



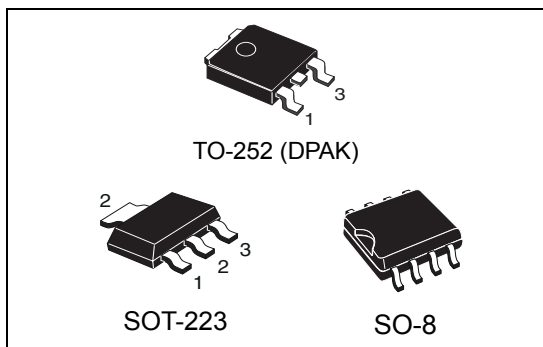
# VND1NV04 VNN1NV04 - VNS1NV04

OMNIFET II  
fully autoprotected Power MOSFET

## Features

| Parameter                         | Symbol      | Value          |
|-----------------------------------|-------------|----------------|
| Max on-state resistance (per ch.) | $R_{ON}$    | 250 m $\Omega$ |
| Current limitation (typ)          | $I_{LIMH}$  | 1.7 A          |
| Drain-source clamp voltage        | $V_{CLAMP}$ | 40 V           |

- Linear current limitation
- Thermal shutdown
- Short circuit protection
- Integrated clamp
- Low current drawn from input pin
- Diagnostic feedback through input pin
- ESD protection
- Direct access to the gate of the Power MOSFET (analog driving)
- Compatible with standard Power MOSFET



## Description

The VND1NV04, VNN1NV04, VNS1NV04 are monolithic devices designed in STMicroelectronics VIPower M0-3 Technology, intended for replacement of standard Power MOSFETs from DC up to 50 KHz applications. Built in thermal shutdown, linear current limitation and overvoltage clamp protect the chip in harsh environments.

Fault feedback can be detected by monitoring the voltage at the input pin.

Table 1. Device summary

| Package       | Order codes |                  |               |                           |
|---------------|-------------|------------------|---------------|---------------------------|
|               | Tube        | Tube (lead free) | Tape and reel | Tape and reel (lead free) |
| TO-252 (DPAK) | VND1NV04    | VND1NV04-E       | VND1NV04TR    | VND1NV04TR-E              |
| SOT-223       | VNN1NV04    | -                | VNN1NV04TR    | -                         |
| SO-8          | VNS1NV04    | -                | VNS1NV04TR    | -                         |

# Contents

|          |   |           |
|----------|---|-----------|
| <b>1</b> | <b>Block diagram and pin description</b>      | <b>5</b>  |
| <b>2</b> | <b>Electrical specifications</b>              | <b>6</b>  |
| 2.1      | Absolute maximum ratings                      | 6         |
| 2.2      | Thermal data                                  | 7         |
| 2.3      | Electrical characteristics                    | 7         |
| 2.4      | Electrical characteristics curves             | 12        |
| <b>3</b> | <b>Protection features</b>                    | <b>16</b> |
| 3.1      | Overvoltage clamp protection                  | 16        |
| 3.2      | Linear current limiter circuit                | 16        |
| 3.3      | Over temperature and short circuit protection | 16        |
| 3.4      | Status feedback                               | 16        |
| <b>4</b> | <b>Package and PCB thermal data</b>           | <b>17</b> |
| 4.1      | DPAK thermal data                             | 17        |
| 4.2      | SOT-223 thermal data                          | 19        |
| 4.3      | SO-8 thermal data                             | 22        |
| <b>5</b> | <b>Package and packing information</b>        | <b>25</b> |
| 5.1      | DPAK mechanical data                          | 25        |
| 5.2      | SOT-223 mechanical data                       | 27        |
| 5.3      | SO8 mechanical data                           | 27        |
| 5.4      | DPAK packing information                      | 29        |
| 5.5      | SOT-223 packing information                   | 30        |
| 5.6      | SO8 packing information                       | 31        |
| <b>6</b> | <b>Revision history</b>                       | <b>32</b> |

## List of tables

|           |                                      |    |
|-----------|--------------------------------------|----|
| Table 1.  | Device summary . . . . .             | 1  |
| Table 2.  | Absolute maximum ratings . . . . .   | 6  |
| Table 3.  | Thermal data. . . . .                | 7  |
| Table 4.  | Electrical characteristics . . . . . | 7  |
| Table 5.  | DPAK thermal parameter . . . . .     | 19 |
| Table 6.  | SOT-223 thermal parameter. . . . .   | 21 |
| Table 7.  | SO-8 thermal parameter . . . . .     | 24 |
| Table 8.  | DPAK mechanical data. . . . .        | 26 |
| Table 9.  | SO-8 mechanical data . . . . .       | 27 |
| Table 10. | Document revision history . . . . .  | 32 |

## List of figures

|            |  |    |
|------------|--|----|
| Figure 1.  | Block diagram . . . . .  | 5  |
| Figure 2.  | Configuration diagram (top view) . . . . .   | 5  |
| Figure 3.  | Current and voltage conventions . . . . .  | 6  |
| Figure 4.  | Switching time test circuit for resistive load . . . . .                           | 9  |
| Figure 5.  | Test circuit for diode recovery times . . . . .                                    | 10 |
| Figure 6.  | Unclamped inductive load test circuits . . . . .                                   | 10 |
| Figure 7.  | Input charge test circuit. . . . .   | 11 |
| Figure 8.  | Unclamped inductive waveforms . . . . .  | 11 |
| Figure 9.  | Source-drain diode forward characteristics . . . . .                               | 12 |
| Figure 10. | Static drain-source on resistance . . . . .  | 12 |
| Figure 11. | Derating curve . . . . .   | 12 |
| Figure 12. | Static drain-source on resistance vs. input voltage (part 1/2) . . . . .           | 12 |
| Figure 13. | Static drain-source on resistance vs. input voltage (part 2/2) . . . . .           | 12 |
| Figure 14. | Transconductance . . . . .   | 12 |
| Figure 15. | Static drain-source on resistance vs. $I_d$ . . . . .                              | 13 |
| Figure 16. | Transfer characteristics . . . . .   | 13 |
| Figure 17. | Turn-on current slope (part 1/2) . . . . .   | 13 |
| Figure 18. | Turn-on current slope (part 2/2) . . . . .   | 13 |
| Figure 19. | Input voltage vs. input charge . . . . .   | 13 |
| Figure 20. | Turn-off drain source voltage slope (part 1/2) . . . . .                           | 13 |
| Figure 21. | Turn-off drain-source voltage slope (part 2/2) . . . . .                           | 14 |
| Figure 22. | Capacitance variations . . . . .   | 14 |
| Figure 23. | Switching time resistive load (part 1/2) . . . . .                                 | 14 |
| Figure 24. | Switching time resistive load (part 2/2) . . . . .                                 | 14 |
| Figure 25. | Output characteristics . . . . .   | 14 |
| Figure 26. | Normalized on resistance vs. temperature . . . . .                                 | 14 |
| Figure 27. | Normalized input threshold voltage vs. temperature . . . . .                       | 15 |
| Figure 28. | Normalized current limit vs. junction temperature . . . . .                        | 15 |
| Figure 29. | Step response current limit . . . . .  | 15 |
| Figure 30. | DPAK PC board . . . . .  | 17 |
| Figure 31. | DPAK $R_{thj-amb}$ vs. PCB copper area in open box free air condition . . . . .    | 17 |
| Figure 32. | DPAK thermal impedance junction ambient single pulse . . . . .                     | 18 |
| Figure 33. | DPAK thermal fitting model of a single channel . . . . .                           | 18 |
| Figure 34. | SOT-223 PC board . . . . .   | 19 |
| Figure 35. | SOT-223 $R_{thj-amb}$ vs. PCB copper area in open box free air condition . . . . . | 20 |
| Figure 36. | SOT-223 thermal impedance junction ambient single pulse . . . . .                  | 20 |
| Figure 37. | SOT-223 thermal fitting model of a single channel . . . . .                        | 21 |
| Figure 38. | SO-8 PC board . . . . .  | 22 |
| Figure 39. | SO-8 $R_{thj-amb}$ vs. PCB copper area in open box free air condition . . . . .    | 22 |
| Figure 40. | SO-8 thermal impedance junction ambient single pulse . . . . .                     | 23 |
| Figure 41. | SO-8 thermal fitting model of a single channel . . . . .                           | 23 |
| Figure 42. | DPAK package dimensions . . . . .  | 25 |
| Figure 43. | SOT-223 mechanical data & package outline . . . . .                                | 27 |
| Figure 44. | SO-8 package dimension . . . . .   | 28 |
| Figure 45. | SOT-223 tape and reel shipment (suffix "TR") . . . . .                             | 30 |
| Figure 46. | SO-8 tube shipment (no suffix) . . . . .   | 31 |
| Figure 47. | SO-8 tape and reel shipment (suffix "TR") . . . . .                                | 31 |

# 1 Block diagram and pin description

Figure 1. Block diagram

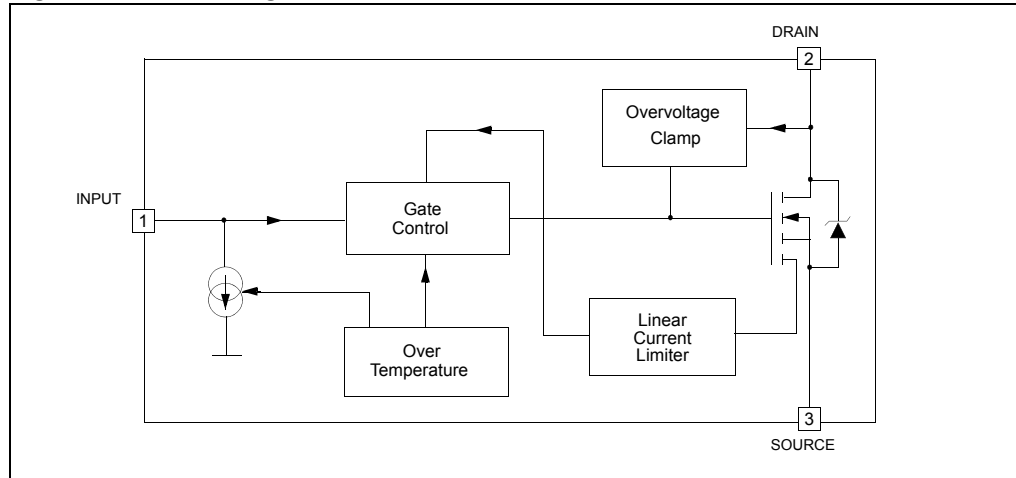
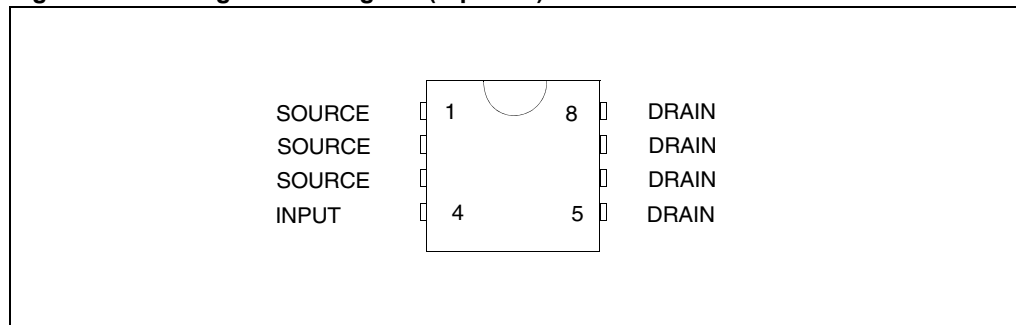


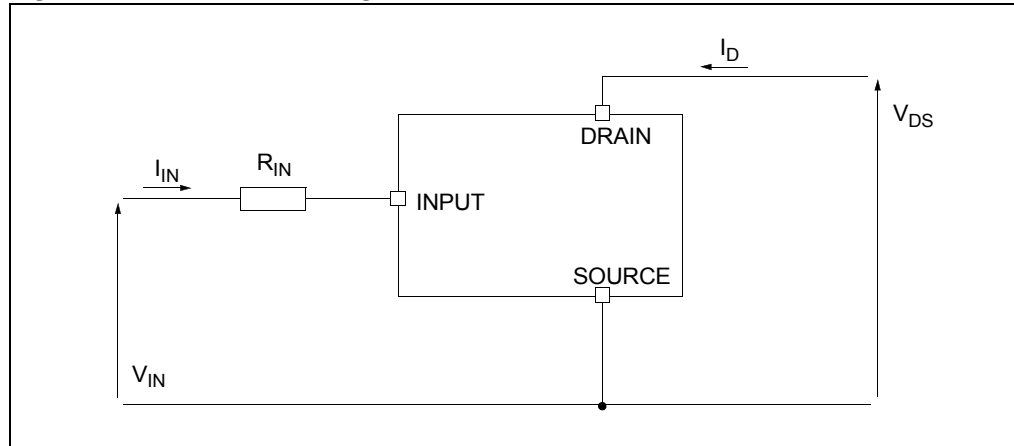
Figure 2. Configuration diagram (top view) (a)



a. For the pins configuration related to SOT-223 and DPAK see outline at page 1.

## 2 Electrical specifications

Figure 3. Current and voltage conventions



### 2.1 Absolute maximum ratings

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

Table 2. Absolute maximum ratings

| Symbol         | Parameter  | Value              |      |      | Unit     |
|----------------|--|--------------------|------|------|----------|
|                |  | SOT-223            | SO-8 | DPAK |          |
| $V_{DSn}$      | Drain-source voltage ( $V_{INn}=0$ V)  | Internally clamped |      |      | V        |
| $V_{INn}$      | Input voltage  | Internally clamped |      |      | V        |
| $I_{INn}$      | Input current  | +/-20              |      |      | mA       |
| $R_{IN\ MINn}$ | Minimum input series impedance   | 330                |      |      | $\Omega$ |
| $I_{Dn}$       | Drain current  | Internally limited |      |      | A        |
| $I_{Rn}$       | Reverse DC output current  | -3                 |      |      | A        |
| $V_{ESD1}$     | Electrostatic discharge ( $R=1.5$ K $\Omega$ , $C=100$ pF)                   | 4000               |      |      | V        |
| $V_{ESD2}$     | Electrostatic discharge on output pins only ( $R=330$ $\Omega$ , $C=150$ pF) | 16500              |      |      | V        |
| $P_{tot}$      | Total dissipation at $T_c=25$ °C   | 7                  | 8.3  | 35   | W        |
| $T_j$          | Operating junction temperature   | Internally limited |      |      | °C       |
| $T_c$          | Case operating temperature   | Internally limited |      |      | °C       |
| $T_{stg}$      | Storage temperature  | -55 to 150         |      |      | °C       |

## 2.2 Thermal data

**Table 3. Thermal data**

| Symbol         | Parameter                           | Max value         |                   |                   | Unit |
|----------------|-------------------------------------|-------------------|-------------------|-------------------|------|
|                |                                     | SOT-223           | SO-8              | DPAK              |      |
| $R_{thj-case}$ | Thermal resistance junction-case    | 18                |                   | 3.5               | °C/W |
| $R_{thj-lead}$ | Thermal resistance junction-lead    |                   | 15                |                   | °C/W |
| $R_{thj-amb}$  | Thermal resistance junction-ambient | 70 <sup>(1)</sup> | 65 <sup>(1)</sup> | 54 <sup>(1)</sup> | °C/W |

1. When mounted on a standard single-sided FR4 board with 50 mm<sup>2</sup> of Cu (at least 35 µm thick) connected to all DRAIN pins

## 2.3 Electrical characteristics

**Table 4. Electrical characteristics**

| Symbol   | Parameter  | Test conditions  | Min       | Typ | Max        | Unit |
|--|--|--|-----------|-----|------------|------|
| <b>Off (-40 °C &lt; T<sub>j</sub> &lt; 150 °C, unless otherwise specified)</b> |  |  |           |     |            |      |
| $V_{CLAMP}$  | Drain-source clamp voltage                               | $V_{IN}=0\text{ V}; I_D=0.5\text{ A}$  | 40        | 45  | 55         | V    |
| $V_{CLTH}$   | Drain-source clamp threshold voltage                     | $V_{IN}=0\text{ V}; I_D=2\text{ mA}$   | 36        |     |            | V    |
| $V_{INTH}$   | Input threshold voltage                                  | $V_{DS}=V_{IN}; I_D=1\text{ mA}$   | 0.5       |     | 2.5        | V    |
| $I_{ISS}$  | Supply current from input pin                            | $V_{DS}=0\text{ V}; V_{IN}=5\text{ V}$   |           | 100 | 150        | µA   |
| $V_{INCL}$   | Input-source clamp voltage                               | $I_{IN}=1\text{ mA}$<br>$I_{IN}=-1\text{ mA}$  | 6<br>-1.0 | 6.8 | 8<br>-0.3  | V    |
| $I_{DSS}$  | Zero input voltage drain current ( $V_{IN}=0\text{ V}$ ) | $V_{DS}=13\text{ V}; V_{IN}=0\text{ V}; T_j=25\text{ °C}$<br>$V_{DS}=25\text{ V}; V_{IN}=0\text{ V}$ |           |     | 30<br>75   | µA   |
| <b>On (-40 °C &lt; T<sub>j</sub> &lt; 150 °C, unless otherwise specified)</b>  |  |  |           |     |            |      |
| $R_{DS(on)}$   | Static drain-source on resistance                        | $V_{IN}=5\text{ V}; I_D=0.5\text{ A}; T_j=25\text{ °C}$<br>$V_{IN}=5\text{ V}; I_D=0.5\text{ A}$     |           |     | 250<br>500 | mΩ   |
| <b>Dynamic (T<sub>j</sub>=25 °C, unless otherwise specified)</b>               |  |  |           |     |            |      |
| $g_{fs}^{(1)}$   | Forward transconductance                                 | $V_{DD}=13\text{ V}; I_D=0.5\text{ A}$   |           | 2   |            | S    |
| $C_{OSS}$  | Output capacitance                                       | $V_{DS}=13\text{ V}; f=1\text{ MHz}; V_{IN}=0\text{ V}$  |           | 90  |            | pF   |
| <b>Switching (T<sub>j</sub>=25 °C, unless otherwise specified)</b>             |  |  |           |     |            |      |

**Table 4. Electrical characteristics (continued)**

| Symbol  | Parameter                     | Test conditions  | Min | Typ  | Max  | Unit             |    |
|---|-------------------------------|--|-----|------|------|------------------|----|
| $t_{d(on)}$   | Turn-on delay time            | $V_{DD}=15\text{ V}; I_D=0.5\text{ A}$<br>$V_{gen}=5\text{ V}; R_{gen}=R_{IN\text{ MIN}}=330\ \Omega$<br>(see <a href="#">Figure 4</a> )   |     | 70   | 200  | ns               |    |
| $t_r$   | Rise time                     |  |     | 170  | 500  | ns               |    |
| $t_{d(off)}$  | Turn-off delay time           |  |     | 350  | 1000 | ns               |    |
| $t_f$   | Fall time                     |  |     | 200  | 600  | ns               |    |
| $t_{d(on)}$   | Turn-on delay time            | $V_{DD}=15\text{ V}; I_D=0.5\text{ A}$<br>$V_{gen}=5\text{ V}; R_{gen}=2.2\text{ K}\Omega$<br>(see <a href="#">Figure 4</a> )  |     | 0.25 | 1.0  | $\mu\text{s}$    |    |
| $t_r$   | Rise time                     |  |     | 1.3  | 4.0  | $\mu\text{s}$    |    |
| $t_{d(off)}$  | Turn-off delay time           |  |     | 1.8  | 5.5  | $\mu\text{s}$    |    |
| $t_f$   | Fall time                     |  |     | 1.2  | 4.0  | $\mu\text{s}$    |    |
| $(di/dt)_{on}$  | Turn-on current slope         | $V_{DD}=15\text{ V}; I_D=1.5\text{ A}$<br>$V_{gen}=5\text{ V}; R_{gen}=R_{IN\text{ MIN}}=330\ \Omega$  |     | 5    |      | A/ $\mu\text{s}$ |    |
| $Q_i$   | Total input charge            | $V_{DD}=12\text{ V}; I_D=0.5\text{ A}; V_{IN}=5\text{ V}$<br>$I_{gen}=2.13\text{ mA}$ (see <a href="#">Figure 7</a> )  |     | 5    |      | nC               |    |
| <b>Source drain diode (<math>T_j=25\text{ }^\circ\text{C}</math>, unless otherwise specified)</b>                           |                               |  |     |      |      |                  |    |
| $V_{SD}^{(1)}$  | Forward on voltage            | $I_{SD}=0.5\text{ A}; V_{IN}=0\text{ V}$   |     | 0.8  |      | V                |    |
| $t_{rr}$  | Reverse recovery time         | $I_{SD}=0.5\text{ A}; di/dt=6\text{ A}/\mu\text{s}$<br>$V_{DD}=30\text{ V}; L=200\ \mu\text{H}$<br>(see <a href="#">Figure 5</a> )   |     | 205  |      | ns               |    |
| $Q_{rr}$  | Reverse recovery charge       |  |     |      | 100  |                  | nC |
| $I_{RRM}$   | Reverse recovery current      |  |     |      | 0.7  |                  | A  |
| <b>Protections (<math>-40\text{ }^\circ\text{C}&lt;T_j&lt;150\text{ }^\circ\text{C}</math>, unless otherwise specified)</b> |                               |  |     |      |      |                  |    |
| $I_{lim}$   | Drain current limit           | $V_{IN}=5\text{ V}; V_{DS}=13\text{ V}$  | 1.7 |      | 3.5  | A                |    |
| $t_{dlim}$  | Step response current limit   | $V_{IN}=5\text{ V}; V_{DS}=13\text{ V}$  |     | 2.0  |      | $\mu\text{s}$    |    |
| $T_{jsh}$   | Over temperature shutdown     |  | 150 | 175  | 200  | $^\circ\text{C}$ |    |
| $T_{jrs}$   | Over temperature reset        |  | 135 |      |      | $^\circ\text{C}$ |    |
| $I_{gf}$  | Fault sink current            | $V_{IN}=5\text{ V}; V_{DS}=13\text{ V}; T_j=T_{jsh}$   | 10  | 15   | 20   | mA               |    |
| $E_{as}$  | Single pulse avalanche energy | Starting $T_j=25\text{ }^\circ\text{C}; V_{DD}=24\text{ V}$<br>$V_{IN}=5\text{ V}; R_{gen}=R_{IN\text{ MIN}}=330\ \Omega;$<br>$L=50\text{ mH}$<br>(see <a href="#">Figure 6</a> and <a href="#">Figure 8</a> ) | 55  |      |      | mJ               |    |

1. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5 %



Figure 4. Switching time test circuit for resistive load

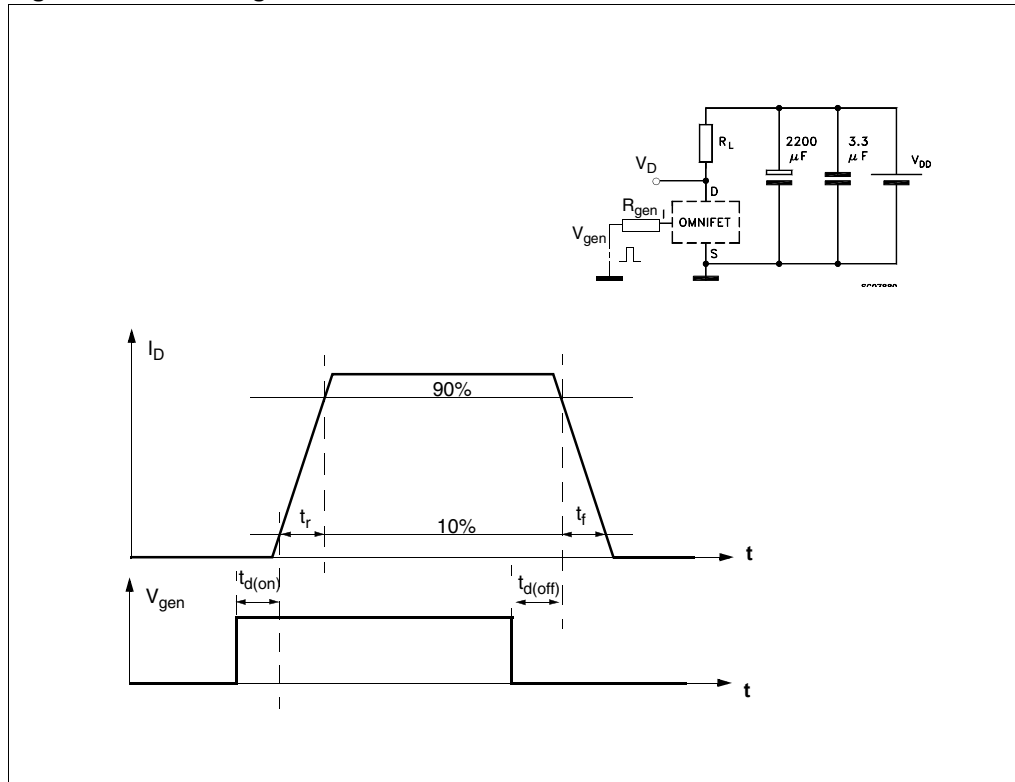


Figure 5. Test circuit for diode recovery times

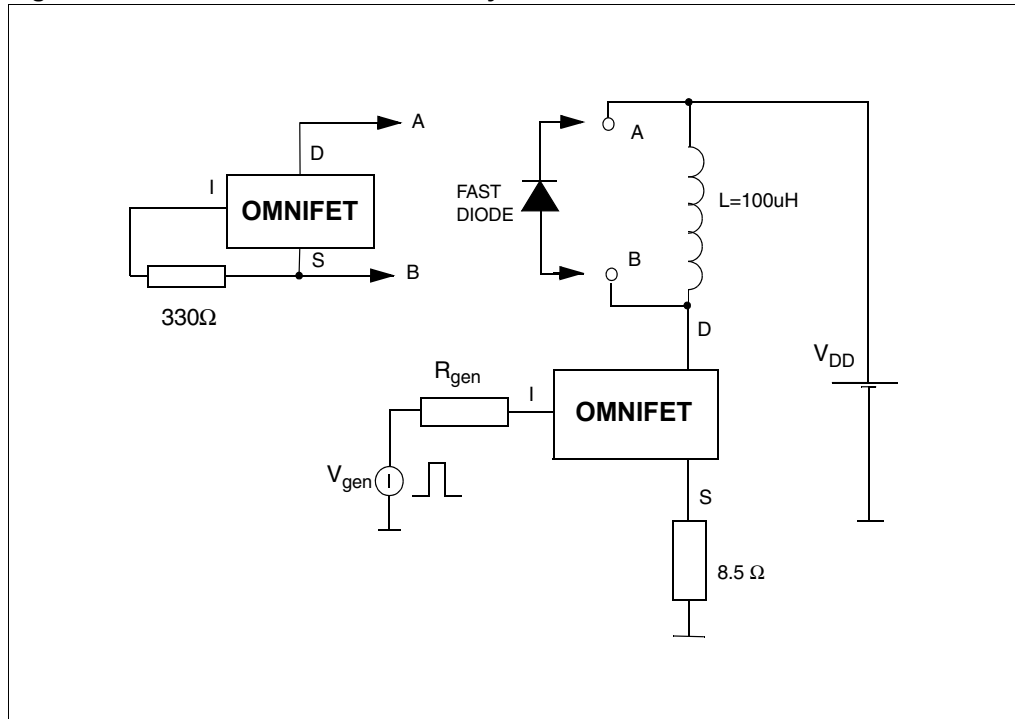


Figure 6. Unclamped inductive load test circuits

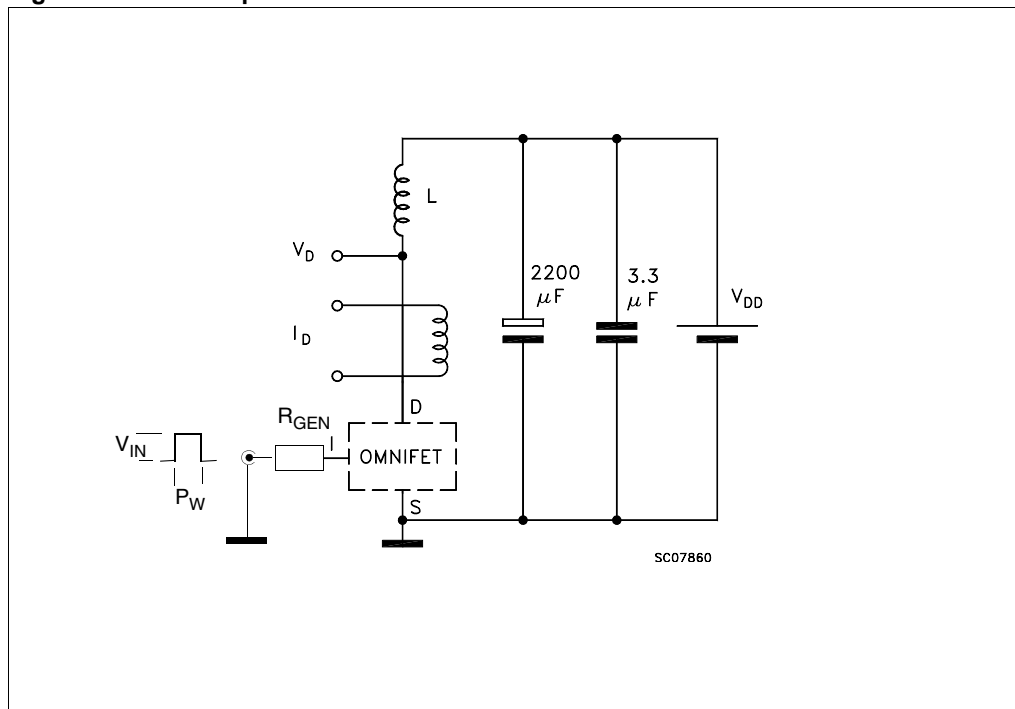


Figure 7. Input charge test circuit

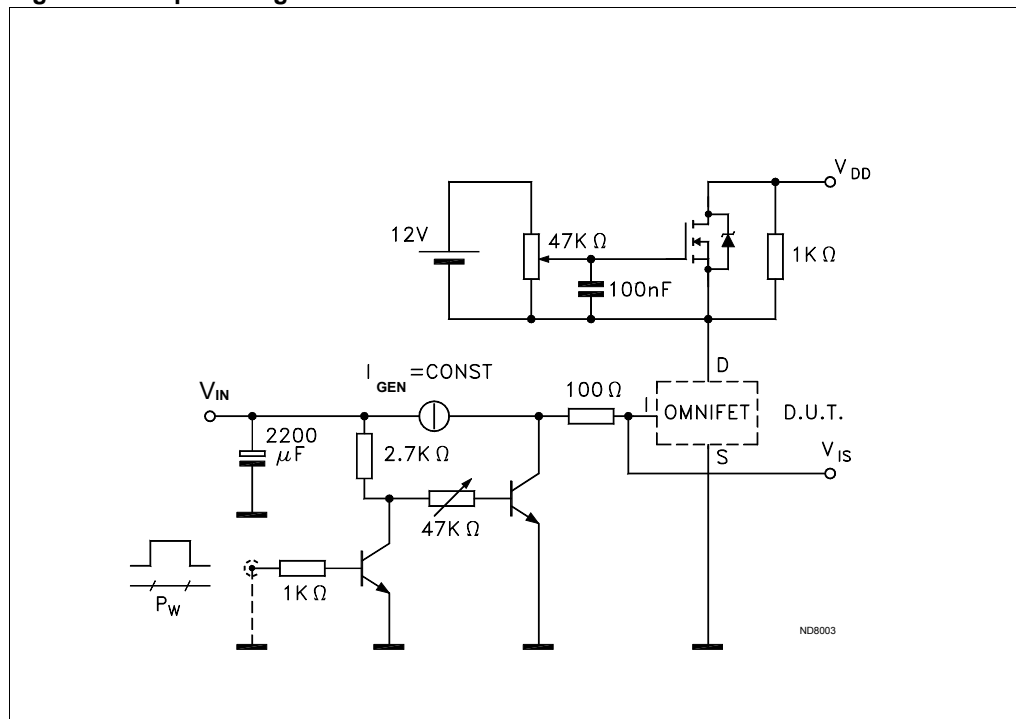
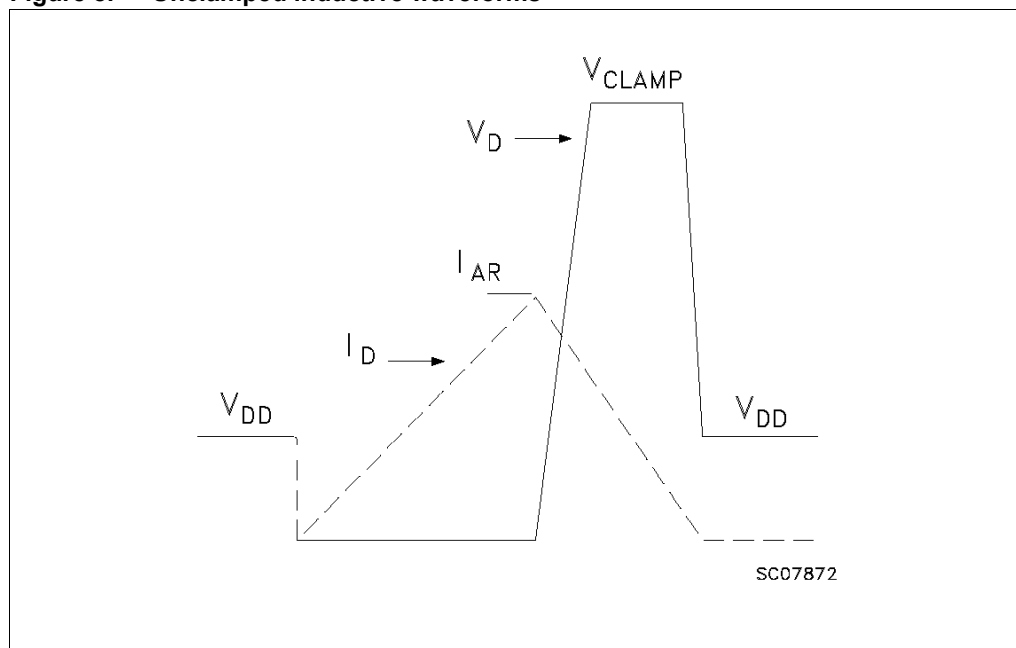


Figure 8. Unclamped inductive waveforms



## 2.4 Electrical characteristics curves

Figure 9. Source-drain diode forward characteristics

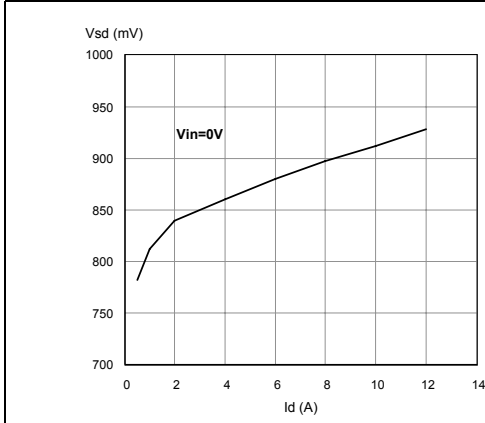


Figure 10. Static drain-source on resistance

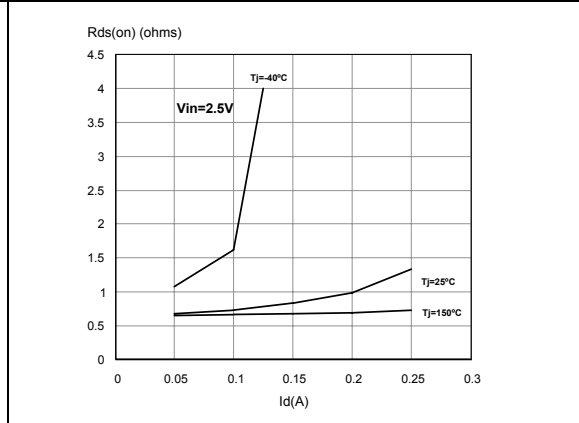


Figure 11. Derating curve

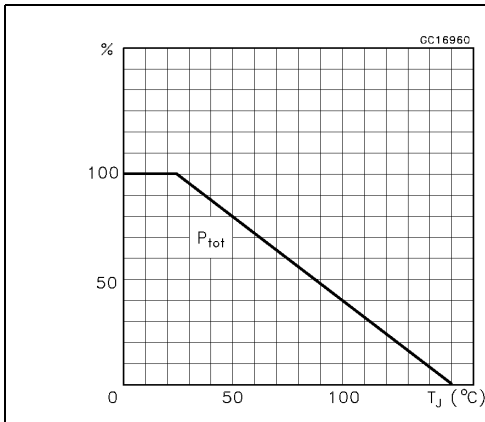


Figure 12. Static drain-source on resistance vs. input voltage (part 1/2)

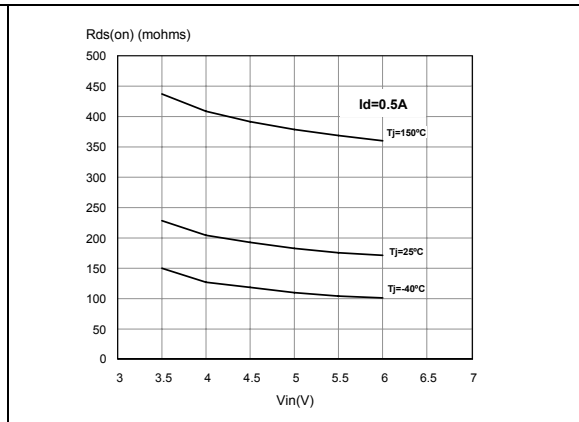


Figure 13. Static drain-source on resistance vs. input voltage (part 2/2)

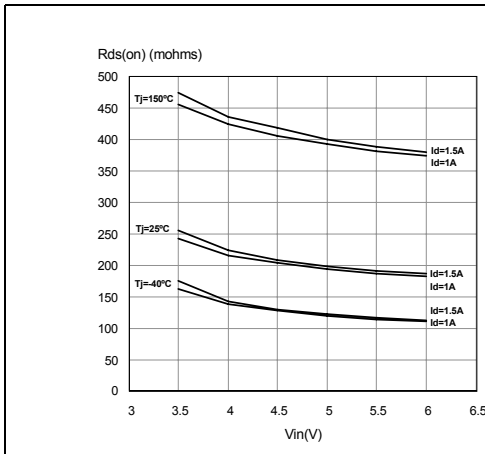


Figure 14. Transconductance

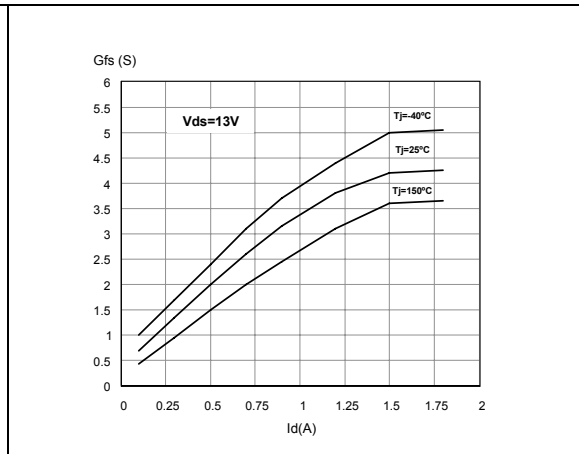


Figure 15. Static drain-source on resistance vs. Id

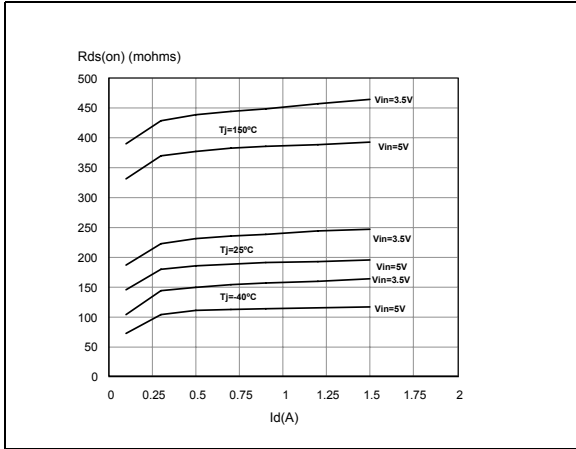


Figure 16. Transfer characteristics

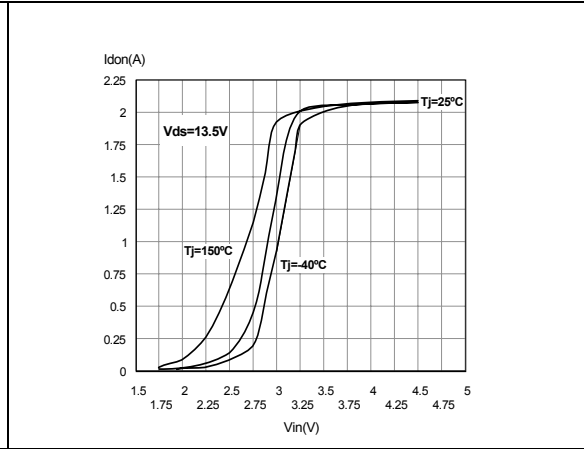


Figure 17. Turn-on current slope (part 1/2)

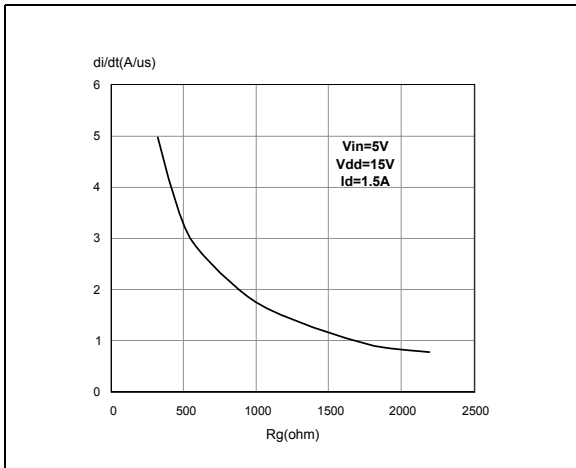


Figure 18. Turn-on current slope (part 2/2)

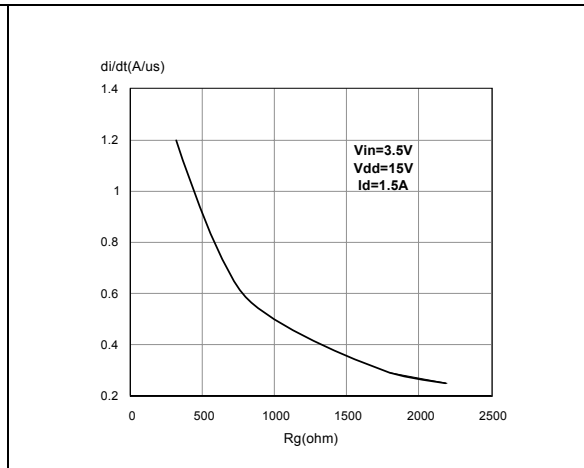


Figure 19. Input voltage vs. input charge

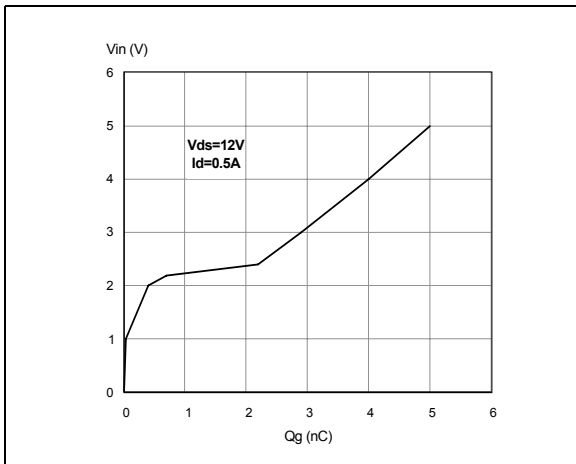


Figure 20. Turn-off drain source voltage slope (part 1/2)

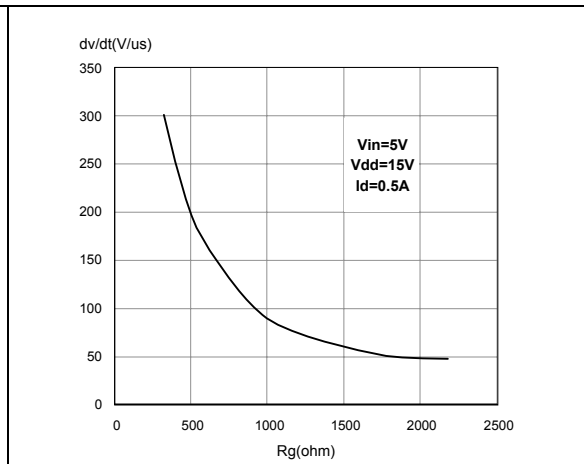


Figure 21. Turn-off drain-source voltage slope Figure 22. Capacitance variations (part 2/2)

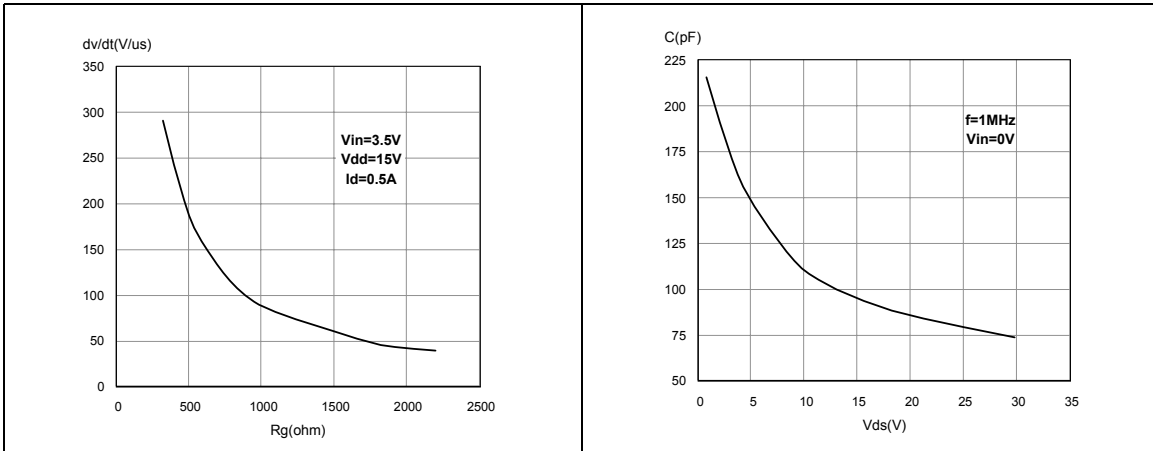


Figure 23. Switching time resistive load (part 1/2)

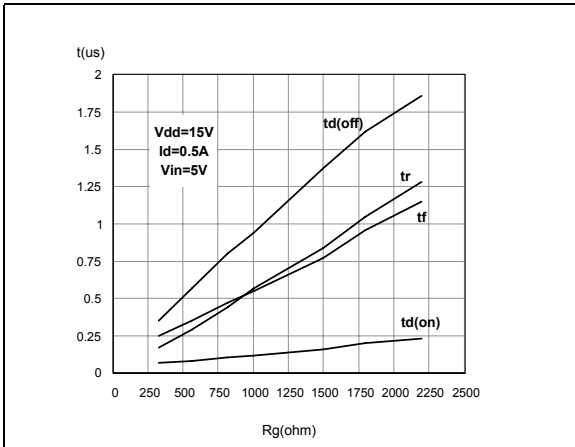


Figure 24. Switching time resistive load (part 2/2)

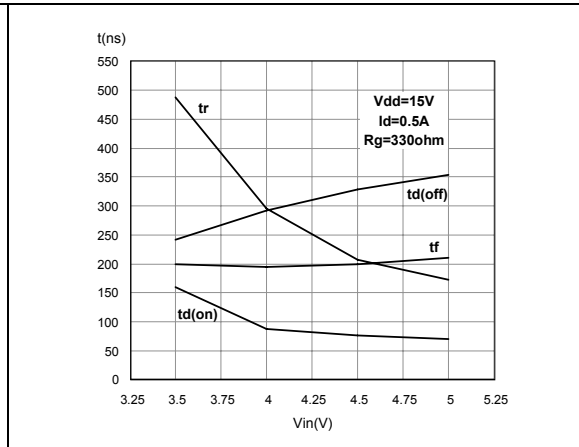


Figure 25. Output characteristics

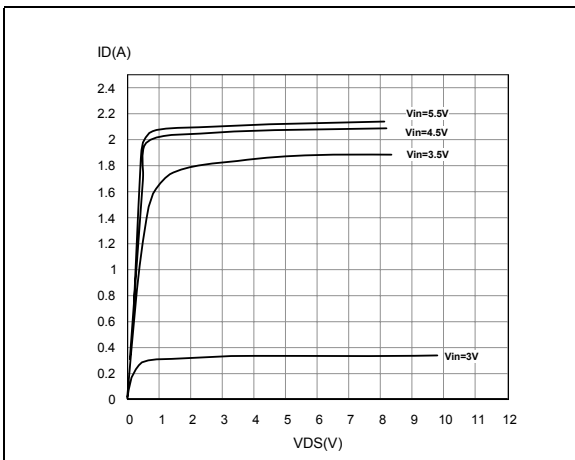
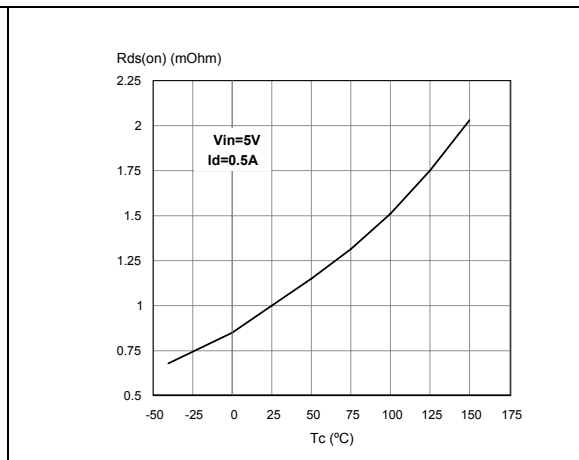
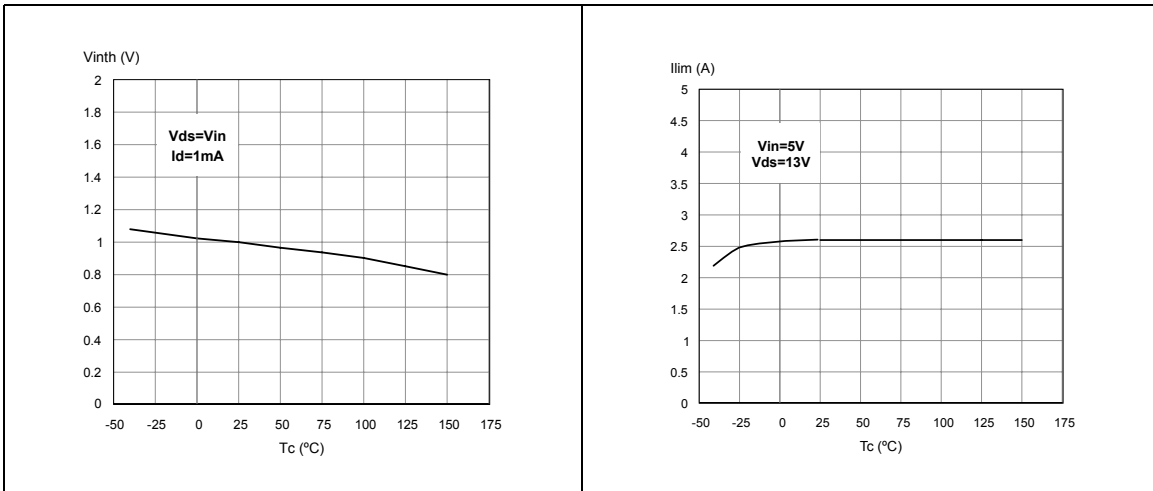


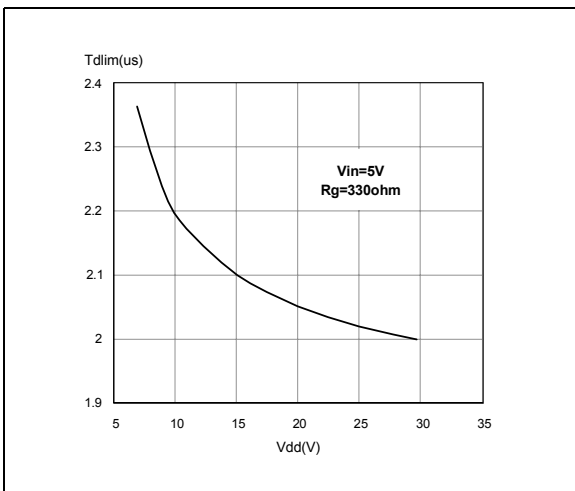
Figure 26. Normalized on resistance vs. temperature



**Figure 27. Normalized input threshold voltage vs. temperature**      **Figure 28. Normalized current limit vs. junction temperature**



**Figure 29. Step response current limit**



## 3 Protection features

During normal operation, the input pin is electrically connected to the gate of the internal Power MOSFET through a low impedance path.

The device then behaves like a standard Power MOSFET and can be used as a switch from DC up to 50 KHz. The only difference from the user's standpoint is that a small DC current  $I_{ISS}$  (typ. 100  $\mu$ A) flows into the input pin in order to supply the internal circuitry.

The device integrates:

### 3.1 Overvoltage clamp protection

Internally set at 45 V, along with the rugged avalanche characteristics of the Power MOSFET stage give this device unrivalled ruggedness and energy handling capability. This feature is mainly important when driving inductive loads.

### 3.2 Linear current limiter circuit

Limits the drain current  $I_D$  to  $I_{lim}$  whatever the input pin voltages. When the current limiter is active, the device operates in the linear region, so power dissipation may exceed the capability of the heatsink. Both case and junction temperatures increase, and if this phase lasts long enough, junction temperature may reach the over temperature threshold  $T_{jsh}$ .

### 3.3 Over temperature and short circuit protection

These are based on sensing the chip temperature and are not dependent on the input voltage. The location of the sensing element on the chip in the power stage area ensures fast, accurate detection of the junction temperature. Over temperature cutout occurs in the range 150 to 190 °C, a typical value being 170 °C. The device is automatically restarted when the chip temperature falls of about 15 °C below shutdown temperature.

### 3.4 Status feedback

In the case of an over temperature fault condition ( $T_j > T_{jsh}$ ), the device tries to sink a diagnostic current  $I_{gf}$  through the input pin in order to indicate fault condition. If driven from a low impedance source, this current may be used in order to warn the control circuit of a device shutdown. If the drive impedance is high enough so that the input pin driver is not able to supply the current  $I_{gf}$ , the input pin will fall to 0 V. This will not however affect the device operation: no requirement is put on the current capability of the input pin driver except to be able to supply the normal operation drive current  $I_{ISS}$ .

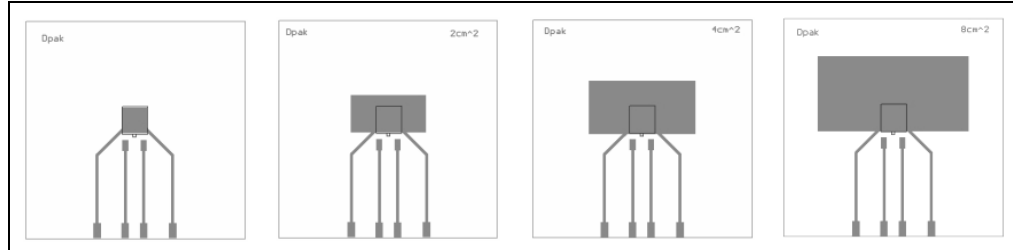
Additional features of this device are ESD protection according to the Human Body model and the ability to be driven from a TTL logic circuit.



## 4 Package and PCB thermal data

### 4.1 DPAK thermal data

Figure 30. DPAK PC board



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  $\mu$ m, Copper areas: from minimum pad layout to 16 cm<sup>2</sup>).

Figure 31. DPAK  $R_{thi-amb}$  vs. PCB copper area in open box free air condition

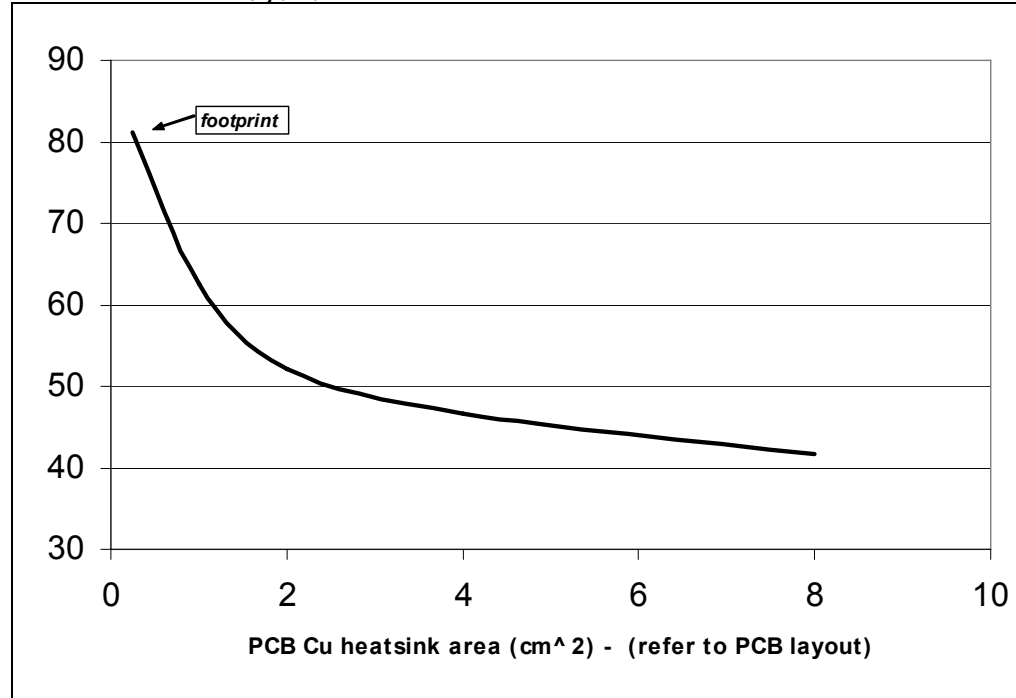
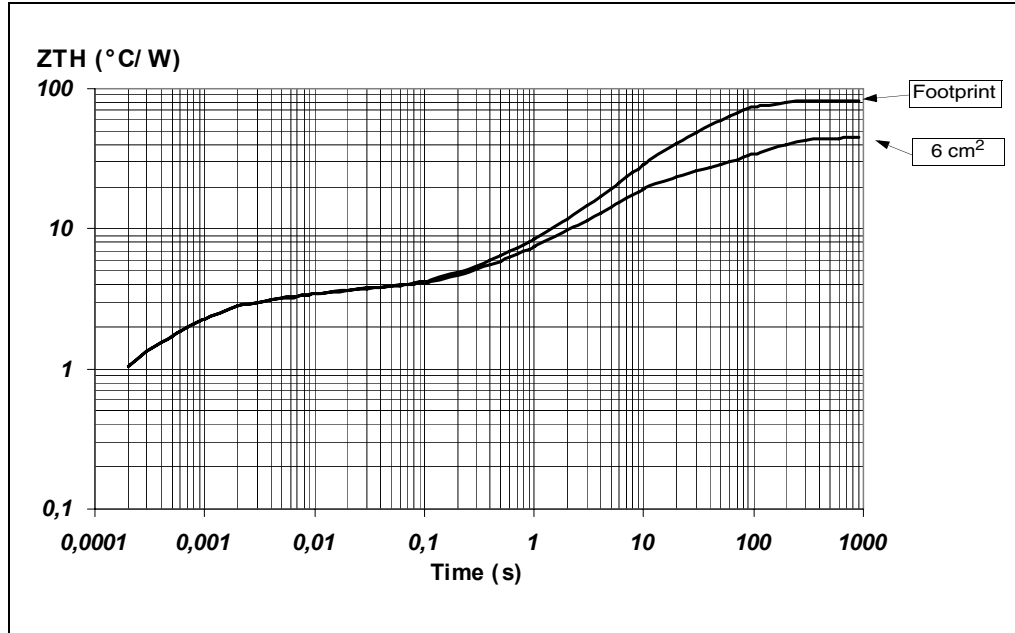


Figure 32. DPAK thermal impedance junction ambient single pulse

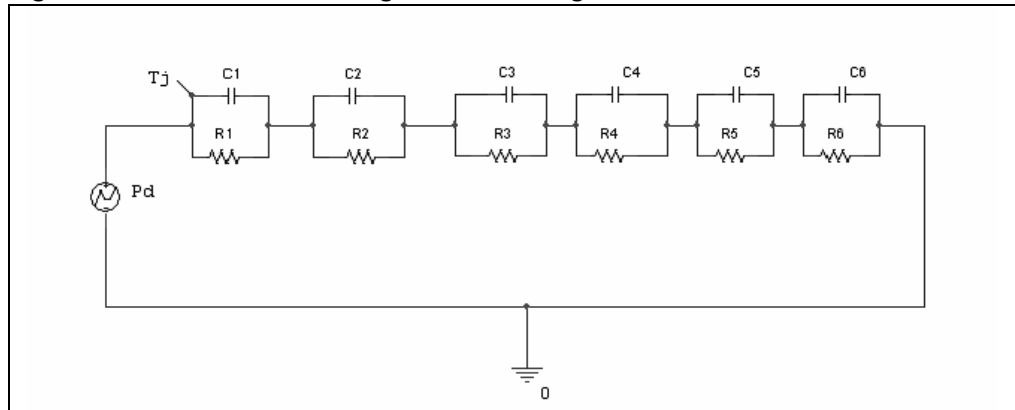


Equation 1: pulse calculation formula

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

where  $\delta = t_p/T$

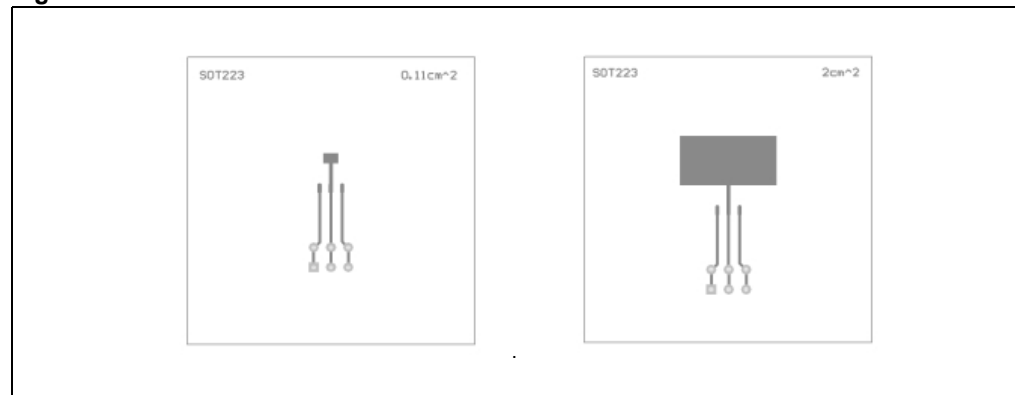
Figure 33. DPAK thermal fitting model of a single channel



**Table 5. DPAK thermal parameter**

| Area/island (cm <sup>2</sup> ) | 0.25    | 6  |
|--------------------------------|---------|----|
| R1 (°C/W)                      | 0.8     |    |
| R2 (°C/W)                      | 1.6     |    |
| R3 (°C/W)                      | 0.8     |    |
| R4 (°C/W)                      | 2       |    |
| R5 (°C/W)                      | 15      |    |
| R6 (°C/W)                      | 61      | 24 |
| C1 (W·s/°C)                    | 0.00006 |    |
| C2 (W·s/°C)                    | 0.0005  |    |
| C3 (W·s/°C)                    | 0.01    |    |
| C4 (W·s/°C)                    | 0.3     |    |
| C5 (W·s/°C)                    | 0.45    |    |
| C6 (W·s/°C)                    | 0.8     | 5  |

## 4.2 SOT-223 thermal data

**Figure 34. SOT-223 PC board**

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  $\mu$ m, Copper areas: from minimum pad layout to 0.8 cm<sup>2</sup>).

Figure 35. SOT-223  $R_{thj-amb}$  vs. PCB copper area in open box free air condition

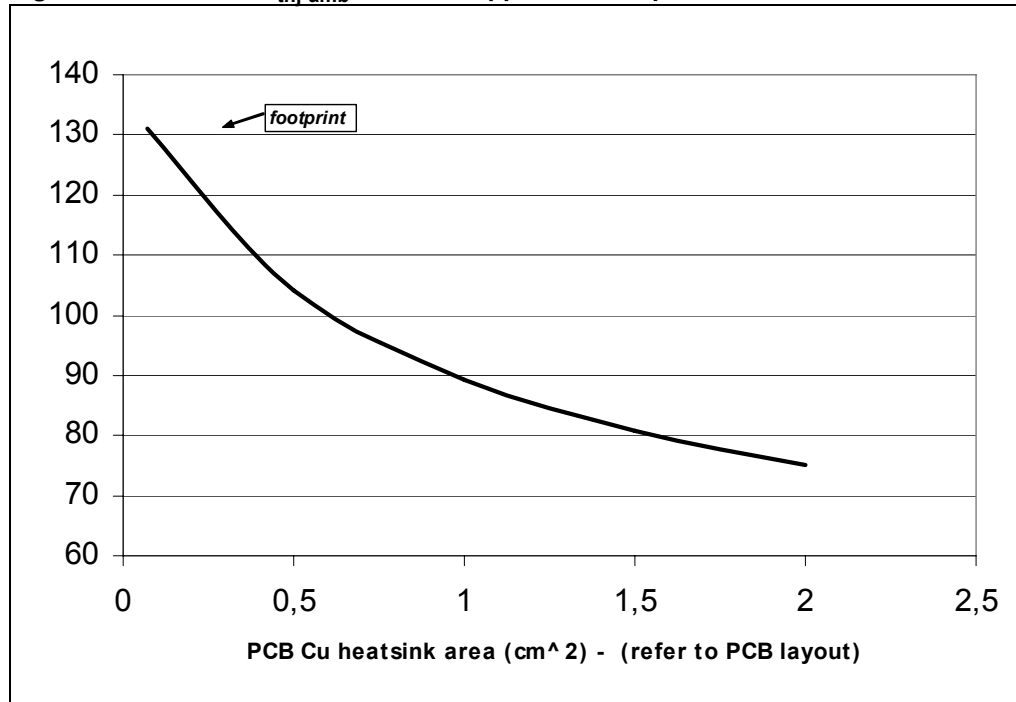
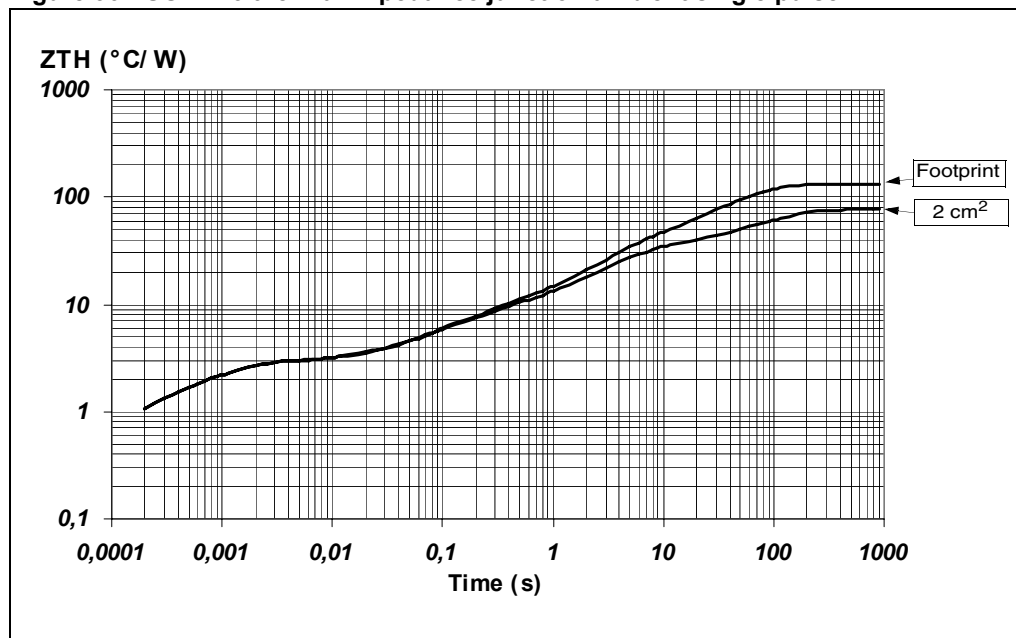


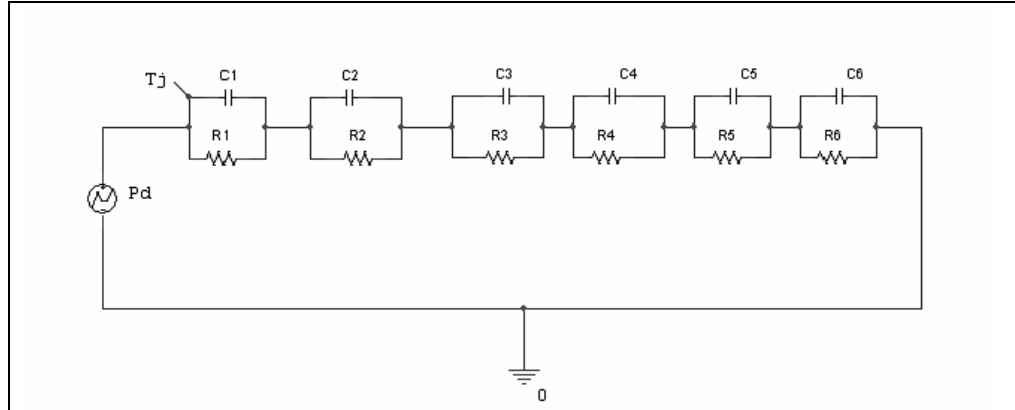
Figure 36. SOT-223 thermal impedance junction ambient single pulse



**Equation 2: pulse calculation formula**

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

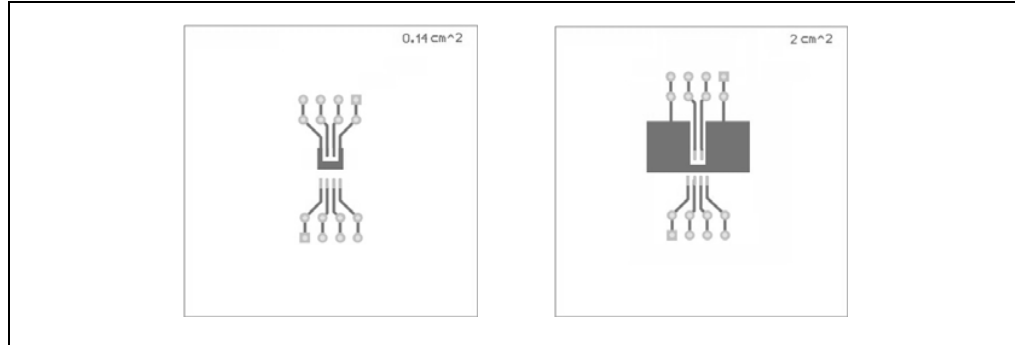
where  $\delta = t_p/T$

**Figure 37. SOT-223 thermal fitting model of a single channel****Table 6. SOT-223 thermal parameter**

| Area/island (cm <sup>2</sup> ) | FP      | 2  |
|--------------------------------|---------|----|
| R1 (°C/W)                      | 0.8     |    |
| R2 (°C/W)                      | 1.6     |    |
| R3 (°C/W)                      | 4.5     |    |
| R4 (°C/W)                      | 24      |    |
| R5 (°C/W)                      | 0.1     |    |
| R6 (°C/W)                      | 100     | 45 |
| C1 (W·s/°C)                    | 0.00006 |    |
| C2 (W·s/°C)                    | 0.0005  |    |
| C3 (W·s/°C)                    | 0.03    |    |
| C4 (W·s/°C)                    | 0.16    |    |
| C5 (W·s/°C)                    | 1000    |    |
| C6 (W·s/°C)                    | 0.5     | 2  |

### 4.3 SO-8 thermal data

Figure 38. SO-8 PC board



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  $\mu$ m, Copper areas: from minimum pad layout to 2 cm<sup>2</sup>).

Figure 39. SO-8  $R_{thj-amb}$  vs. PCB copper area in open box free air condition

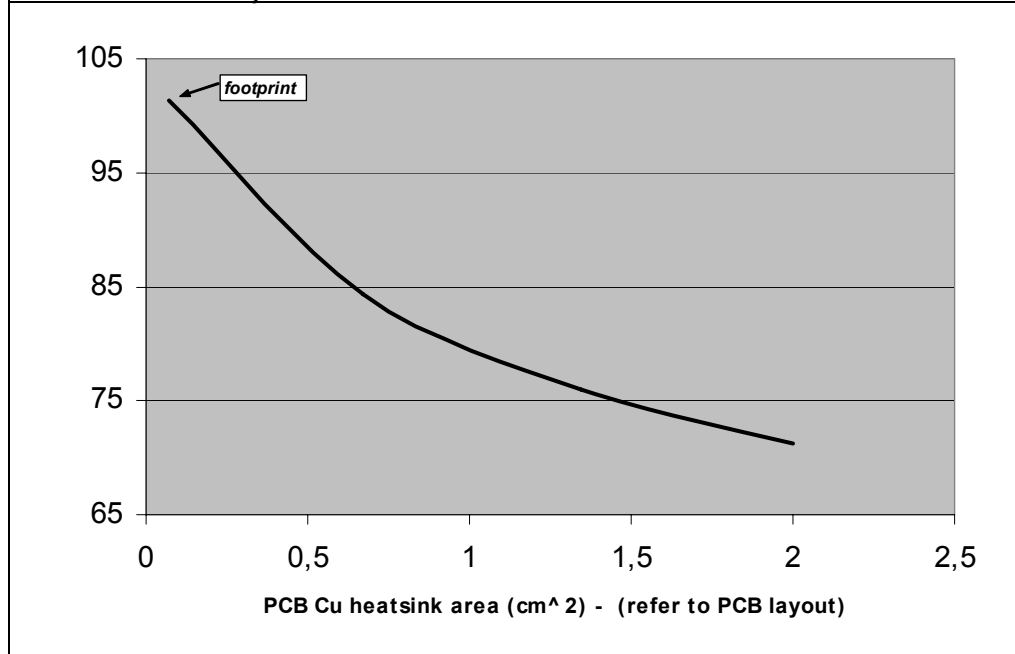
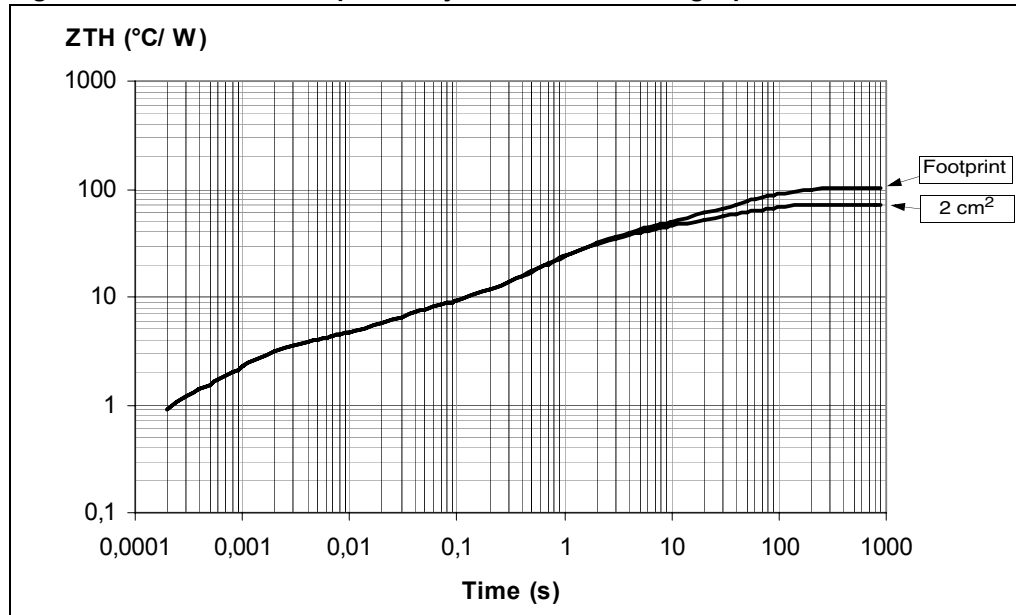


Figure 40. SO-8 thermal impedance junction ambient single pulse

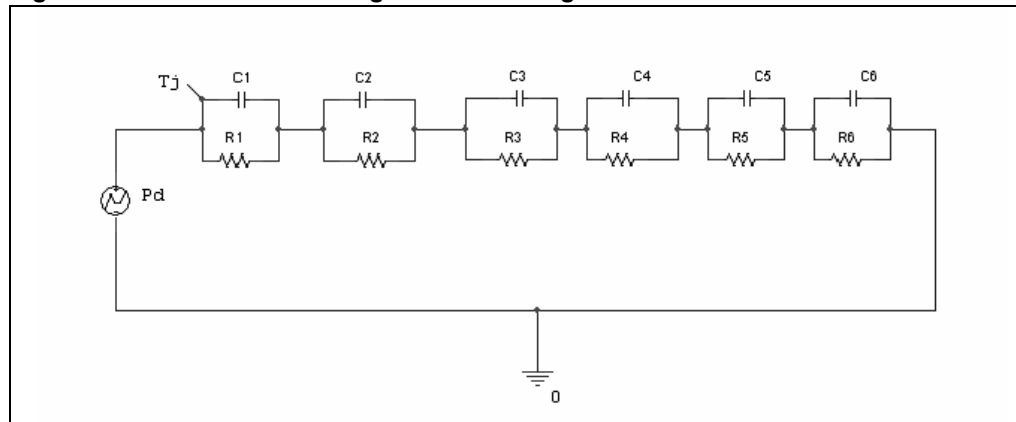


Equation 3: pulse calculation formula

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

where  $\delta = t_p/T$

Figure 41. SO-8 thermal fitting model of a single channel



**Table 7. SO-8 thermal parameter**

| Area/island (cm <sup>2</sup> ) | FP      | 2  |
|--------------------------------|---------|----|
| R1 (°C/W)                      | 0.8     |    |
| R2 (°C/W)                      | 2.6     |    |
| R3 (°C/W)                      | 3.5     |    |
| R4 (°C/W)                      | 21      |    |
| R5 (°C/W)                      | 16      |    |
| R6 (°C/W)                      | 58      | 28 |
| C1 (W·s/°C)                    | 0.00006 |    |
| C2 (W·s/°C)                    | 0.0005  |    |
| C3 (W·s/°C)                    | 0.0075  |    |
| C4 (W·s/°C)                    | 0.045   |    |
| C5 (W·s/°C)                    | 0.35    |    |
| C6 (W·s/°C)                    | 1.05    | 2  |



## 5 Package and packing information

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

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

### 5.1 DPAK mechanical data

Figure 42. DPAK package dimensions

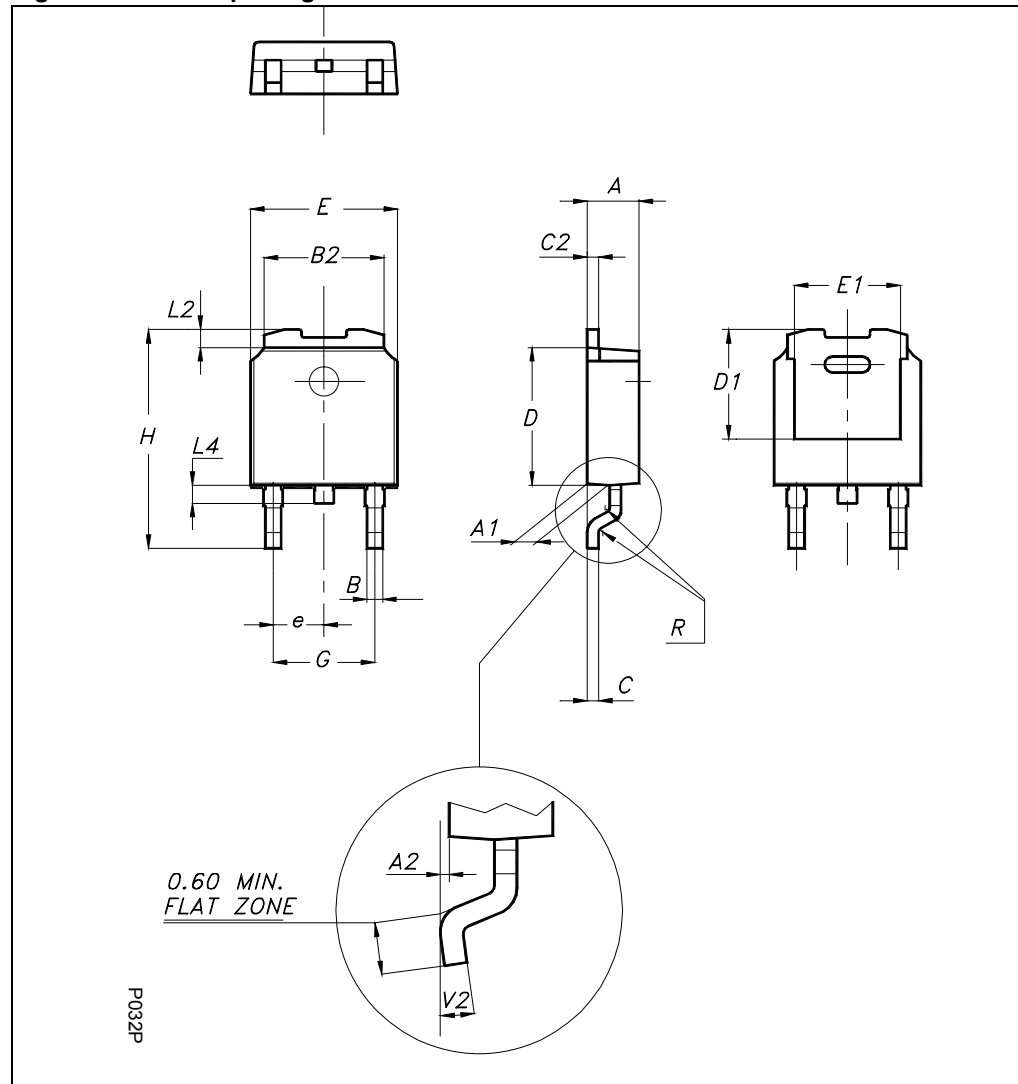
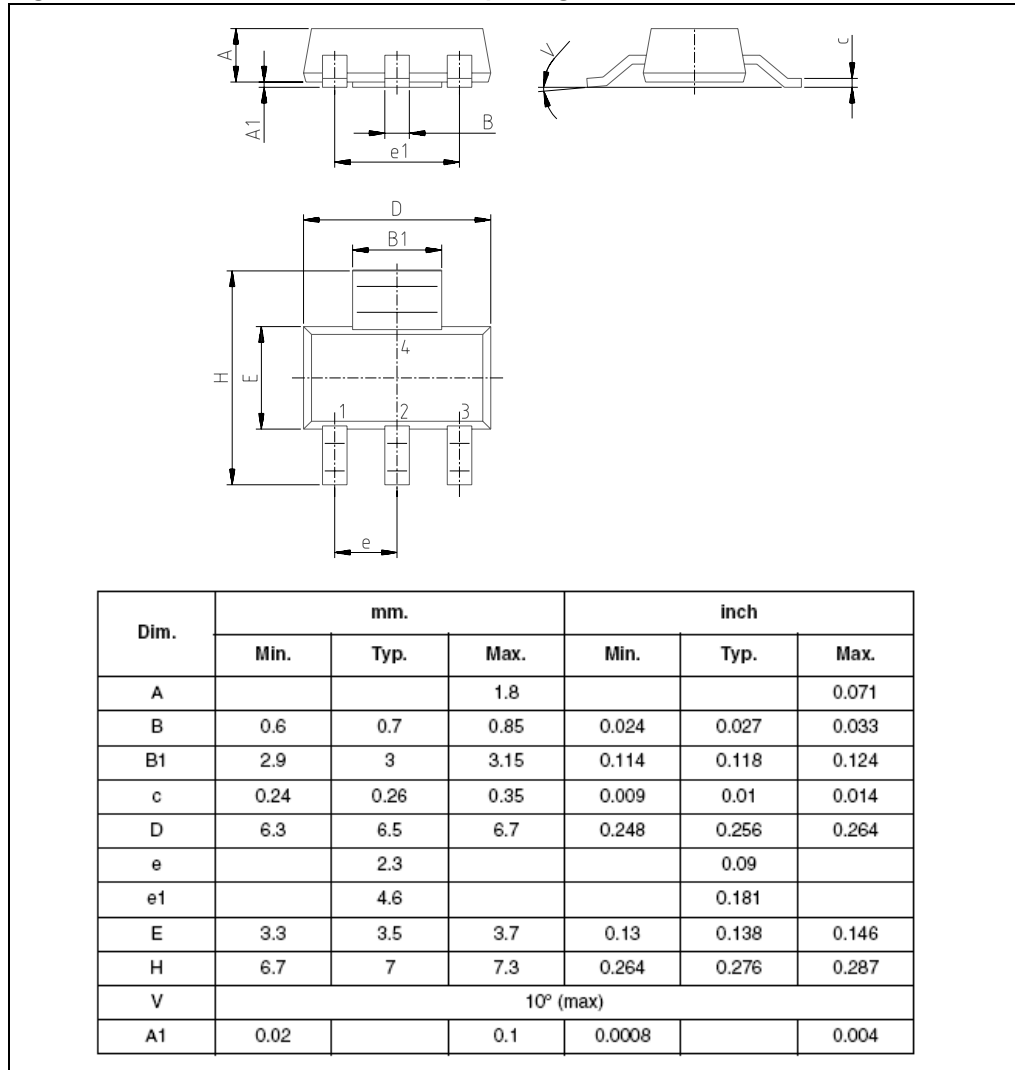


Table 8. DPAK mechanical data

| Dim.           | mm.      |      |       |
|----------------|----------|------|-------|
|                | Min.     | Typ. | Max.  |
| A              | 2.20     |      | 2.40  |
| A1             | 0.90     |      | 1.10  |
| A2             | 0.03     |      | 0.23  |
| B              | 0.64     |      | 0.90  |
| B2             | 5.20     |      | 5.40  |
| C              | 0.45     |      | 0.60  |
| C2             | 0.48     |      | 0.60  |
| D              | 6.00     |      | 6.20  |
| D1             |          | 5.1  |       |
| E              | 6.40     |      | 6.60  |
| E1             |          | 4.7  |       |
| e              |          | 2.28 |       |
| G              | 4.40     |      | 4.60  |
| H              | 9.35     |      | 10.10 |
| L2             |          | 0.8  |       |
| L4             | 0.60     |      | 1.00  |
| R              |          | 0.2  |       |
| V2             | 0°       | 8°   |       |
| Package weight | Gr. 0.29 |      |       |

## 5.2 SOT-223 mechanical data

Figure 43. SOT-223 mechanical data & package outline



## 5.3 SO8 mechanical data

Table 9. SO-8 mechanical data

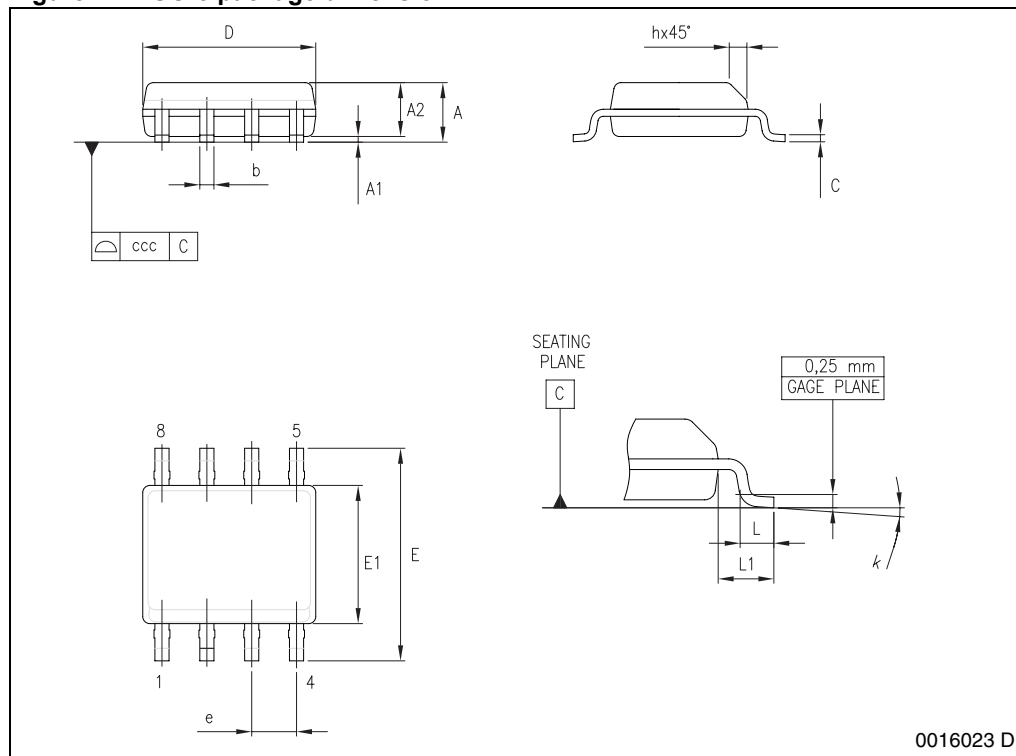
| Dim. | mm   |      |      |
|------|------|------|------|
|      | Min. | Typ. | Max. |
| A    |      |      | 1.75 |
| A1   | 0.10 |      | 0.25 |
| A2   | 1.25 |      |      |

Table 9. SO-8 mechanical data (continued)

| Dim.              | mm   |      |      |
|-------------------|------|------|------|
|                   | Min. | Typ. | Max. |
| b                 | 0.28 |      | 0.48 |
| c                 | 0.17 |      | 0.23 |
| D <sup>(1)</sup>  | 4.80 | 4.90 | 5.00 |
| E                 | 5.80 | 6.00 | 6.20 |
| E1 <sup>(2)</sup> | 3.80 | 3.90 | 4.00 |
| e                 |      | 1.27 |      |
| h                 | 0.25 |      | 0.50 |
| L                 | 0.40 |      | 1.27 |
| L1                |      | 1.04 |      |
| k                 | 0°   |      | 8°   |
| ccc               |      |      | 0.10 |

1. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusions or gate burrs shall not exceed 0.15 mm in total (both side).
2. Dimension "E1" does not include interlead flash or protrusions. Interlead flash or protrusions shall not exceed 0.25 mm per side.

Figure 44. SO-8 package dimension



0016023 D

### 5.4 DPAK packing information

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

**DPAK FOOTPRINT**

**TUBE SHIPMENT (no suffix)**

|                            |      |
|----------------------------|------|
| <b>Base Q.ty</b>           | 75   |
| <b>Bulk Q.ty</b>           | 3000 |
| <b>Tube length (± 0.5)</b> | 532  |
| <b>A</b>                   | 6    |
| <b>B</b>                   | 21.3 |
| <b>C (± 0.1)</b>           | 0.6  |

All dimensions are in mm.

**TAPE AND REEL SHIPMENT (suffix "13TR")**

**REEL DIMENSIONS**

|                     |      |
|---------------------|------|
| <b>Base Q.ty</b>    | 2500 |
| <b>Bulk Q.ty</b>    | 2500 |
| <b>A (max)</b>      | 330  |
| <b>B (min)</b>      | 1.5  |
| <b>C (± 0.2)</b>    | 13   |
| <b>F</b>            | 20.2 |
| <b>G (+ 2 / -0)</b> | 16.4 |
| <b>N (min)</b>      | 60   |
| <b>T (max)</b>      | 22.4 |

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

|                          |                     |     |
|--------------------------|---------------------|-----|
| <b>Tape width</b>        | <b>W</b>            | 16  |
| <b>Tape Hole Spacing</b> | <b>P0 (± 0.1)</b>   | 4   |
| <b>Component Spacing</b> | <b>P</b>            | 8   |
| <b>Hole Diameter</b>     | <b>D (± 0.1/-0)</b> | 1.5 |
| <b>Hole Diameter</b>     | <b>D1 (min)</b>     | 1.5 |
| <b>Hole Position</b>     | <b>F (± 0.05)</b>   | 7.5 |
| <b>Compartment Depth</b> | <b>K (max)</b>      | 6.5 |
| <b>Hole Spacing</b>      | <b>P1 (± 0.1)</b>   | 2   |

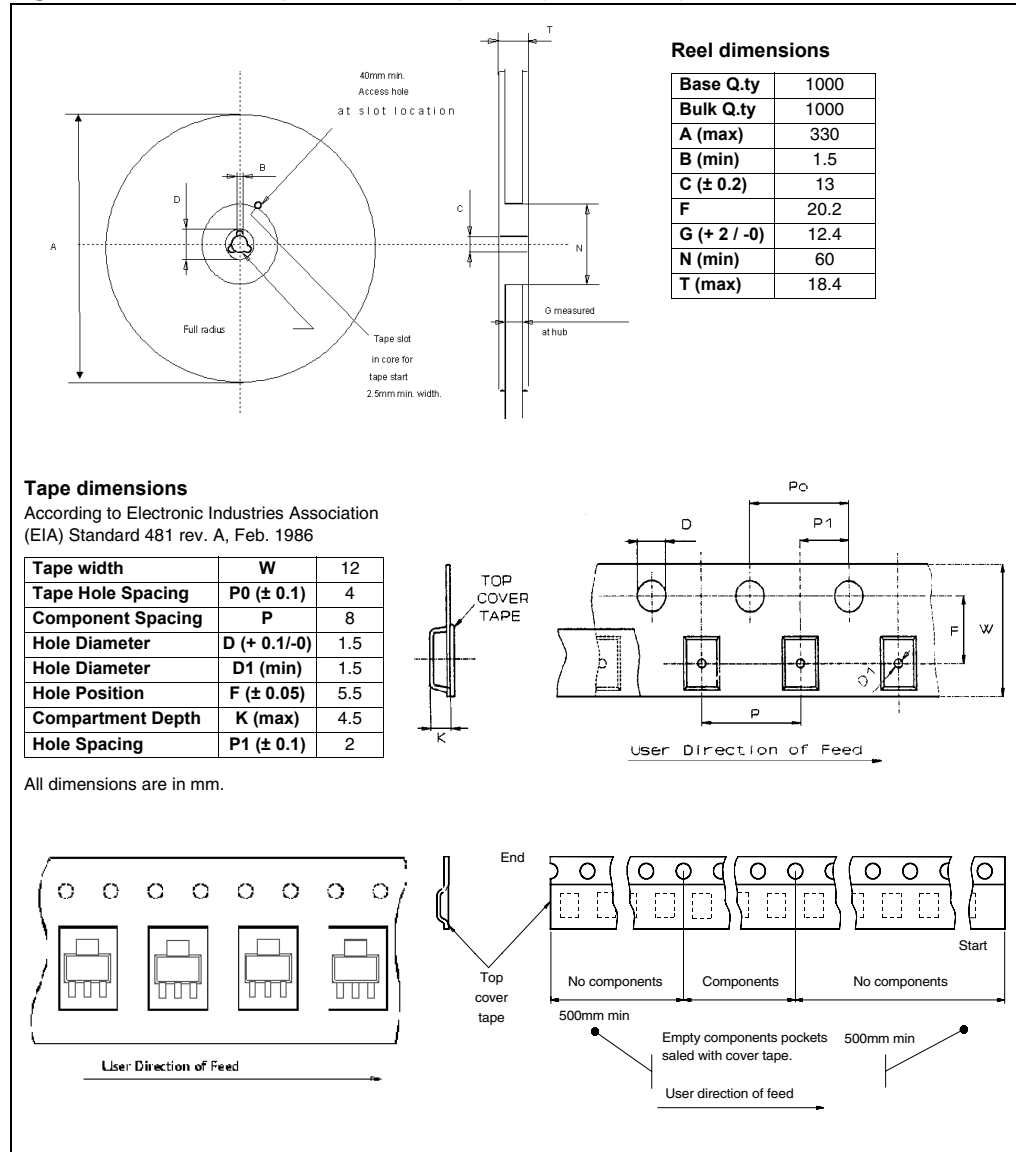
All dimensions are in mm.

User Direction of Feed

User Direction of Feed

### 5.5 SOT-223 packing information

Figure 45. SOT-223 tape and reel shipment (suffix “TR”)



### 5.6 SO8 packing information

Figure 46. SO-8 tube shipment (no suffix)

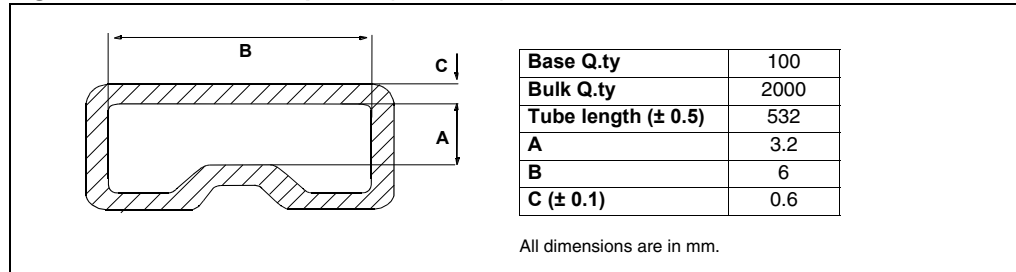
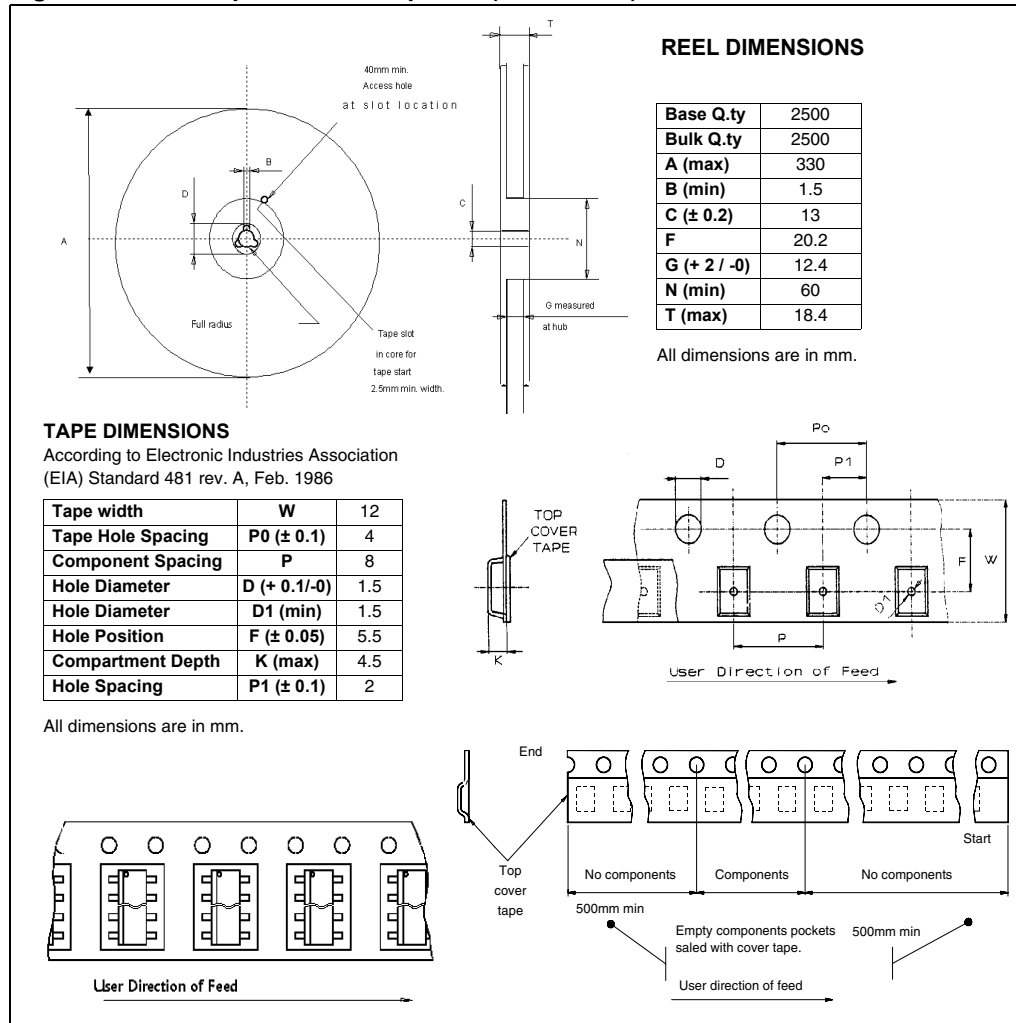


Figure 47. SO-8 tape and reel shipment (suffix “TR”)



## 6 Revision history

Table 10. Document revision history

| Date        | Revision | Changes  |
|-------------|----------|--|
| Feb-2003    | 1        | Initial release.   |
| 16-Apr-2009 | 2        | Added <a href="#">Table 1: Device summary on page 1</a> and <a href="#">Section 4: Package and PCB thermal data</a><br>Updated <a href="#">Section 5: Package and packing information on page 25</a> |



**Please Read Carefully:**

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

**UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.**

**UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.**

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2009 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Philippines - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

[www.st.com](http://www.st.com)

