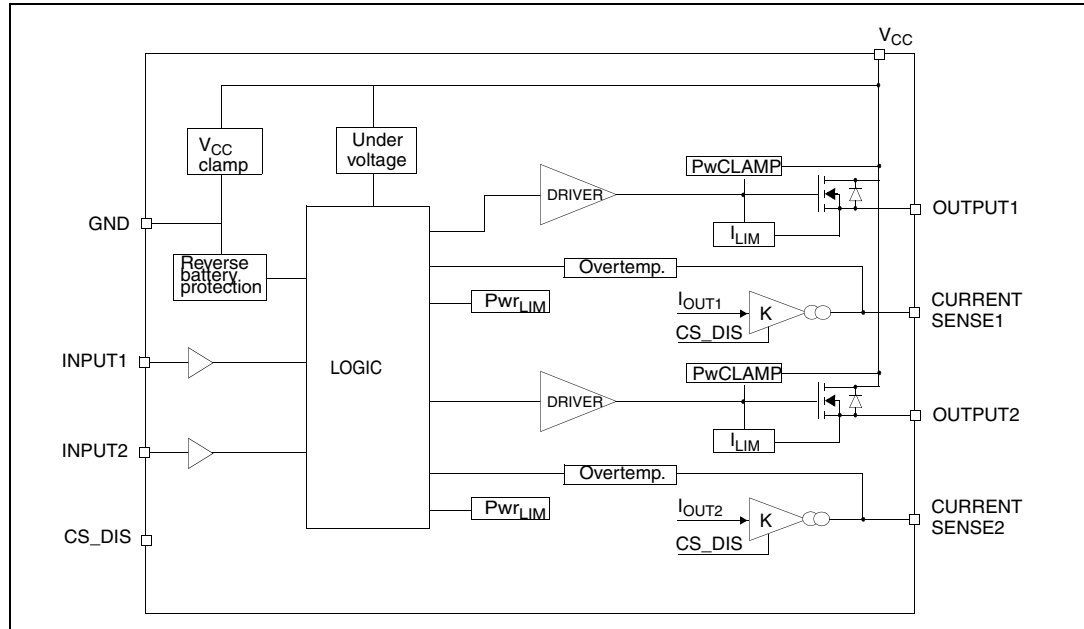


Table 2. Pin functions

Name	Function
VCC	Battery connection
OUTPUT1,2	Power output
GND	Ground connection
INPUT1,2	Voltage controlled input pin with hysteresis, CMOS compatible. Controls output switch state
CURRENT SENSE1,2	Analog current sense pin, delivers a current proportional to the load current
CS_DIS	Active high CMOS compatible pin, to disable the current sense pins

Figure 2. Configuration diagram (not in scale)

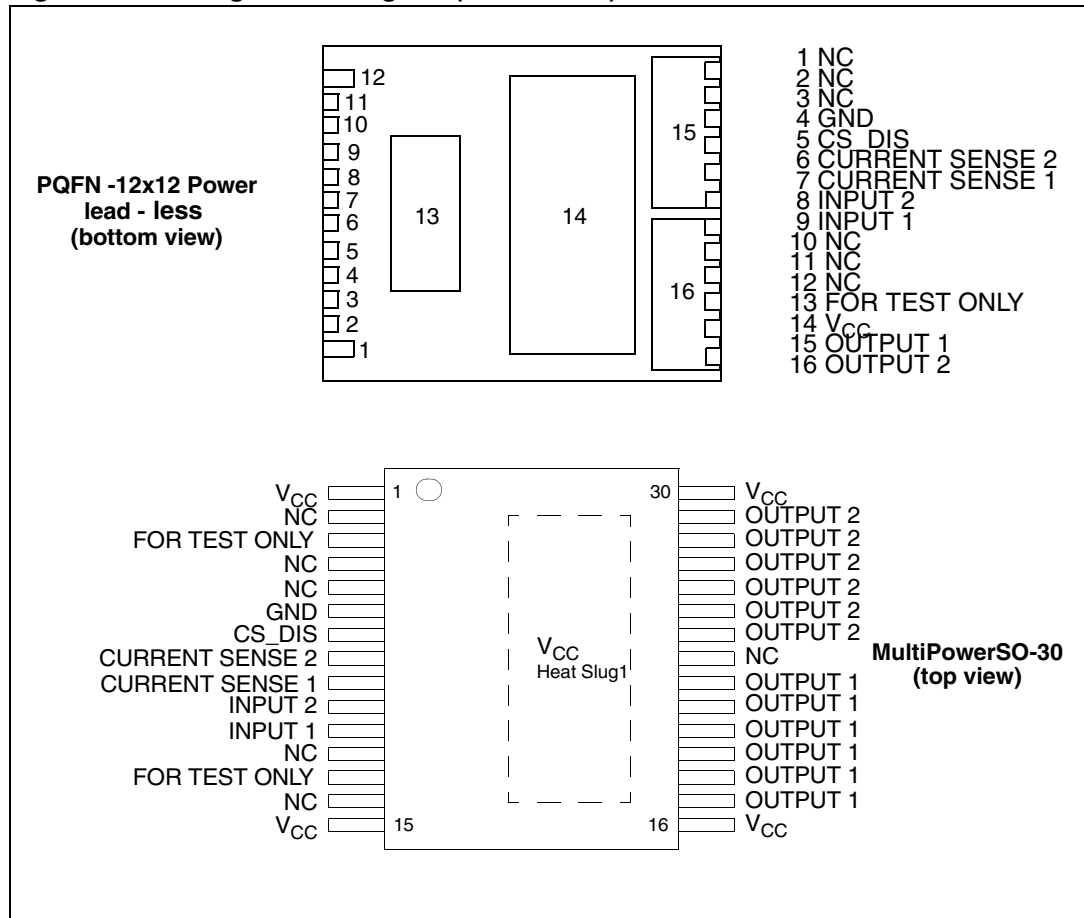


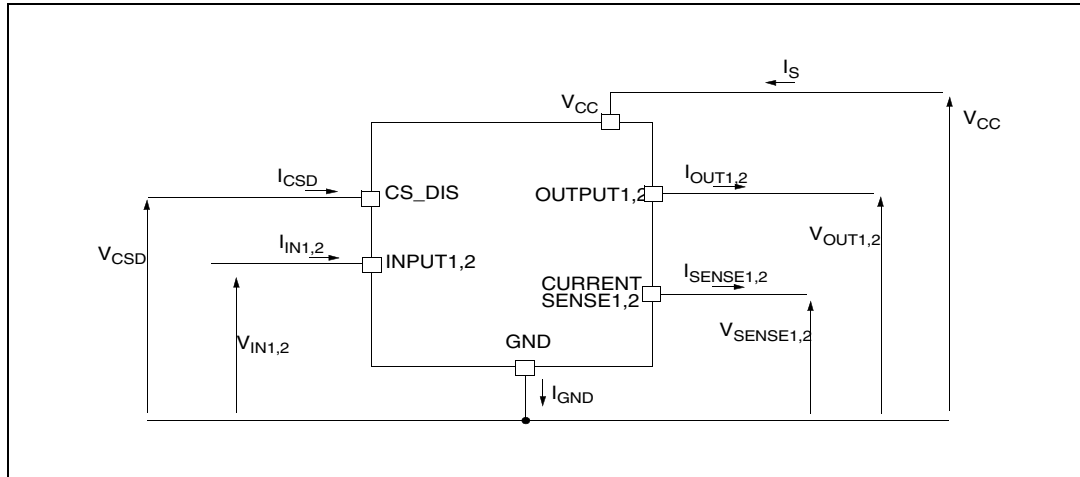
Table 3. Suggested connections for unused and n.c. pins

Connection / Pin	Current Sense	N.C.	Output	Input	CS_DIS	For test only
Floating	N.R. <sup>(1)</sup>	X	X	X	X	X
To ground	Through 1kΩ resistor	X	N.R.	Through 10kΩ resistor	Through 10kΩ resistor	N.R.

1. Not recommended.

## 2 Electrical specifications

Figure 3. Current and voltage conventions



### 2.1 Absolute maximum ratings

Stressing the device above the ratings listed in the “Absolute maximum ratings” tables 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 this section for extended periods may affect device reliability. Refer also to the STMicroelectronics SURE Program and other relevant quality documents.

Table 4. Absolute maximum ratings

Symbol	Parameter	Value	Unit
$V_{CC}$	DC supply voltage	27	V
$V_{CCPK}$	Transient supply voltage ( $T < 400\text{ms}$ , $R_{load} > 0.5\Omega$ )	41	V
$-V_{CC}$	Reverse DC supply voltage	16	V
$I_{OUT}$	DC output current	Internally limited	A
$-I_{OUT}$	Reverse DC output current	70	A
$I_{IN}$	DC input current	-1 to 10	mA
$I_{CSD}$	DC current sense disable input current	-1 to 10	mA
$V_{CSSENSE}$	Current sense maximum voltage ( $V_{CC} > 0V$ )	$V_{CC} - 41$ $+V_{CC}$	V V
$E_{MAX}$	Maximum switching energy (single pulse) ( $L = 0.3\text{mH}$ ; $R_L = 0\Omega$ ; $V_{bat} = 13.5V$ ; $T_{jstart} = 150^\circ\text{C}$ ; $I_{OUT} = I_{limL}(Typ.)$ )	342	mJ
$V_{ESD}$	Electrostatic discharge (Human Body Model: $R = 1.5\text{k}\Omega$ ; $C = 100\text{pF}$ )	2000	V
$V_{ESD}$	Charge device model (CDM-AEC-Q100-011)	750	V

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

Symbol	Parameter	Value	Unit
$T_j$	Junction operating temperature	-40 to 150	°C
$T_{STG}$	Storage temperature	-55 to 150	°C

## 2.2 Thermal data

**Table 5. Thermal data**

Symbol	Parameter	Value		Unit
		MultiPowerSO-30	12x12 PLLP	
$R_{thj-case}$	Thermal resistance junction-case (MAX) (with one channel ON)	0.35	0.35	°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient (MAX)	58 <sup>(1)</sup>	39 <sup>(2)</sup>	°C/W

1. PCB FR4 area 58mmX58mm , PCB thickness 2mm, Cu thickness 35  $\mu$ m, minimum pad layout.
2. PCB FR4 area 78mmX78mm , PCB thickness 2mm, Cu thickness 35  $\mu$ m, minimum pad layout.



## 2.3 Electrical characteristics

Values specified in this section are for  $8V < V_{CC} < 24V$ ,  $-40^{\circ}C < T_j < 150^{\circ}C$ , unless otherwise stated.

**Table 6. Power section**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{CC}$	Operating supply voltage		4.5	13	27	V
$V_{USD}$	Undervoltage shutdown			3.5	4.5	V
$V_{USDhyst}$	Undervoltage shut-down hysteresis			0.5		V
$R_{ON}$	On-state resistance <sup>(1)</sup>	$I_{OUT}=15A; T_j=25^{\circ}C$ $I_{OUT}=15A; T_j=150^{\circ}C$ $I_{OUT}=15A; V_{CC}=5V; T_j=25^{\circ}C$			4 8 6	mΩ mΩ mΩ
$R_{ON REV}$	$R_{dson}$ in reverse battery condition	$V_{CC}=-13V; I_{OUT}=-15A; T_j=25^{\circ}C$			4	mΩ
$V_{clamp}$	$V_{CC}$ clamp voltage	$I_{CC}=20 mA; I_{OUT1,2}=0A$	41	46	52	V
$I_S$	Supply current	Off state; $V_{CC}=13V; T_j=25^{\circ}C$ ; $V_{IN}=V_{OUT}=V_{SENSE}=V_{CSD}=0V$ On state; $V_{CC}=13V; V_{IN}=5V; I_{OUT}=0A$		2 <sup>(2)</sup> 3.5	5 <sup>(2)</sup> 6	μA mA
$I_{L(off)}$	Off-state output current <sup>(1)</sup>	$V_{IN}=V_{OUT}=0V; V_{CC}=13V; T_j=25^{\circ}C$ $V_{IN}=V_{OUT}=0V; V_{CC}=13V; T_j=125^{\circ}C$	0 0	0.01	3 5	μA

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

**Table 7. Switching ( $V_{CC} = 13V; T_j = 25^{\circ}C$ )**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$R_L=0.87\Omega$ (see <a href="#">Figure 5.</a> )		25		μs
$t_{d(off)}$	Turn-off delay time	$R_L=0.87\Omega$ (see <a href="#">Figure 5.</a> )		35		μs
$(dV_{OUT}/dt)_{on}$	Turn-on voltage slope	$R_L=0.87\Omega$		See <a href="#">Figure 16.</a>		V/μs
$(dV_{OUT}/dt)_{off}$	Turn-off voltage slope	$R_L=0.87\Omega$		See <a href="#">Figure 18.</a>		V/μs
$W_{ON}$	Switching energy losses during $t_{won}$	$R_L=0.87\Omega$ (see <a href="#">Figure 5.</a> )		5.4		mJ
$W_{OFF}$	Switching energy losses during $t_{woff}$	$R_L=0.87\Omega$ (see <a href="#">Figure 5.</a> )		2.3		mJ

**Table 8. Logic input**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{IL1,2}$	Input low level voltage				0.9	V
$I_{IL1,2}$	Low level input current	$V_{IN}=0.9V$	1			$\mu A$
$V_{IH1,2}$	Input high level voltage		2.1			V
$I_{IH1,2}$	High level input current	$V_{IN}=2.1V$			10	$\mu A$
$V_{I(hyst)1,2}$	Input hysteresis voltage		0.25			V
$V_{ICL1,2}$	Input clamp voltage	$I_{IN}=1mA$ $I_{IN}=-1mA$	5.5	-0.7	7	V V
$V_{CSDL}$	CS_DIS low level voltage				0.9	V
$I_{CSDL}$	Low level CS_DIS current	$V_{CSD}=0.9V$	1			$\mu A$
$V_{CSDH}$	CS_DIS high level voltage		2.1			V
$I_{CSDH}$	High level CS_DIS current	$V_{CSD}=2.1V$			10	$\mu A$
$V_{CSD(hyst)}$	CS_DIS hysteresis voltage		0.25			V
$V_{CSCL}$	CS_DIS clamp voltage	$I_{CSD}=1mA$ $I_{CSD}=-1mA$	5.5	-0.7	7	V V

**Table 9. Protection and diagnostics<sup>(1)</sup>**

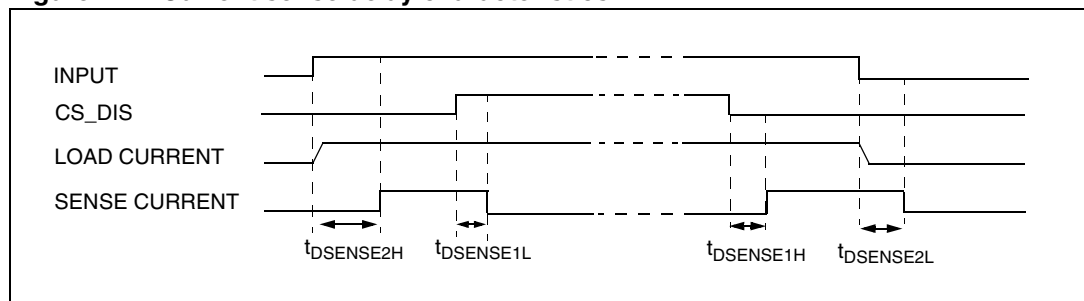
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{limH}$	Short circuit current	$V_{CC}=13V$ $5V < V_{CC} < 24V$	70	100	140 140	A A
$I_{limL}$	Short circuit current during thermal cycling	$V_{CC}=13V$ ; $T_R < T_J < T_{TSD}$		40		A
$T_{TSD}$	Shutdown temperature		150	175	200	$^{\circ}C$
$T_R$	Reset temperature		$T_{RS}+1$	$T_{RS}+5$		$^{\circ}C$
$T_{RS}$	Thermal reset of STATUS		135			$^{\circ}C$
$T_{HYST}$	Thermal hysteresis ( $T_{TSD}-T_R$ )			7		$^{\circ}C$
$V_{DEMAG}$	Turn-off output voltage clamp	$I_{OUT}=2A$ ; $V_{IN}=0$ ; $L=6mH$	$V_{CC}-27$	$V_{CC}-30$	$V_{CC}-33$	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.

**Table 10. Current sense (8V<VCC<16V)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$K_1$	$I_{OUT}/I_{SENSE}$	$I_{OUT}=15A; V_{SENSE}=4V; V_{CSD}=0V;$ $T_j=-40^{\circ}C$ $T_j=25^{\circ}C...150^{\circ}C$	11530 12730	16000 16000	19340 19270	
$K_2$	$I_{OUT}/I_{SENSE}$	$I_{OUT}=30A; V_{SENSE}=4V; V_{CSD}=0V;$ $T_j=-40^{\circ}C$ $T_j=25^{\circ}C...150^{\circ}C$	13430 14500	16150 16150	17880 17880	
$I_{SENSE0}$	Analog sense current	$I_{OUT}=0A; V_{SENSE}=0V;$ $V_{CSD}=5V; V_{IN}=0V; T_j=-40^{\circ}C$ to $150^{\circ}C$ $V_{CSD}=0V; V_{IN}=5V; T_j=-40^{\circ}C$ to $150^{\circ}C$	0 0		5 400	$\mu A$ $\mu A$
$V_{SENSE}$	Max analog sense output voltage	$I_{OUT}=45A; V_{CSD}=0V; R_{SENSE}=3.9k\Omega$	5			V
$V_{SENSEH}$	Analog sense output voltage in overtemperature condition	$V_{CC}=13V; R_{SENSE}=3.9k\Omega$		9		V
$I_{SENSEH}$	Analog sense output current in overtemperature condition	$V_{CC}=13V; V_{SENSE}=5V$		8		mA
$t_{DSENSE1H}$	Delay response time from falling edge of CS_DIS pin	$V_{SENSE}<4V, 5A<I_{OUT}<30A$ $I_{SENSE}=90\%$ of $I_{SENSE\ max}$ (see <a href="#">Figure 4.</a> )		50	100	$\mu s$
$t_{DSENSE1L}$	Delay response time from rising edge of CS_DIS pin	$V_{SENSE}<4V, 5A<I_{OUT}<30A$ $I_{SENSE}=10\%$ of $I_{SENSE\ max}$ (see <a href="#">Figure 4.</a> )		5	20	$\mu s$
$t_{DSENSE2H}$	Delay response time from rising edge of INPUT pin	$V_{SENSE}<4V, 5A<I_{OUT}<30A$ $I_{SENSE}=90\%$ of $I_{SENSE\ max}$ (see <a href="#">Figure 4.</a> )		270	600	$\mu s$
$t_{DSENSE2L}$	Delay response time from falling edge of INPUT pin	$V_{SENSE}<4V, 5A<I_{OUT}<30A$ $I_{SENSE}=10\%$ of $I_{SENSE\ max}$ (see <a href="#">Figure 4.</a> )		100	250	$\mu s$

**Figure 4. Current sense delay characteristics**

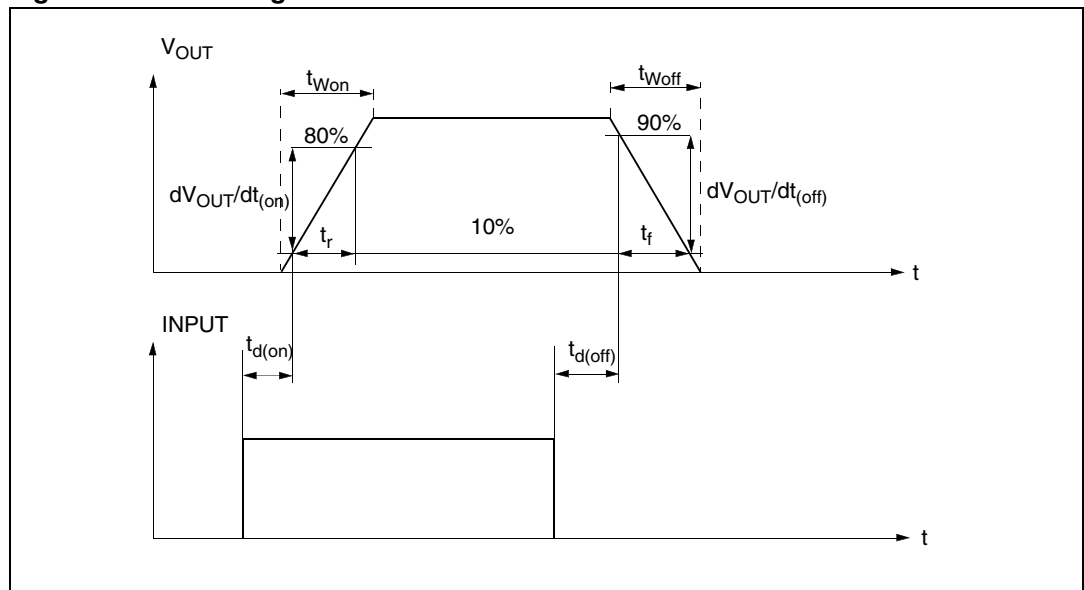


**Table 11. Truth table**

Conditions	INPUTn	OUTPUTn	SENSEn ( $V_{CSD}=0V$ ) <sup>(1)</sup> (see <a href="#">Figure 3.</a> )
Normal operation	L	L	0
	H	H	Nominal
Overtemperature	L	L	0
	H	L	$V_{SENSEH}$
Undervoltage	L	L	0
	H	L	0
Short circuit to GND ( $R_{sc} \leq 10\text{ m}\Omega$ )	L	L	0
	H	L	0 if $T_j < T_{TSD}$
	H	L	$V_{SENSEH}$ if $T_j > T_{TSD}$
Short circuit to $V_{CC}$	L	H	0
	H	H	< Nominal
Negative output voltage clamp	L	L	0

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

**Figure 5. Switching characteristics**



**Table 12. Electrical transient requirements**

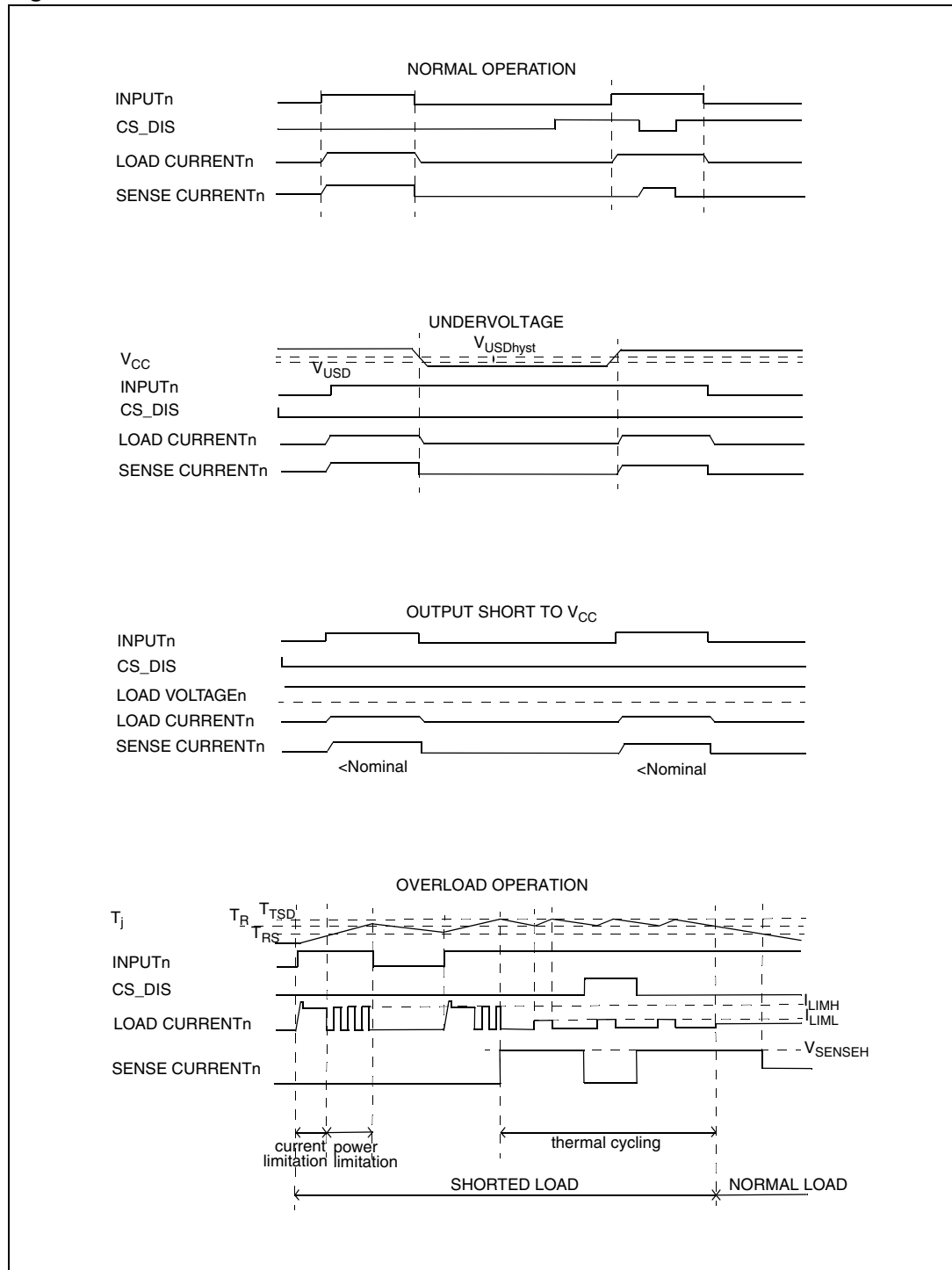
ISO 7637-2: 2004(E) Test pulse	Test levels <sup>(1)</sup>		Number of pulses or test times	Burst cycle/pulse repetition time		Delays and Impedance
	III	IV				
1	-75 V	-100 V	5000 pulses	0.5 s	5 s	2 ms, 10 Ω
2a	+37 V	+50 V	5000 pulses	0.2 s	5 s	50 μs, 2 Ω
3a	-100 V	-150 V	1h	90 ms	100 ms	0.1 μs, 50 Ω
3b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

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

1. The above test levels must be considered referred to Vcc = 13.5V except for pulse 5b
2. Valid in case of external load dump clamp: 40V maximum referred to ground.
3. Suppressed load dump (pulse 5b) is withstood with a minimum load connected as specified in [Table 4.:](#) *Absolute maximum ratings.*

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

Figure 6. Waveforms



## 2.4 Electrical characteristics curves

Figure 7. Off state output current

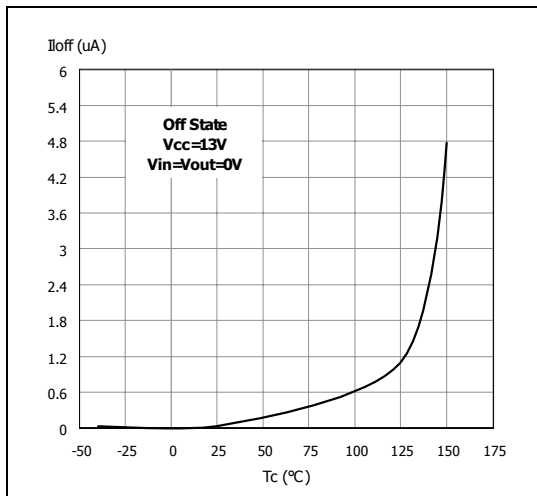


Figure 8. High level input current

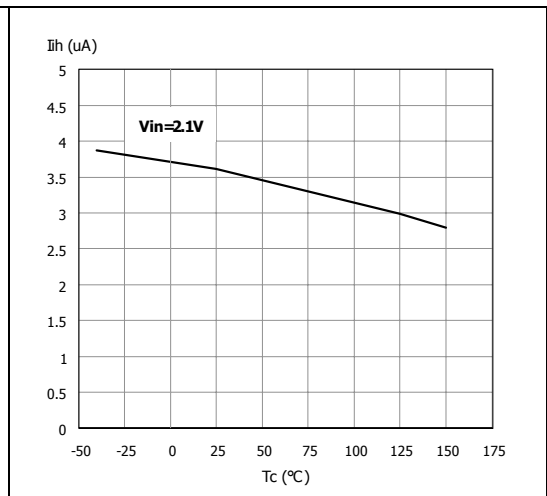


Figure 9. Input clamp voltage

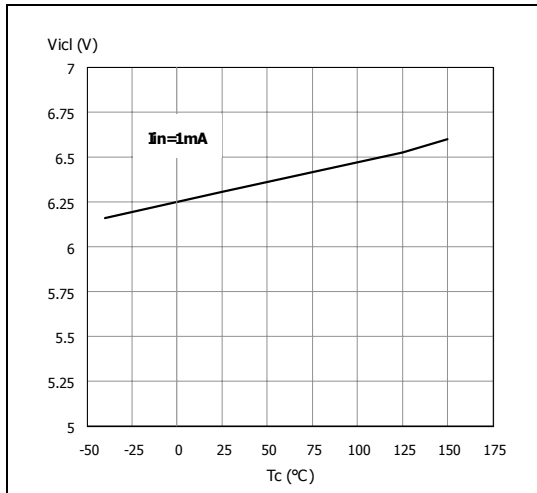


Figure 10. Input low level

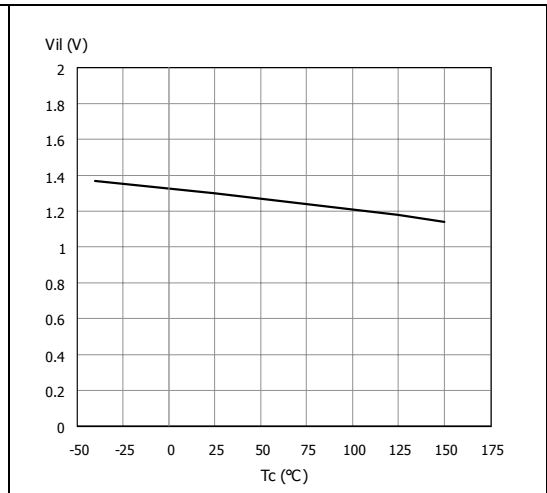


Figure 11. Input high level

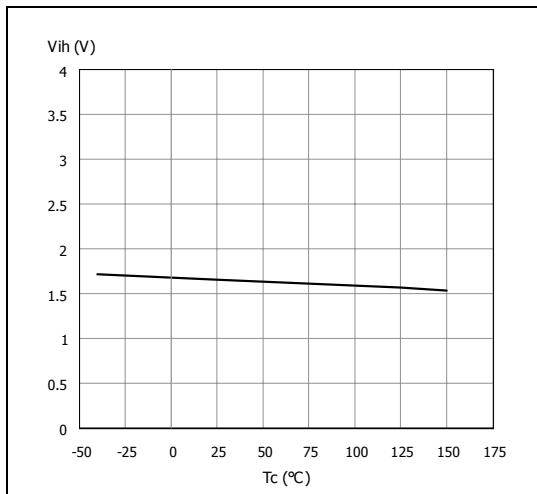


Figure 12. Input hysteresis voltage

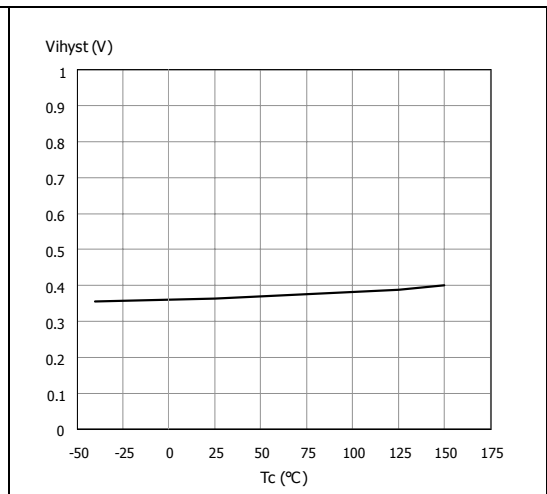


Figure 13. On state resistance vs.  $T_{case}$

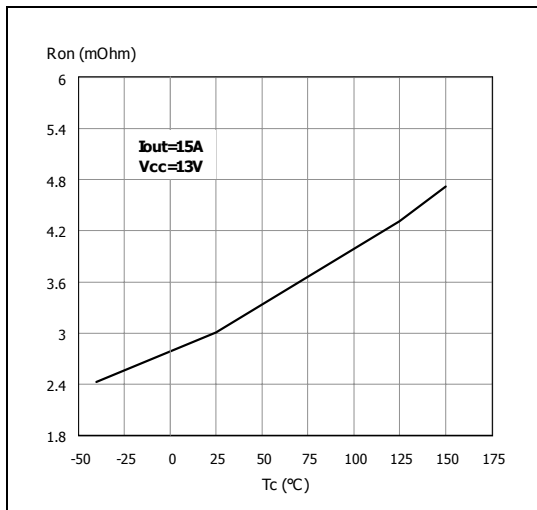


Figure 14. On state resistance vs.  $V_{CC}$

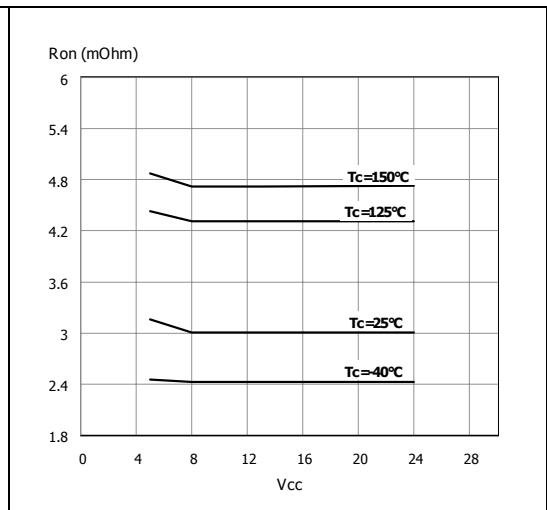


Figure 15. Undervoltage shutdown

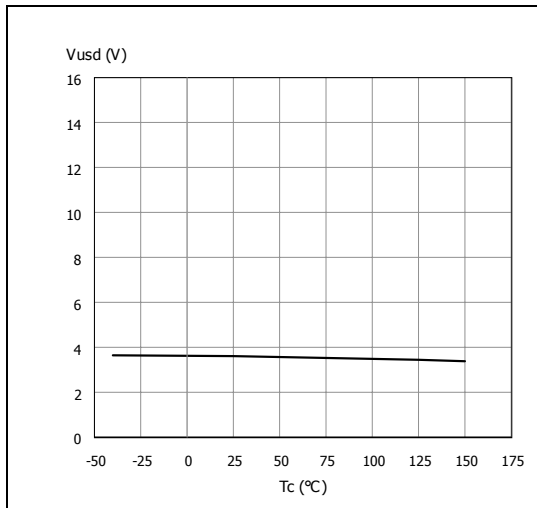


Figure 16. Turn-On voltage slope

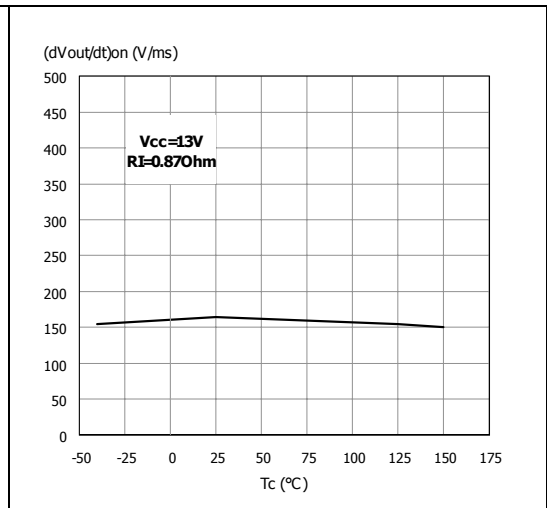


Figure 17.  $I_{LIMH}$  vs.  $T_{case}$

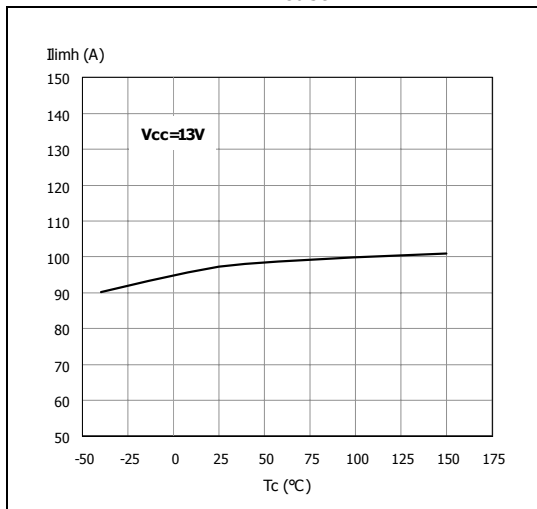
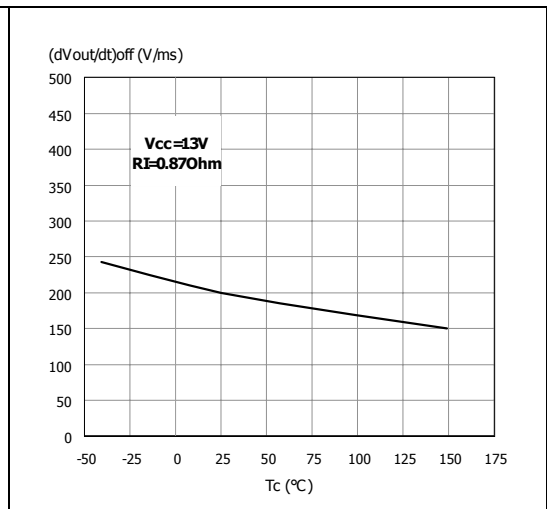
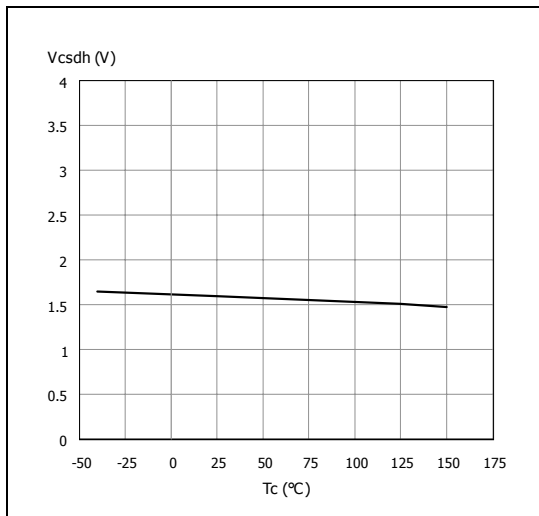


Figure 18. Turn-Off voltage slope

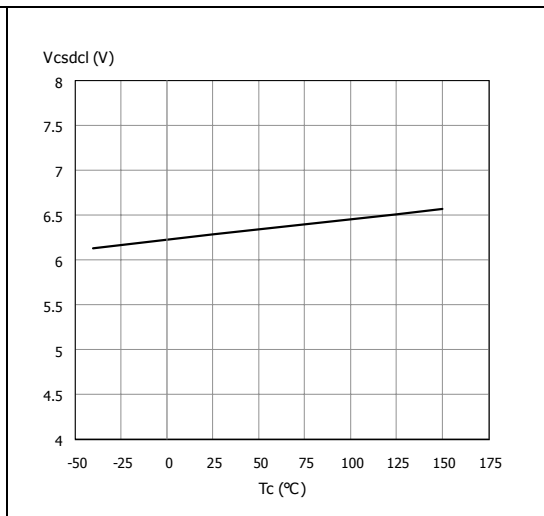




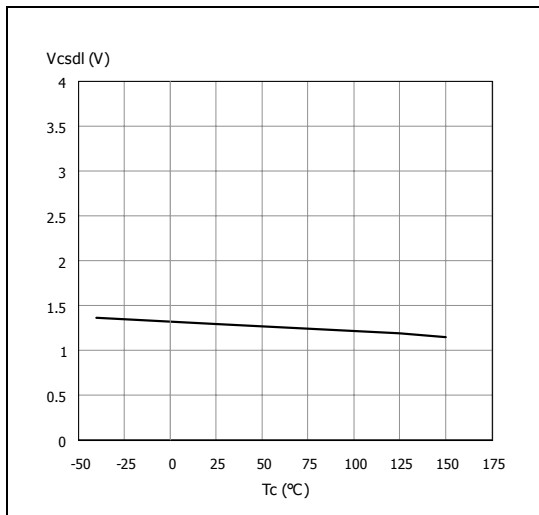
**Figure 19. CS\_DIS high level voltage**



**Figure 20. CS\_DiS clamp voltage**

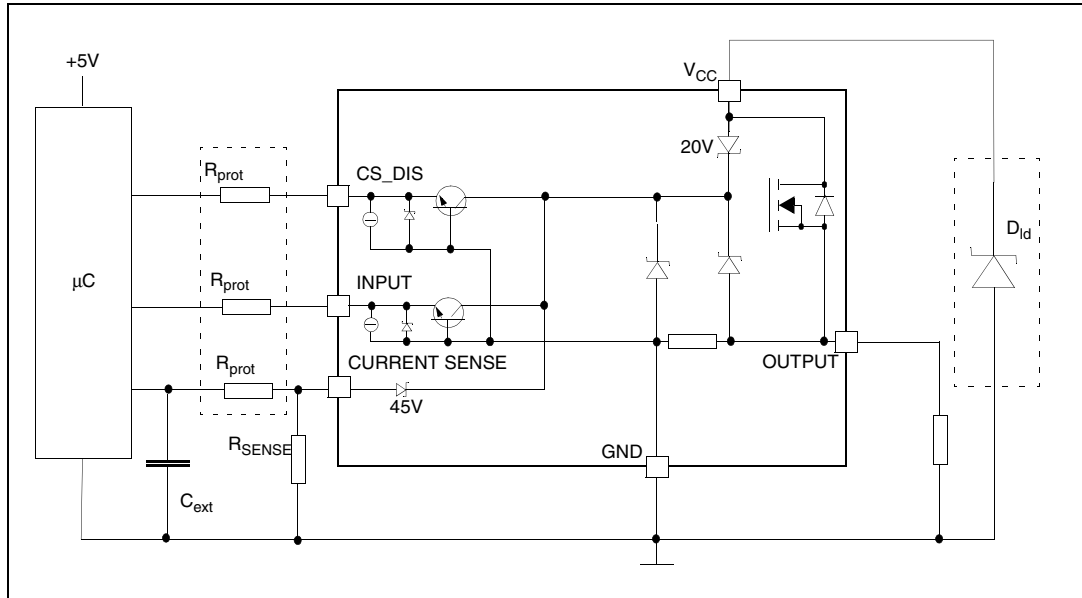


**Figure 21. CS\_DIS low level voltage**



### 3 Application information

Figure 22. Application schematic



#### 3.1 MCU I/Os protection

When negative transients are present on the V<sub>CC</sub> line, the control pins will be pulled negative to approximately -1.5V.

ST suggests the insertion of resistors (R<sub>prot</sub>) in the lines to prevent the µC I/Os pins from latching up.

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

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

Calculation example:

For V<sub>CCpeak</sub> = -1.5V and I<sub>latchup</sub> ≥ 20mA; V<sub>OHµC</sub> ≥ 4.5V

$$75\Omega \leq R_{prot} \leq 240k\Omega$$

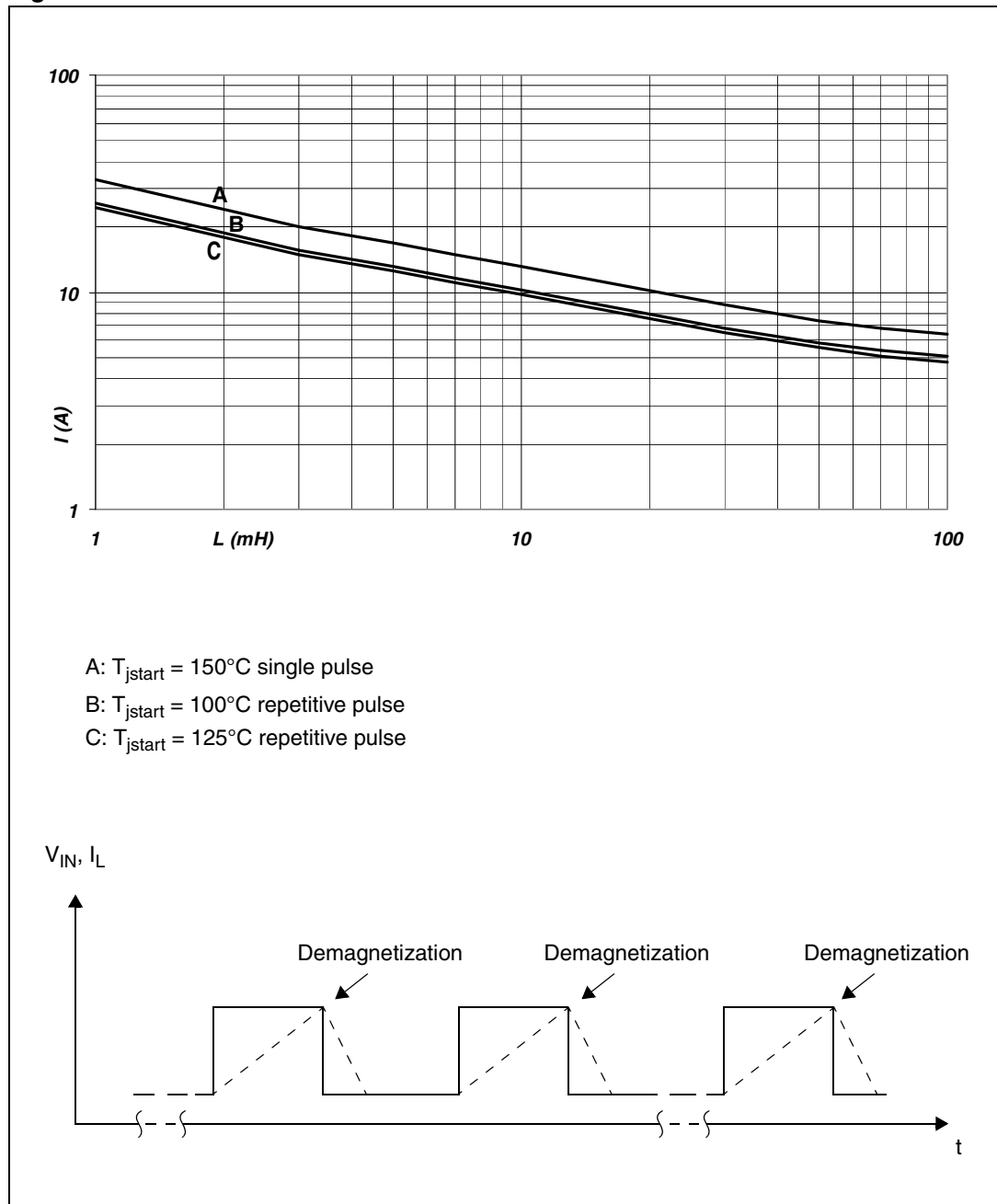
Recommended values: R<sub>prot</sub> = 10kΩ, C<sub>EXT</sub> = 10nF

#### 3.2 Load dump protection

D<sub>id</sub> is necessary (Voltage Transient Suppressor) if the load dump peak voltage exceeds the V<sub>CCPK</sub> max rating. The same applies if the device will be subject to transients on the V<sub>CC</sub> line that are greater than the ones shown in the ISO 7637-2: 2004(E) table.

### 3.3 Maximum demagnetization energy ( $V_{CC} = 13.5V$ )

Figure 23. Maximum turn off current versus inductance

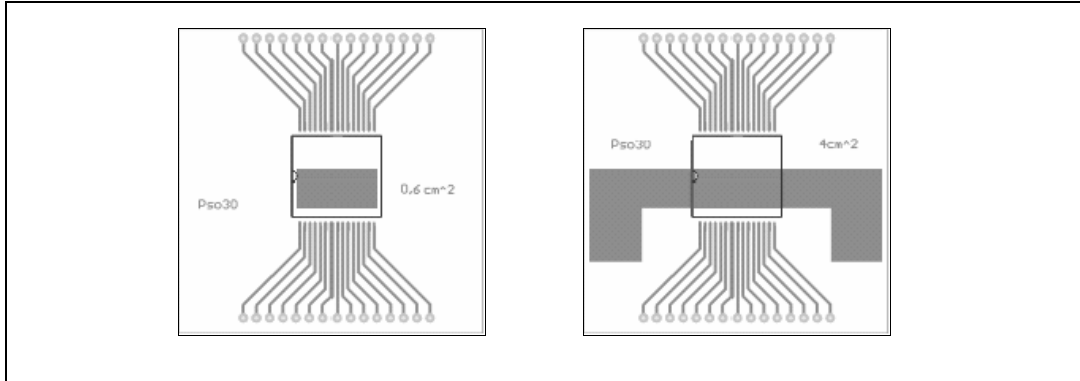


Note: Values are generated with  $R_L = 0 \Omega$   
 In case of repetitive pulses,  $T_{jstart}$  (at beginning of each demagnetization) of every pulse must not exceed the temperature specified above for curves A and B.

## 4 Package and PC board thermal data

### 4.1 MultiPowerSO-30 thermal data

Figure 24. MultiPowerSO-30 PC board



Note: Layout condition of  $R_{th}$  and  $Z_{th}$  measurements (PCB: Double layer, Thermal Vias, FR4 area= 58mm x 58mm, PCB thickness=2mm, Cu thickness=35 $\mu$ m (front and back side), Copper areas: from minimum pad lay-out to 16cm<sup>2</sup>).

Figure 25.  $R_{thj-amb}$  Vs. PCB copper area in open box free air condition (one channel ON)

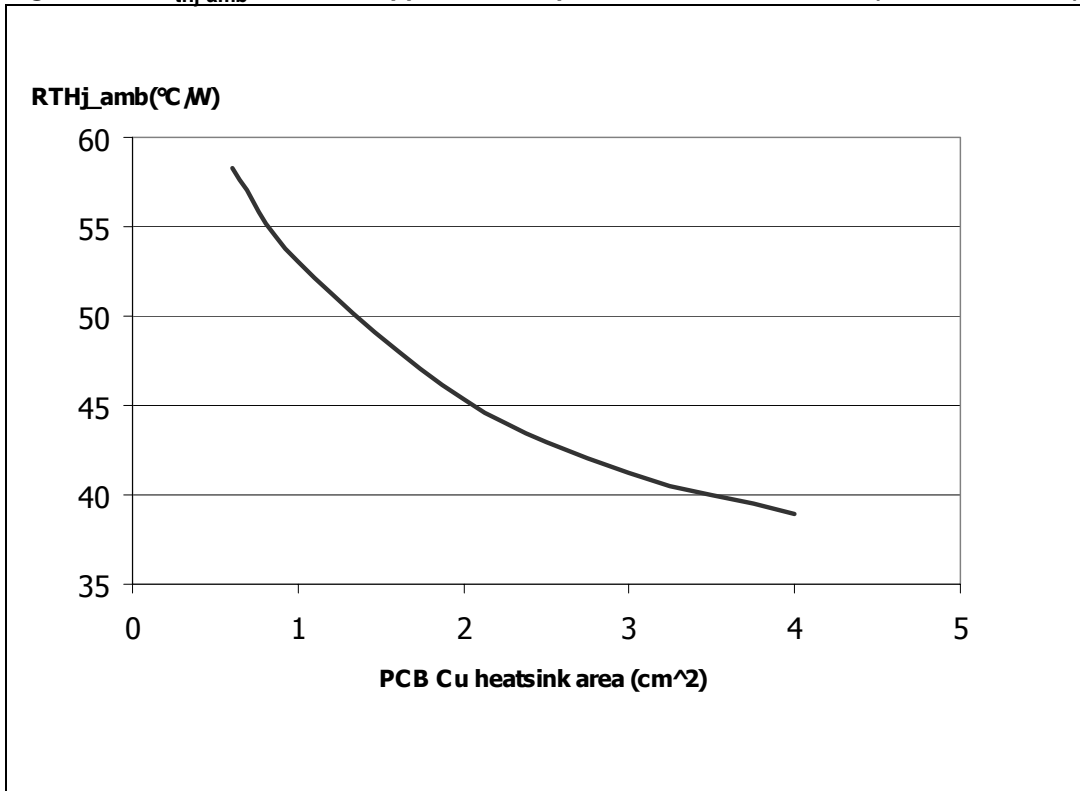


Figure 26. MultiPowerSO-30 thermal impedance junction ambient single pulse (one channel ON)

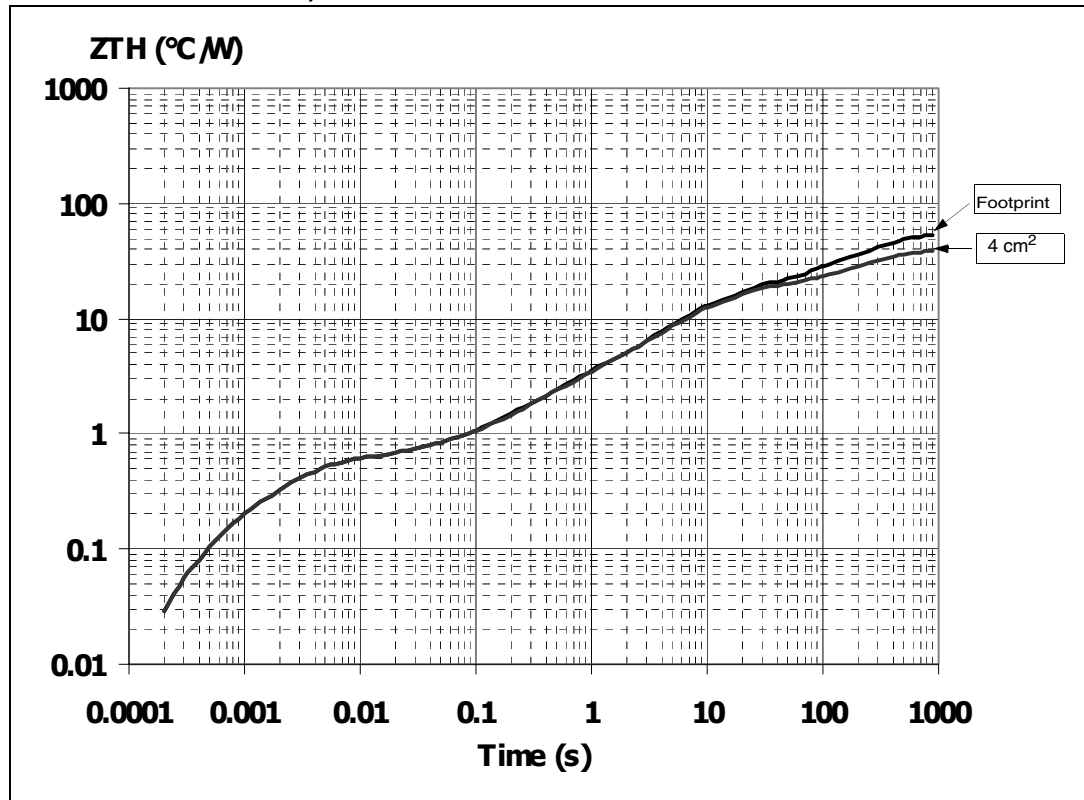
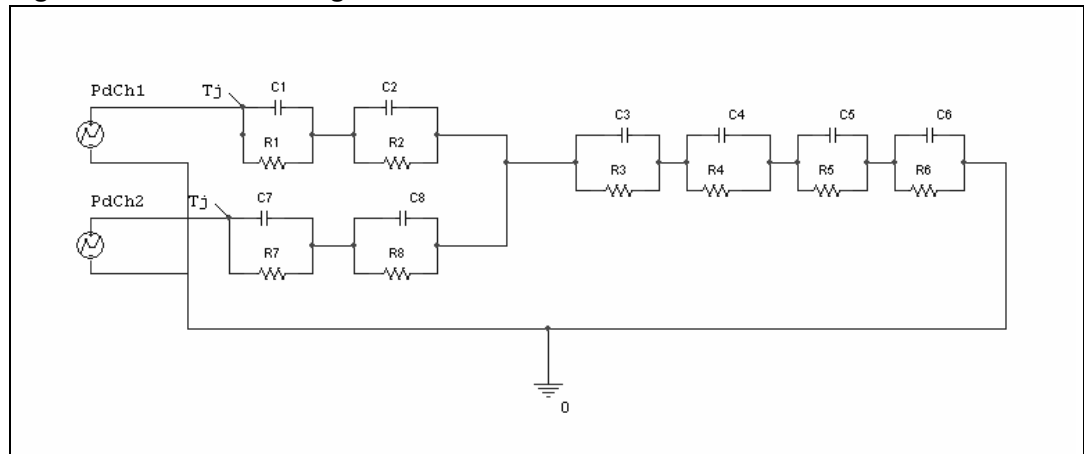


Figure 27. Thermal fitting model of a double channel HSD in MultiPowerSO-30 (a)



a. The fitting model is a simplified thermal tool and is valid for transient evolutions where the embedded protections (power limitation or thermal cycling during thermal shutdown) are not triggered.

**Equation 1: pulse calculation formula**

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

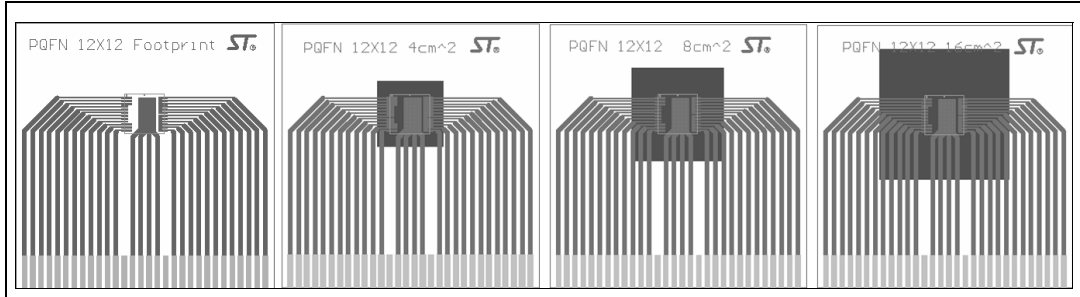
where  $\delta = t_p / T$

**Table 13. Thermal parameters for MultiPowerSO-30**

Area/island (cm <sup>2</sup> )	Footprint	4
R1 (°C/W)	0.05	
R2 (°C/W)	0.3	
R3 (°C/W)	0.5	
R4 (°C/W)	1.3	
R5 (°C/W)	14	
R6 (°C/W)	44.7	23.7
R7 (°C/W)	0.05	
R8 (°C/W)	0.3	
C1 (W.s/°C)	0.005	
C2 (W.s/°C)	0.008	
C3 (W.s/°C)	0.01	
C4 (W.s/°C)	0.3	
C5 (W.s/°C)	0.6	
C6 (W.s/°C)	5	11
C7 (W.s/°C)	0.005	
C8 (W.s/°C)	0.008	

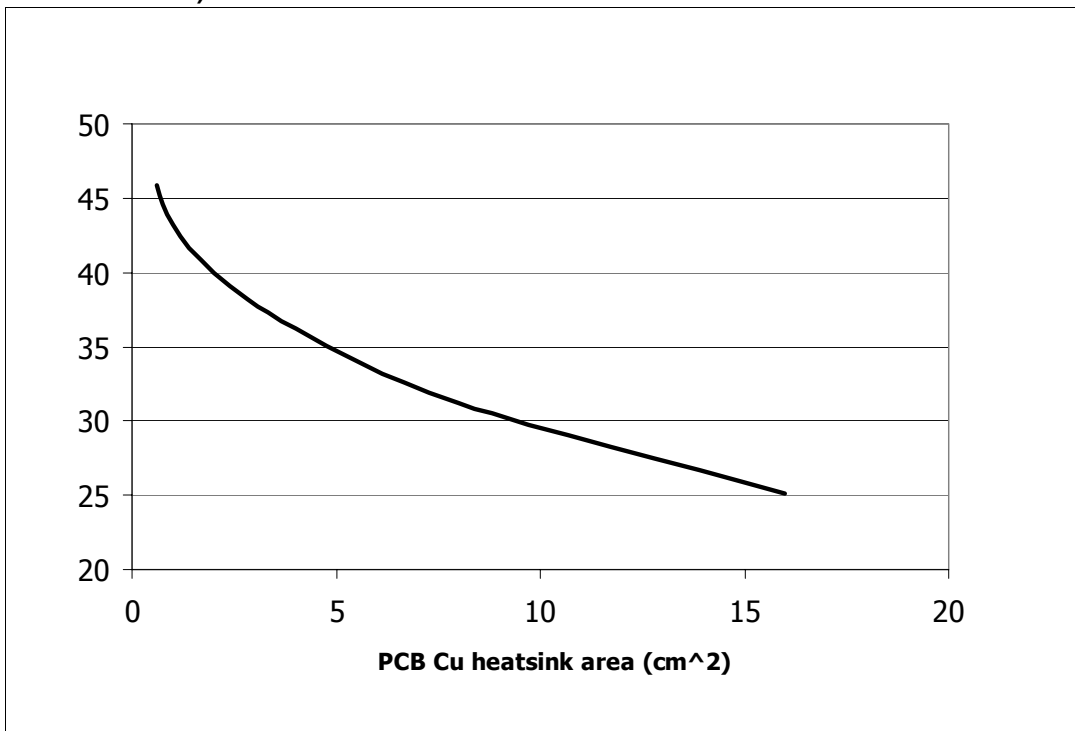
## 4.2 PQFN - 12x12 Power lead-less thermal data

Figure 28. 12x12 Power lead-less package PC board

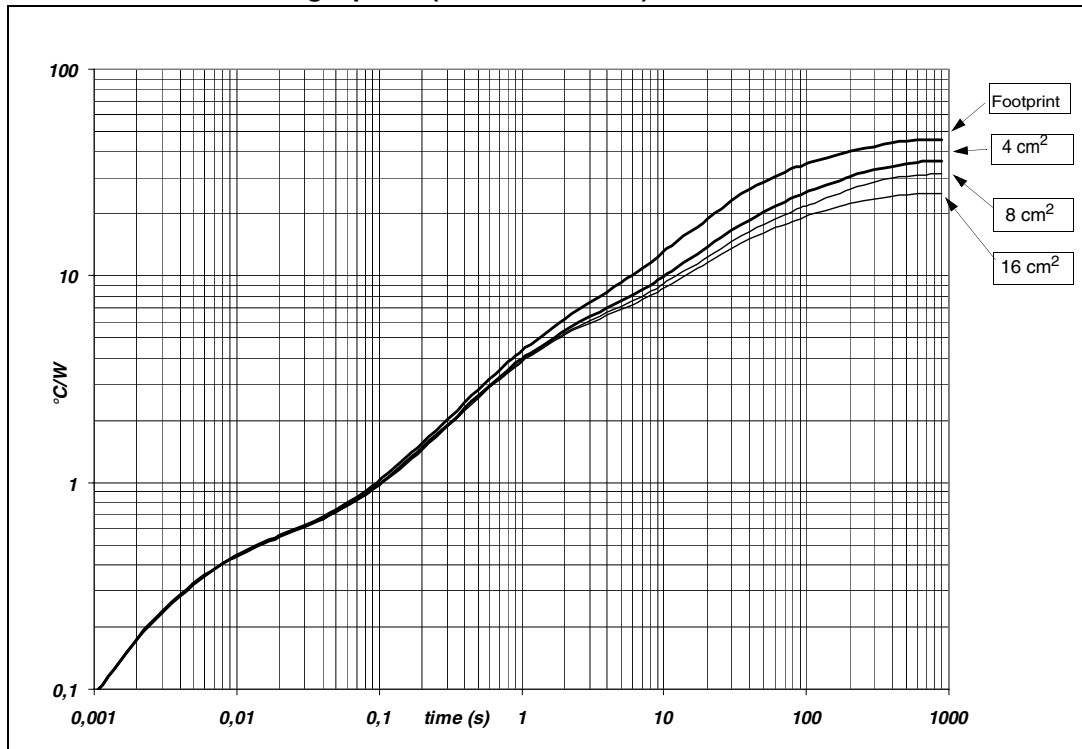


Note: Layout condition of  $R_{th}$  and  $Z_{th}$  measurements (PCB: Double layer, Thermal Vias, FR4 area= 78mm x 78mm, PCB thickness=2mm, Cu thickness=35 $\mu$ m (front and back side), Copper areas: minimum pad lay-out).

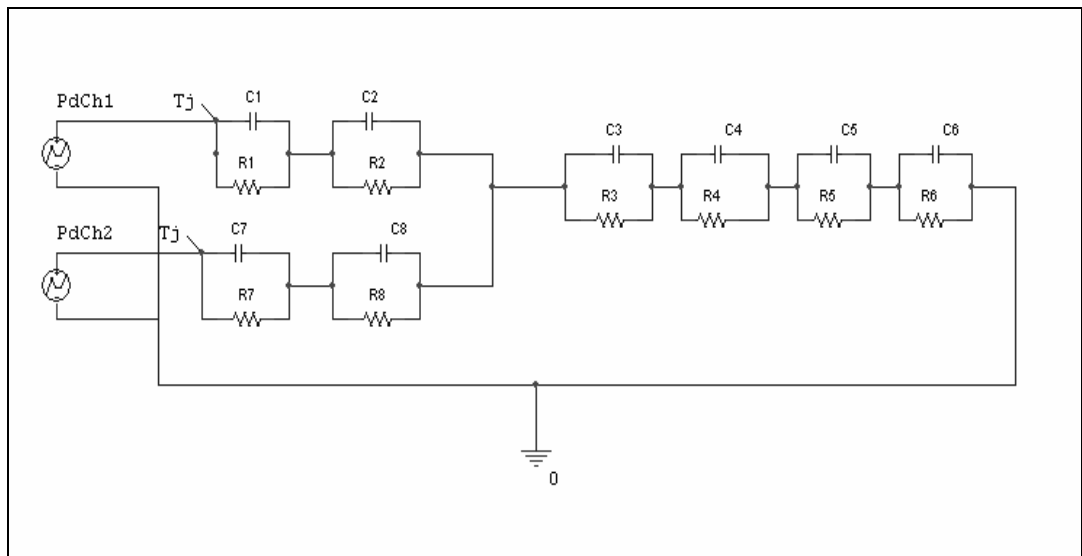
Figure 29.  $R_{thj-amb}$  Vs. PCB copper area in open box free air condition (one channel ON)



**Figure 30. PQFN - 12x12 Power lead-less package thermal impedance junction ambient single pulse (one channel ON)**



**Figure 31. Thermal fitting model of a double channel HSD in PQFN - 12x12 Power lead-less<sup>(b)</sup>**



b. The fitting model is a simplified thermal tool and is valid for transient evolutions where the embedded protections (power limitation or thermal cycling during thermal shutdown) are not triggered.



**Equation 2: pulse calculation formula**

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

where  $\delta = t_p / T$

**Table 14. Thermal parameters for PQFN - 12x12 Power lead-less**

Area/island (cm <sup>2</sup> )	Footprint	4	8	16
R1 (°C/W)	0.3			
R2 (°C/W)	0.15			
R3 (°C/W)	4.2			
R4 (°C/W)	9.6	9.4	9.2	9
R5 (°C/W)	15.1	10.5	8.5	5.5
R6 (°C/W)	16.7	12	9	6
R7 (°C/W)	0.3			
R8 (°C/W)	0.15			
C1 (W.s/°C)	0.021			
C2 (W.s/°C)	0.015			
C3 (W.s/°C)	0.2			
C4 (W.s/°C)	1.9	2.2	2.32	2.45
C5 (W.s/°C)	2.45	7.3	13.7	20
C6 (W.s/°C)	11.85	22	25	30
C7 (W.s/°C)	0.021			
C8 (W.s/°C)	0.015			

## 5 Package and packing information

### 5.1 ECOPACK<sup>®</sup> packages

In order to meet environmental requirements, ST offers these devices in ECOPACK<sup>®</sup> packages. ECOPACK<sup>®</sup> 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](http://www.st.com).

### 5.2 MultiPowerSO-30 mechanical data

Figure 32. MultiPowerSO-30 outline

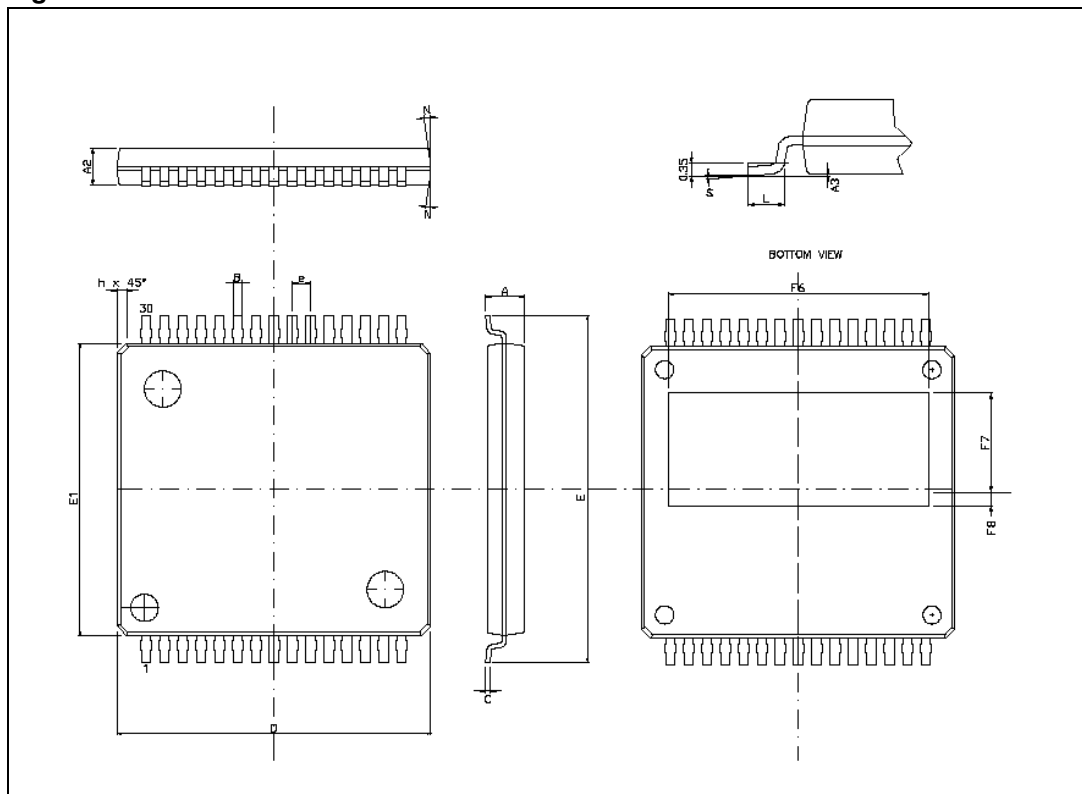


Table 15. MultiPowerSO-30 mechanical data

Symbol	Millimeters		
	Min.	Typ.	Max.
A			2.35
A2	1.85		2.25
A3	0		0.1
B	0.42		0.58
C	0.23		0.32
D	17.1	17.2	17.3
E	18.85		19.15
E1	15.9	16	16.1
"e"	1		
F6		14.3	
F7		5.45	
F8		0.73	
L	0.8		1.15
N			10 Deg
S	0 Deg		7 Deg

### 5.3 PQFN - 12x12 Power lead-less mechanical data

Figure 33. PQFN - 12x12 Power lead-less outline

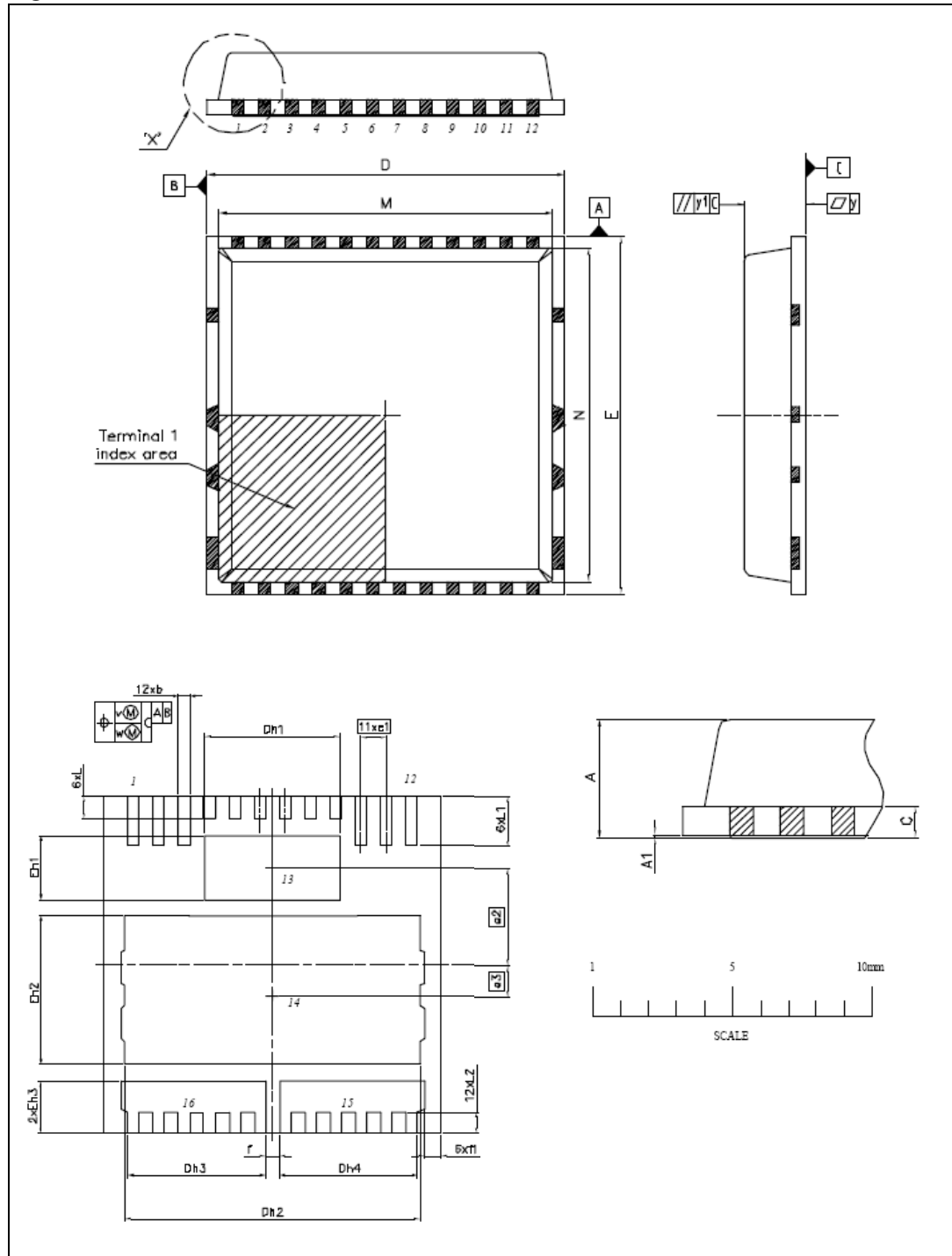


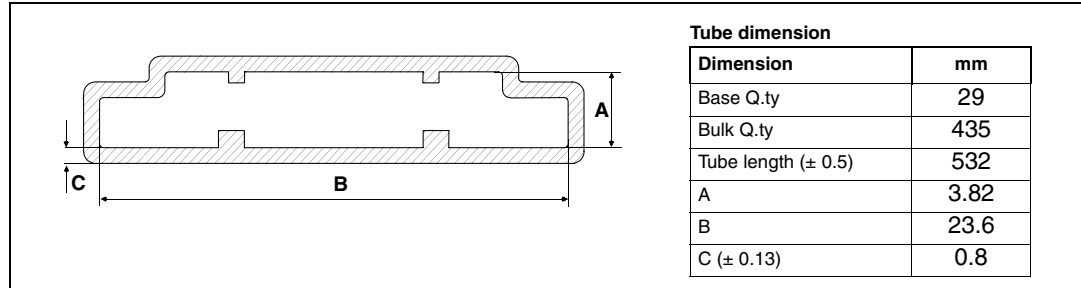
Table 16. PQFN - 12x12 Power lead-less mechanical data

Symbol	Millimeters		
	Min.	Typ.	Max.
A	2		2.2
A1	0		0.05
b	0.35		0.47
C		0.50	
D	11.90		12.10
Dh1	4.65		4.95
Dh2	10.45		10.65
Dh3	4.80		5
Dh4	4.80		5
E	11.90		12.10
Eh1	2.15		2.45
Eh2	5.15		5.45
Eh3	1.70		2
e1		0.90	
e2		3.45	
e3		1.10	
f		0.50	
f1		0.60	
L	0.75		0.95
L1	1.65		1.90
L2	0.76		0.78
M	11.10		11.30
N	11.10		11.30
v		0.1	
w		0.05	
y		0.05	
y1		0.1	

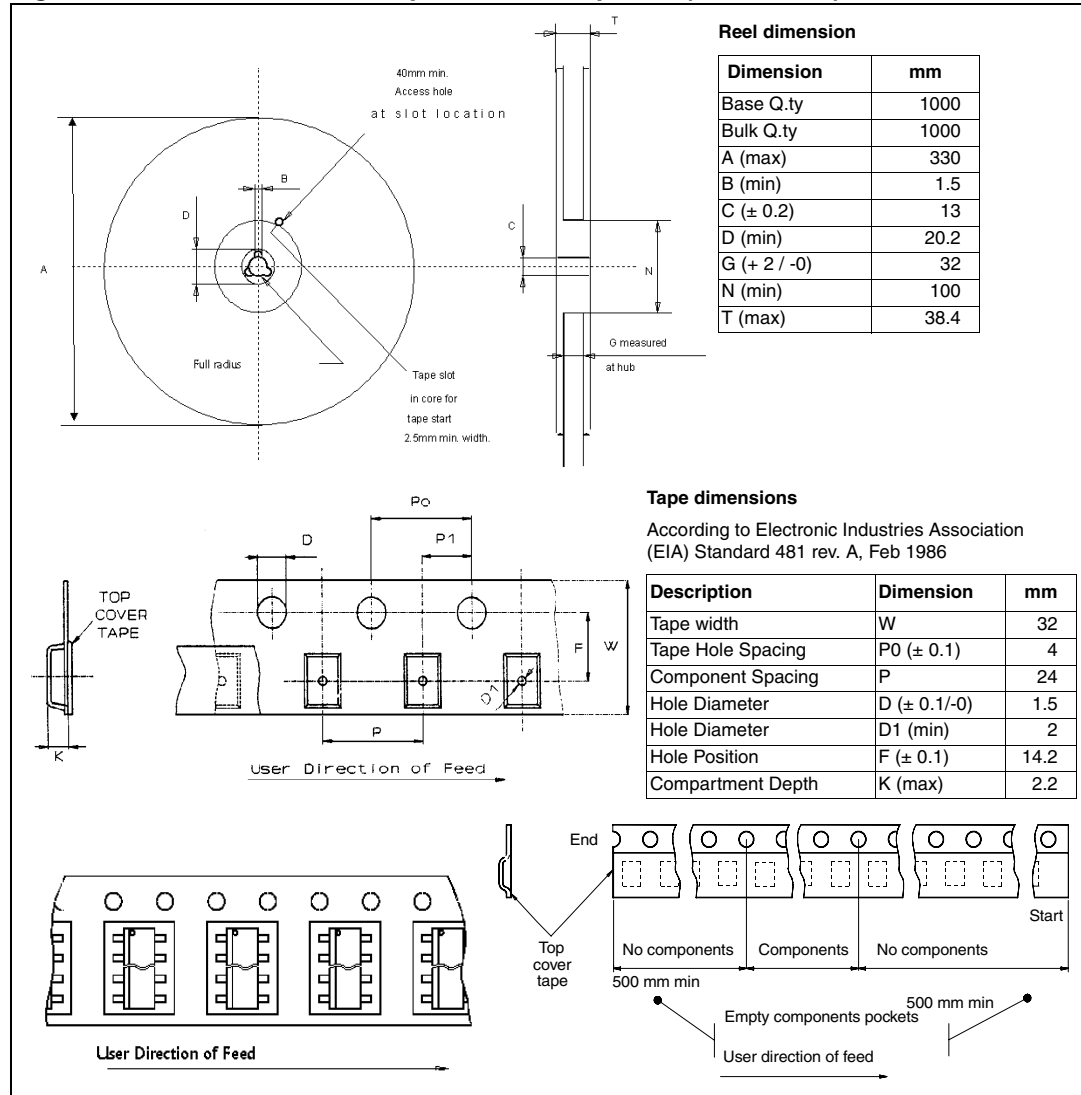
### 5.4 MultiPowerSO-30 packing information

The devices can be packed in tube or tape and reel shipments (see the [Devices summary on page 1](#) for packaging quantities).

**Figure 34. MultiPowerSO-30 tube shipment (no suffix)**



**Figure 35. MultiPowerSO-30 tape and reel shipment (suffix “TR”)**



### 5.5 PQFN - 12x12 Power lead-less packing information

The devices can be packed in tray or tape and reel shipments (see the [Devices summary on page 1](#) for packaging quantities).

**Figure 36. PQFN - 12x12 Power lead-less tray shipment (no suffix)**

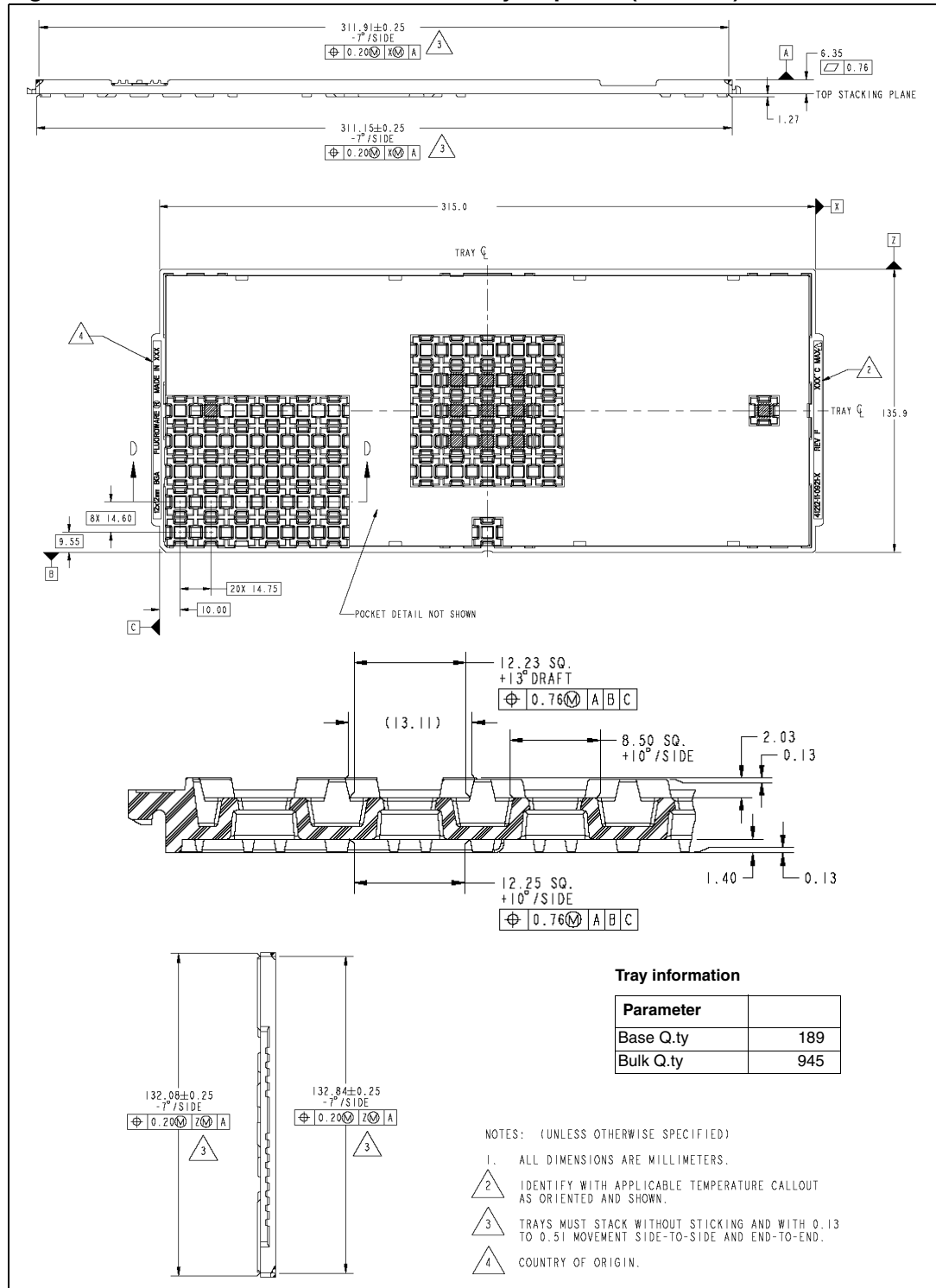
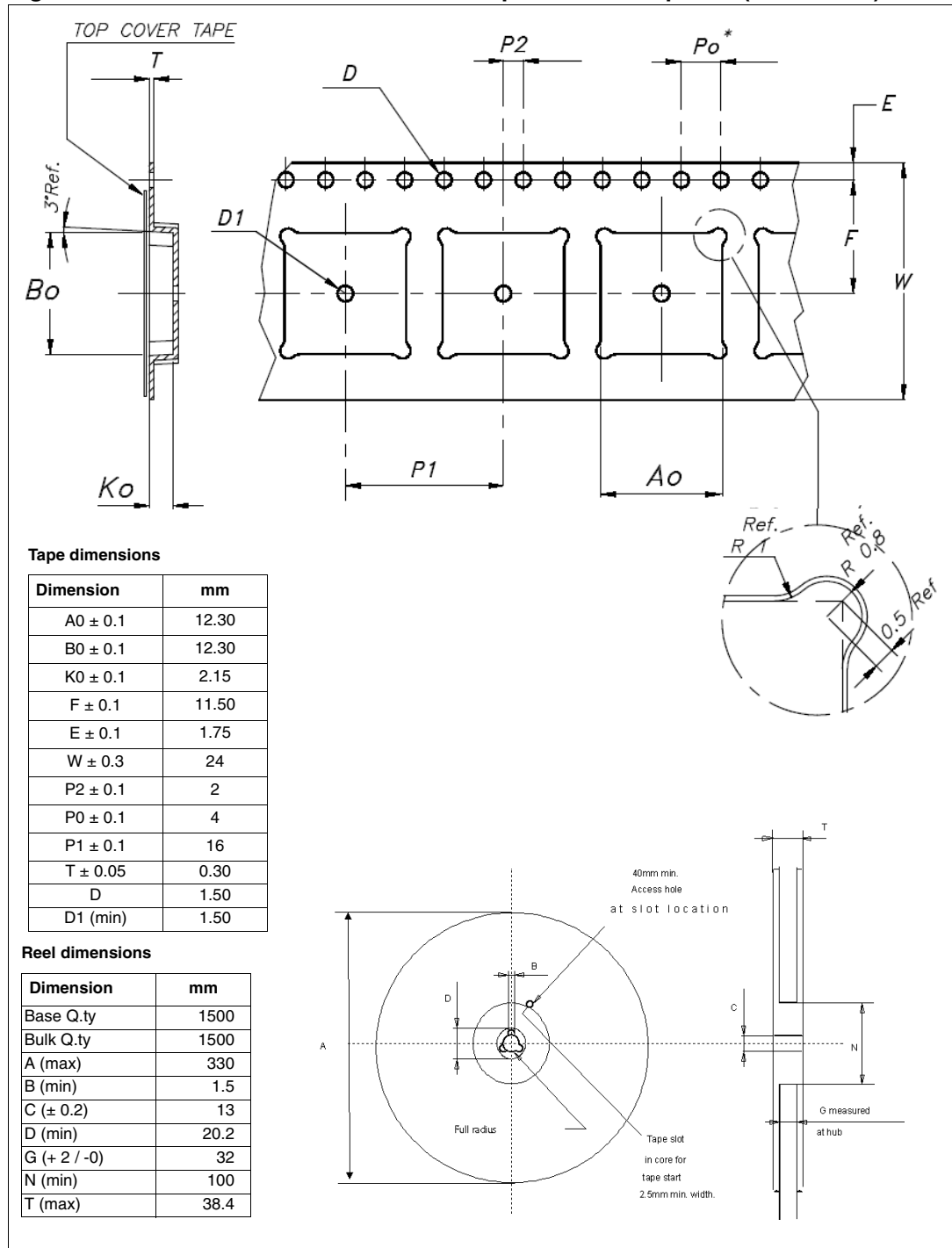


Figure 37. PQFN - 12x12 Power lead-less tape and reel shipment (suffix "TR")





## 6 Revision history

**Table 17. Document revision history**

Date	Revision	Changes
15-Sep-2003	1	Initial release.
21-Jun-2004	2	MultiPowerSO-30 package insertion.
22-Mar-2006	3	Major general update
02-Jul-2007	4	Document converted into new ST corporate template. Contents and lists of tables and figures added. <i>Section 3.3: Maximum demagnetization energy (VCC = 13.5V)</i> added. <i>Section 5: Package and packing information</i> updated
10-Dec-2007	5	<i>Table 12: Electrical transient requirements</i> - added note 3.

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