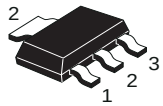
# VNN3NV04, VNS3NV04
# VND3NV04, VND3NV04-1

## OMNIFET II
## fully autoprotected Power MOSFET

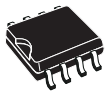
## Features

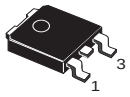
| Type | $R_{DS(on)}$ | $I_{lim}$ | $V_{clamp}$ |
|---|---|---|---|
| VNN3NV04<br>VNS3NV04<br>VND3NV04<br>VND3NV04-1 | 120 mΩ | 3.5 A | 40 V |

- 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 in compliance with the 2002/95/EC European Directive

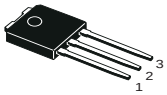


SOT-223


SO-8



TO252 (DPAK)



TO251 (IPAK)

## Description

The VNN3NV04, VNS3NV04, VND3NV04 VND3NV04-1, 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) |
| SOT-223 | VNN3NV04 | - | VNN3NV0413TR | - |
| SO-8 | VNS3NV04 | - | VNS3NV0413TR | - |
| TO-252 | VND3NV04 | VND3NV04-E | VND3NV0413TR | VND3NV04TR-E |
| TO-251 | VND3NV04-1 | VND3NV04-1-E | - | - |

# Contents

# List of tables

# List of figures

# 1 Block diagram and pin description

**Figure 1. Block diagram**

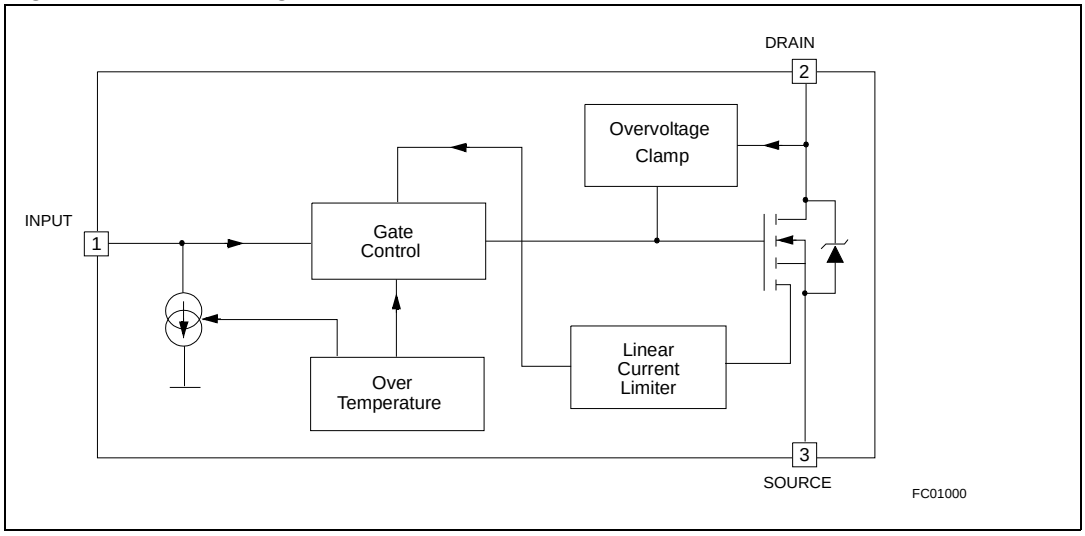
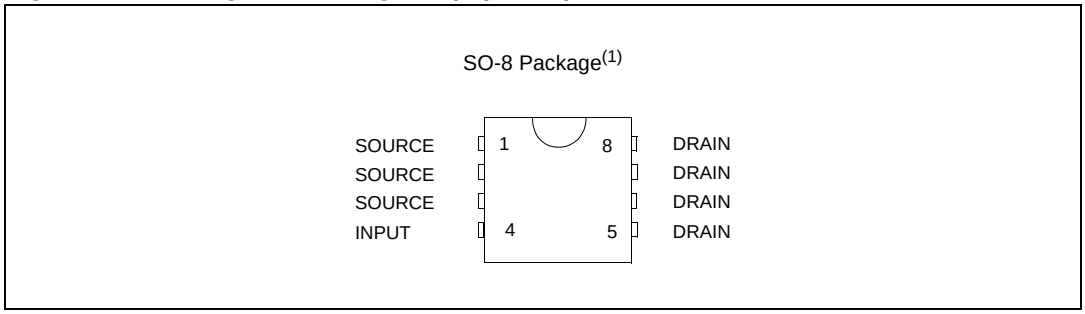


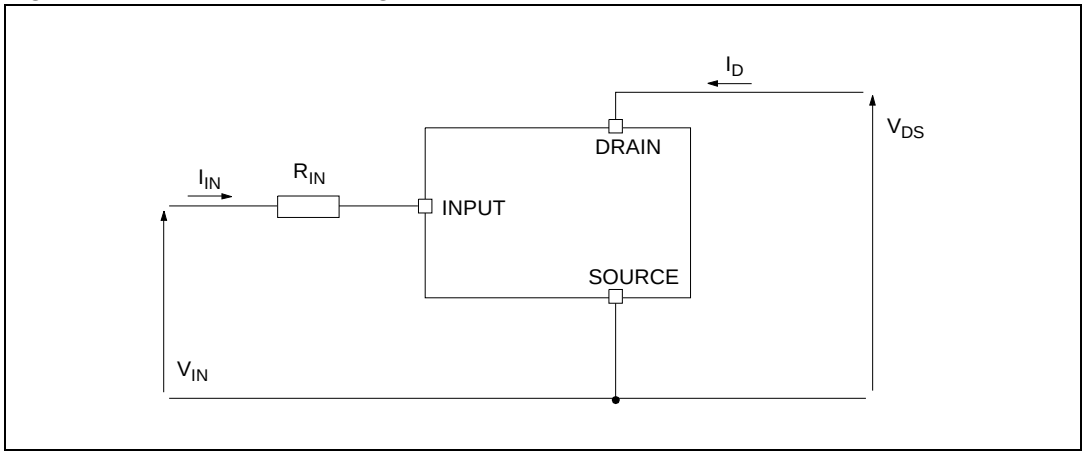

**Figure 2. Configuration diagram (top view)**




1. For the pins configuration related to SOT-223, DPAK, IPAK see outlines at page 1.

# 2 Electrical specifications

**Figure 3. Current and voltage conventions**




## 2.1 Absolute maximum ratings

**Table 2. Absolute maximum ratings**

| Symbol | Parameter | Value | | | Unit |
|---|---|---|---|---|---|
| | | SOT-223 | SO-8 | DPAK/IPAK | |
| $V_{DS}$ | Drain-source voltage ($V_{IN}$=0 V) | Internally clamped | | | V |
| $V_{IN}$ | Input voltage | Internally clamped | | | V |
| $I_{IN}$ | Input current | +/-20 | | | mA |
| $R_{IN\ MIN}$ | Minimum input series impedance | 220 | | | Ω |
| $I_D$ | Drain current | Internally limited | | | A |
| $I_R$ | Reverse DC output current | -5.5 | | | A |
| $V_{ESD1}$ | Electrostatic discharge (R=1.5 KΩ, C=100 pF) | 4000 | | | V |
| $V_{ESD2}$ | Electrostatic discharge on output pin only (R=330 Ω, 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 | Value | | | | Unit |
|---|---|---|---|---|---|---|
| | | SOT-223 | SO-8 | DPAK | IPAK | |
| $R_{thj\text{-}case}$ | Thermal resistance junction-case max | 18 | | 3.5 | 3.5 | °C/W |
| $R_{thj\text{-}lead}$ | Thermal resistance junction-lead max | | 15 | | | °C/W |
| $R_{thj\text{-}amb}$ | Thermal resistance junction-ambient max | 70(1) | 65(1) | 54(1) | 100 | °C/W |

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

## 2.3 Electrical characteristics

-40 °C < $T_j$ < 150 °C, unless otherwise specified.

**Table 4. Electrical characteristics**

| Symbol | Parameter | Test conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Off** | | | | | | |
| $V_{CLAMP}$ | Drain-source clamp voltage | $V_{IN}$=0 V; $I_D$=1.5 A | 40 | 45 | 55 | V |
| $V_{CLTH}$ | Drain-source clamp threshold voltage | $V_{IN}$=0 V; $I_D$=2 mA | 36 | | | V |
| $V_{INTH}$ | Input threshold voltage | $V_{DS}$=$V_{IN}$; $I_D$=1 mA | 0.5 | | 2.5 | V |
| $I_{ISS}$ | Supply current from input pin | $V_{DS}$=0 V; $V_{IN}$=5 V | | 100 | 150 | µA |
| $V_{INCL}$ | Input-source clamp voltage | $I_{IN}$=1 mA<br>$I_{IN}$=-1 mA | 6<br>-1.0 | 6.8 | 8<br>-0.3 | V |
| $I_{DSS}$ | Zero input voltage drain current ($V_{IN}$=0 V) | $V_{DS}$=13 V; $V_{IN}$=0 V; $T_j$=25 °C<br>$V_{DS}$=25 V; $V_{IN}$=0 V | | | 30<br>75 | µA |
| **On** | | | | | | |
| $R_{DS(on)}$ | Static drain-source on resistance | $V_{IN}$=5 V; $I_D$=1.5 A; $T_j$=25 °C<br>$V_{IN}$=5 V; $I_D$=1.5 A | | | 120<br>240 | mΩ |
| **Dynamic ($T_j$=25 °C, unless otherwise specified)** | | | | | | |
| $g_{fs}$ (1) | Forward transconductance | $V_{DD}$=13 V; $I_D$=1.5 A | | 5.0 | | S |
| $C_{OSS}$ | Output capacitance | $V_{DS}$=13 V; f=1 MHz; $V_{IN}$=0 V | | 150 | | pF |
| **Switching ($T_j$=25 °C, unless otherwise specified)** | | | | | | |

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

| Symbol | Parameter | Test conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD}$=15 V; $I_D$=1.5 A<br>$V_{gen}$=5 V; $R_{gen}$=$R_{IN\ MIN}$=220 Ω<br>(see figure *Figure 4.*) | | 90 | 300 | ns |
| $t_r$ | Rise time | | | 250 | 750 | ns |
| $t_{d(off)}$ | Turn-off delay time | | | 450 | 1350 | ns |
| $t_f$ | Fall time | | | 250 | 750 | ns |
| $t_{d(on)}$ | Turn-on delay time | $V_{DD}$=15 V; $I_D$=1.5 A<br>$V_{gen}$=5 V; $R_{gen}$=2.2 KΩ<br>(see figure *Figure 4.*) | | 0.45 | 1.35 | µs |
| $t_r$ | Rise time | | | 2.5 | 7.5 | µs |
| $t_{d(off)}$ | Turn-off delay time | | | 3.3 | 10.0 | µs |
| $t_f$ | Fall time | | | 2.0 | 6.0 | µs |
| $(dI/dt)_{on}$ | Turn-on current slope | $V_{DD}$=15 V; $I_D$=1.5 A<br>$V_{gen}$=5 V; $R_{gen}$=$R_{IN\ MIN}$=220 Ω | | 4.7 | | A/µs |
| $Q_i$ | Total input charge | $V_{DD}$=12 V; $I_D$=1.5 A; $V_{IN}$=5 V<br>$I_{gen}$=2.13 mA (see figure *Figure 7.*) | | 8.5 | | nC |
| **Source drain diode ($T_j$=25 °C, unless otherwise specified)** | | | | | | |
| $V_{SD}$(1) | Forward on voltage | $I_{SD}$=1.5 A; $V_{IN}$=0 V | | 0.8 | | V |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$=1.5 A; dI/dt=12 A/µs<br>$V_{DD}$=30 V; L=200 µH<br>(see test circuit, figure *Figure 5.*) | | 107 | | ns |
| $Q_{rr}$ | Reverse recovery charge | | | 37 | | µC |
| $I_{RRM}$ | Reverse recovery current | | | 0.7 | | A |
| **Protections (-40 °C < $T_j$ < 150 °C, unless otherwise specified)** | | | | | | |
| $I_{lim}$ | Drain current limit | $V_{IN}$=5 V; $V_{DS}$=13 V | 3.5 | 5 | 7 | A |
| $t_{dlim}$ | Step response current limit | $V_{IN}$=5 V; $V_{DS}$=13 V | | 10 | | µs |
| $T_{jsh}$ | Over temperature shutdown | | 150 | 175 | 200 | °C |
| $T_{jrs}$ | Over temperature reset | | 135 | | | °C |
| $I_{gf}$ | Fault sink current | $V_{IN}$=5 V; $V_{DS}$=13 V; $T_j$=$T_{jsh}$ | 10 | 15 | 20 | mA |
| $E_{as}$ | Single pulse avalanche energy | starting $T_j$=25µ°C; $V_{DD}$=24 V<br>$V_{IN}$=5 V $R_{gen}$=$R_{IN\ MIN}$=220 Ω; L=24 mH<br>(see figures *Figure 6.* & *Figure 8.*) | 100 | | | mJ |

1. Pulsed: Pulse duration = 300 µs, duty cycle 1.5 %

# 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. 100µA) flows into the input pin in order to supply the internal circuitry.

The device integrates:

- 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.
- 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 $T_{jsh}$.
- 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.
- 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.

**Figure 4. Switching time test circuit for resistive load**

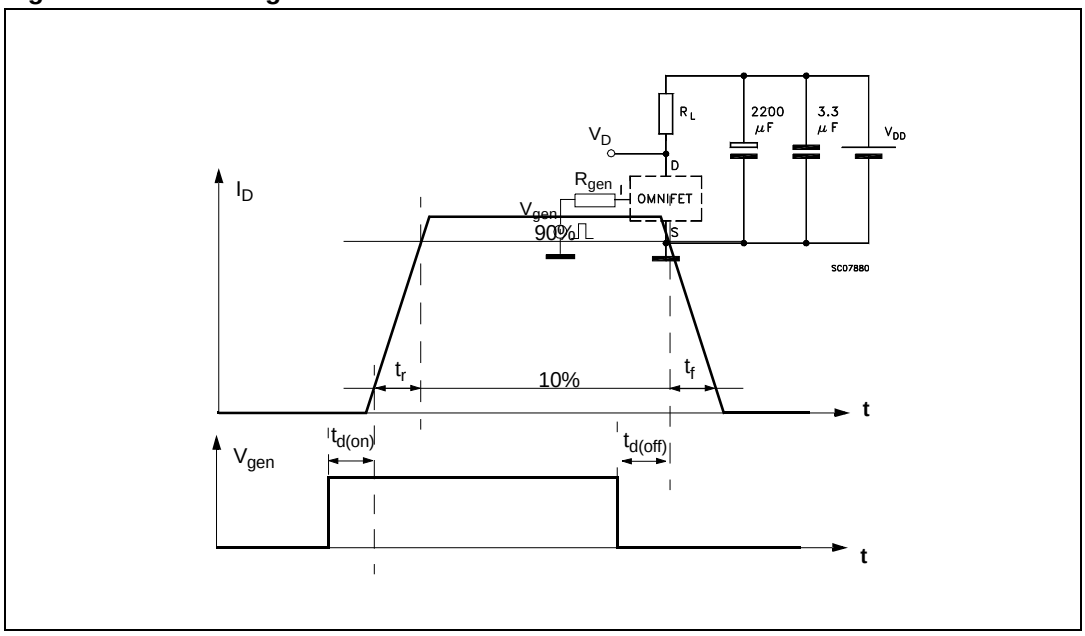



**Figure 5. Test circuit for diode recovery times**

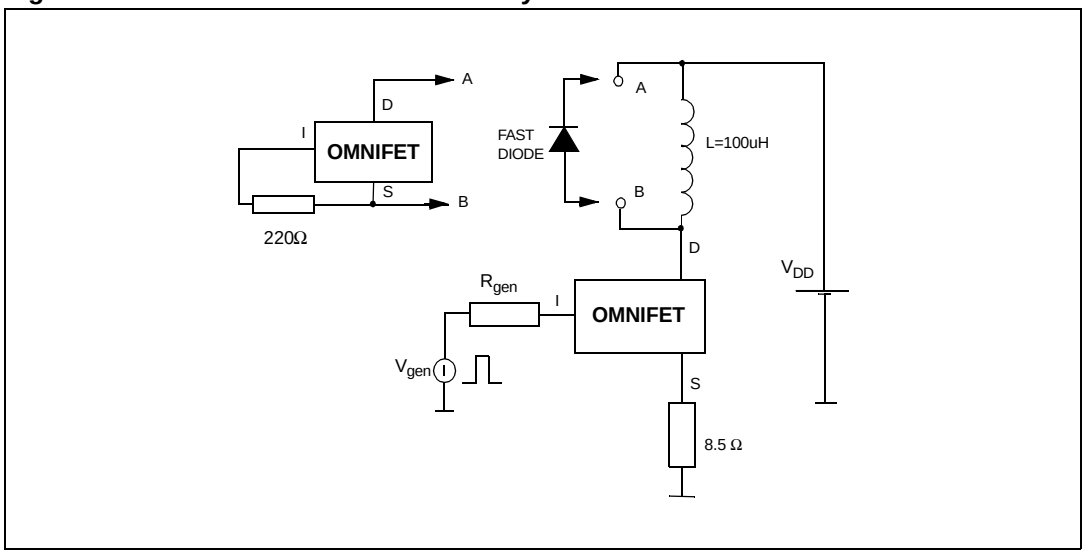


**Figure 6. Unclamped inductive load test circuits**

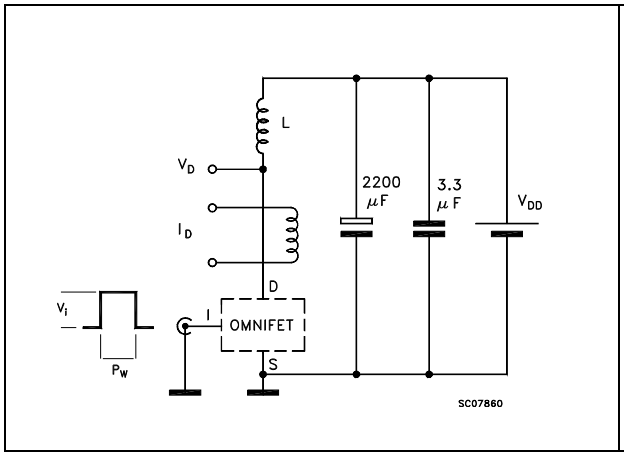



**Figure 7. Input charge test circuit**

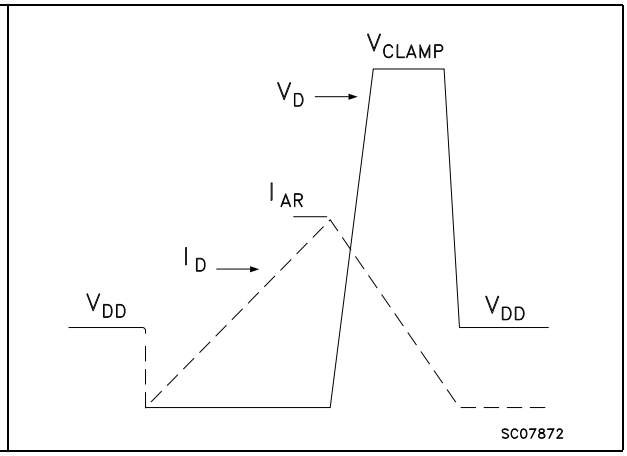
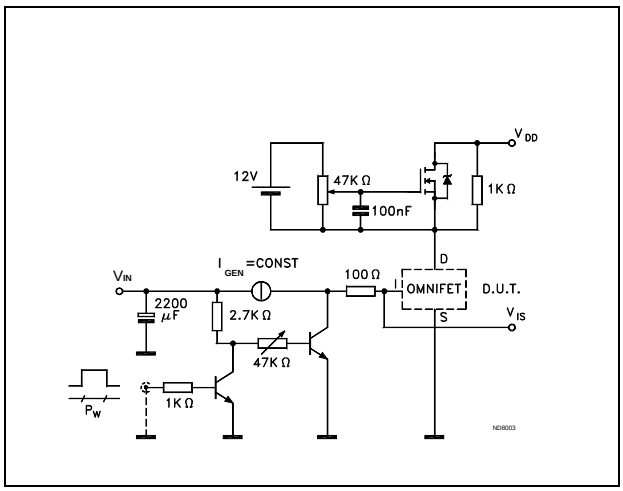



**Figure 8. Unclamped inductive waveforms**



## 3.1 Electrical characteristics curves

**Figure 9. Thermal impedance for DPAK/IPAK**

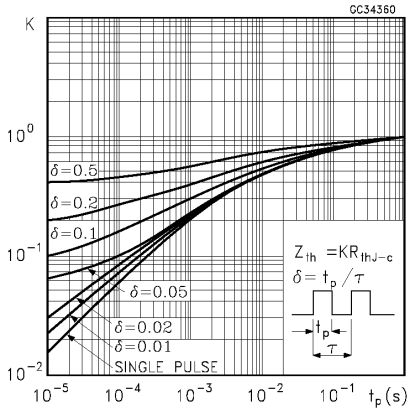



**Figure 10. Thermal impedance for SOT-223**

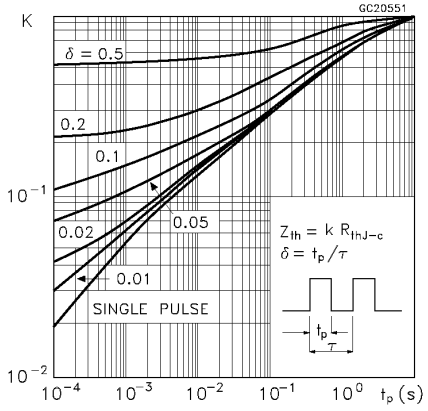



**Figure 11. Derating curve**

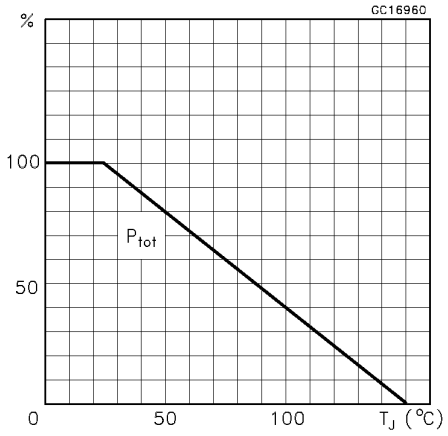



**Figure 12. Transconductance**

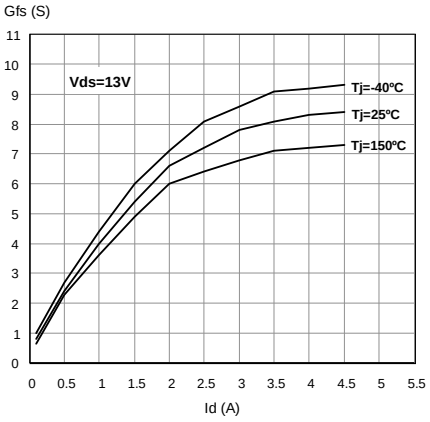



**Figure 13. Static drain-source on resistance vs input voltage (part 1/2)**

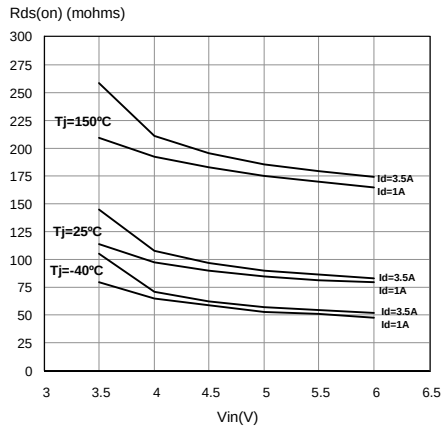



**Figure 14. Static drain-source on resistance vs input voltage (part 2/2)**

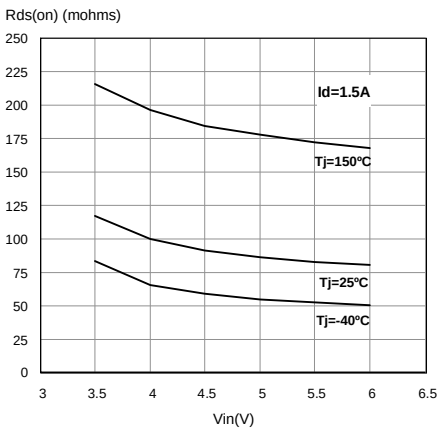


**Figure 15. Source-drain diode forward characteristics**

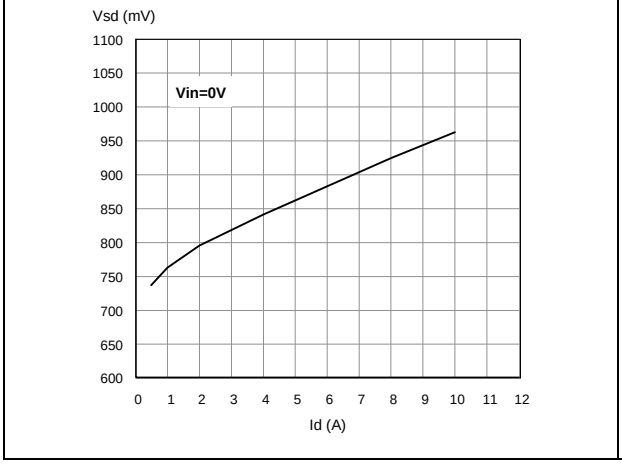



**Figure 16. Static drain source on resistance**

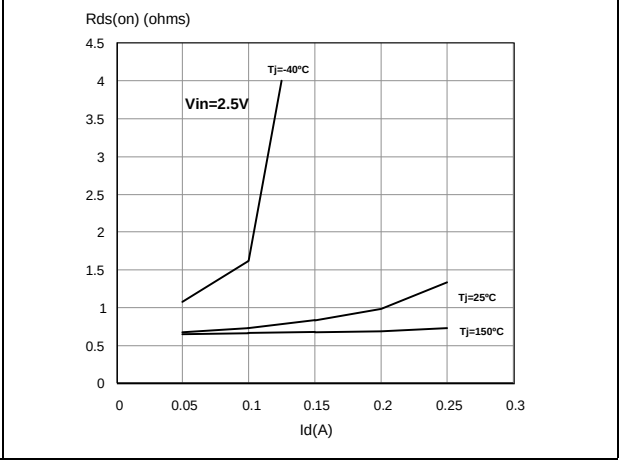



**Figure 17. Turn-on current slope (part 1/2)**

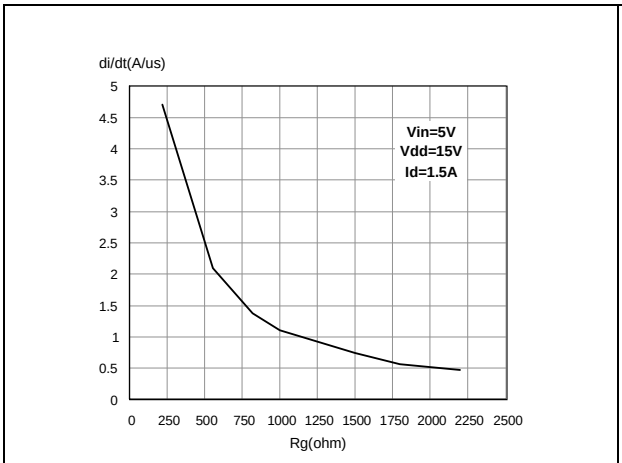



**Figure 18. Turn-on current slope (part 2/2)**

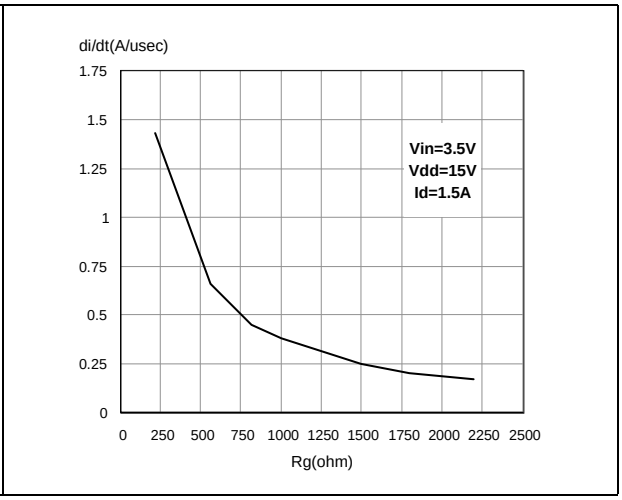



**Figure 19. Transfer characteristics**

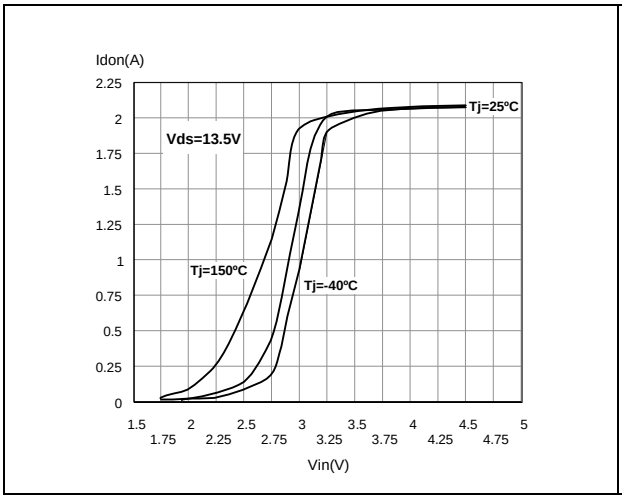



**Figure 20. Static drain-source on resistance vs Id**

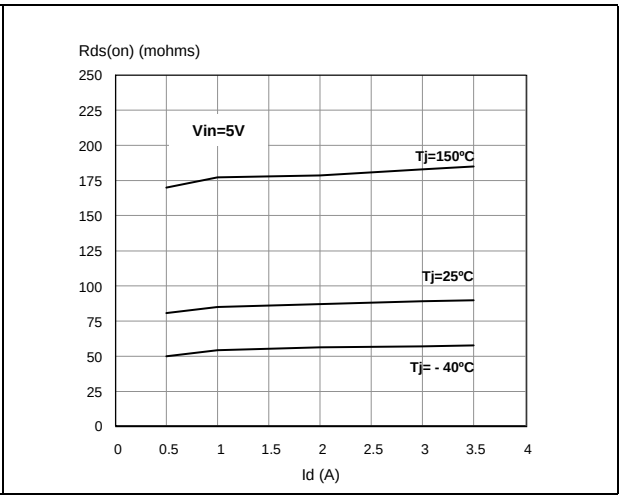


**Figure 21. Input voltage vs input charge**

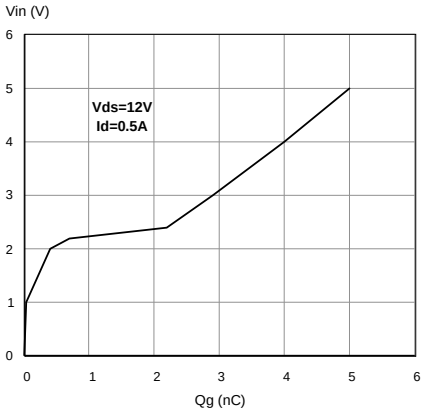



**Figure 22. Turn-off drain source voltage slope (part 1/2)**

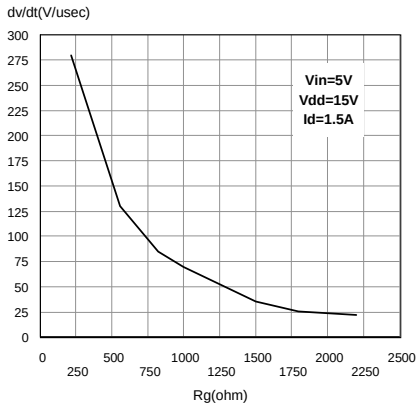



**Figure 23. Turn-off drain source voltage slope (part 2/2)**

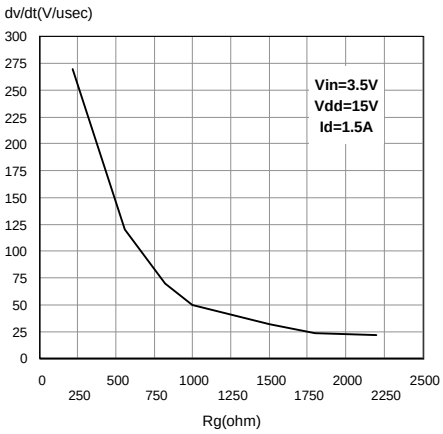



**Figure 24. Capacitance variations**

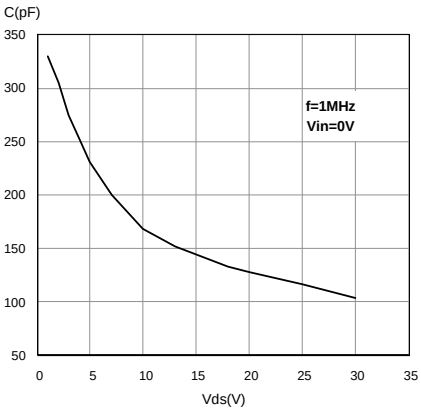



**Figure 25. Output characteristics**

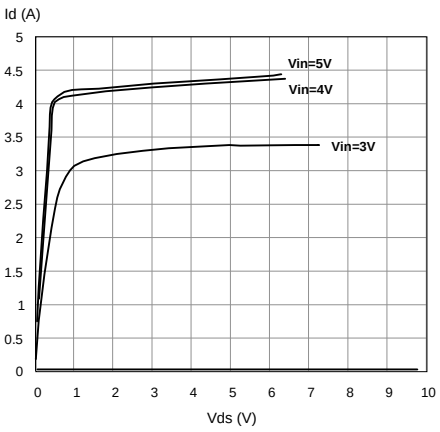



**Figure 26. Normalized on resistance vs temperature**

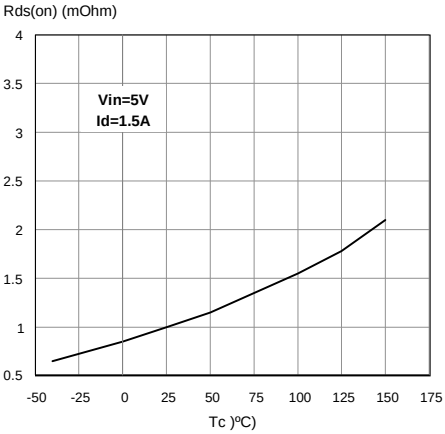


**Figure 27. Switching time resistive load (part 1/2)**

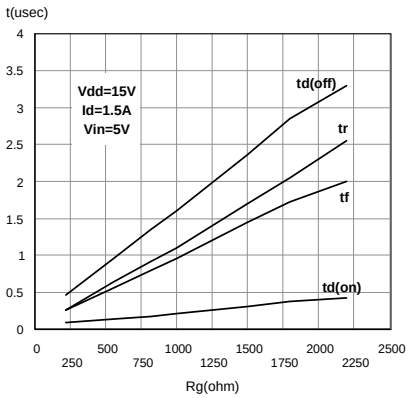



**Figure 28. Switching time resistive load (part 2/2)**

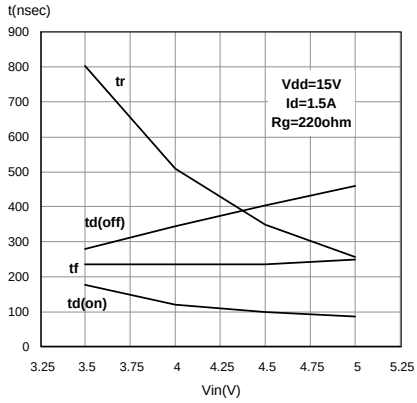



**Figure 29. Normalized input threshold voltage vs temperature**

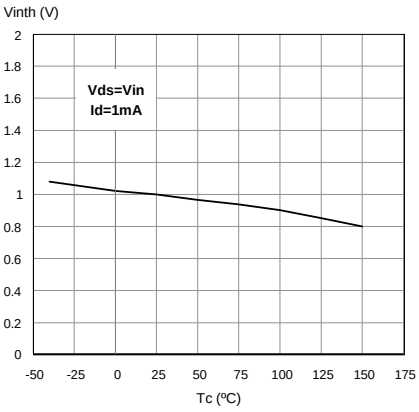



**Figure 30. Normalized current limit vs junction temperature**

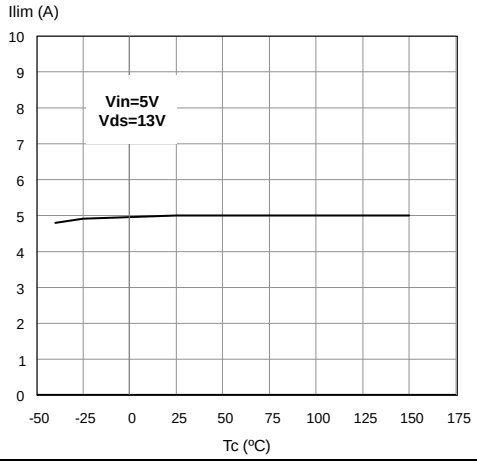
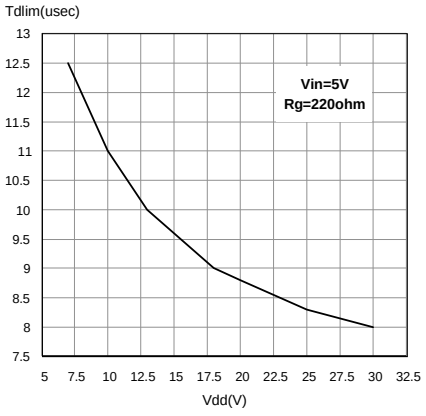



**Figure 31. Step response current limit**



# 4 Package and packing information

## 4.1 ECOPACK®

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

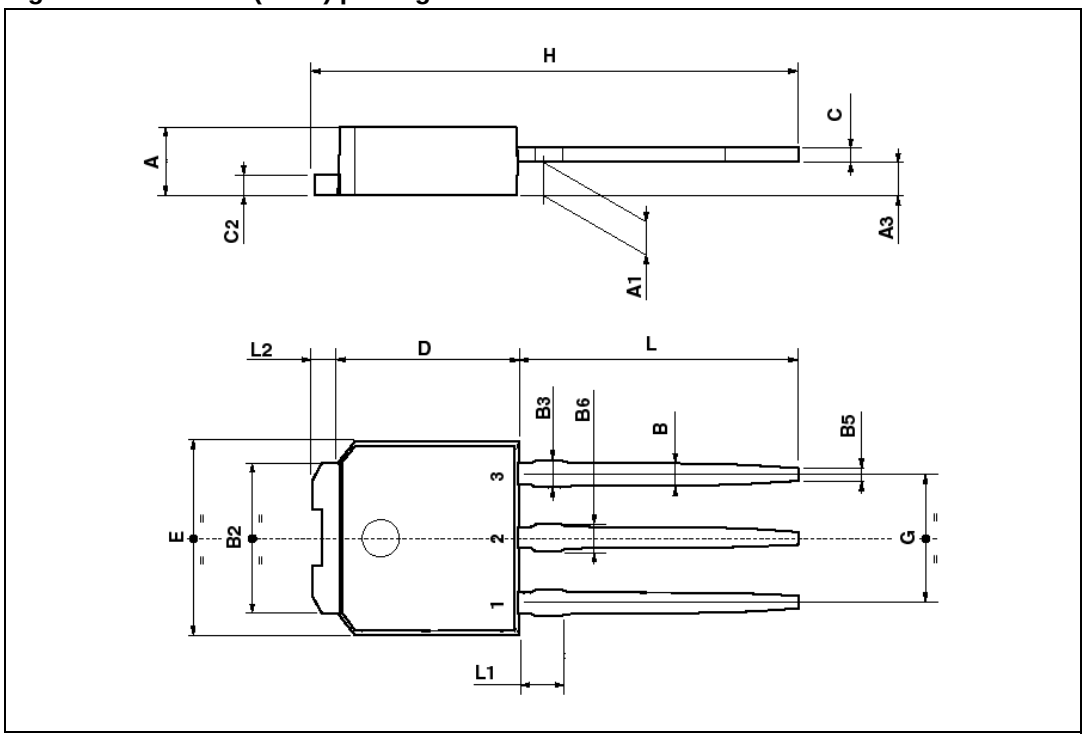
ECOPACK® is an ST trademark.

## 4.2 TO-251 (IPAK) mechanical data

**Table 5. TO-251 (IPAK) mechanical data**

| Symbol | millimeters | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 2.2 | | 2.4 |
| A1 | 0.9 | | 1.1 |
| A3 | 0.7 | | 1.3 |
| B | 0.64 | | 0.9 |
| B2 | 5.2 | | 5.4 |
| B3 | | | 0.85 |
| B5 | | 0.3 | |
| B6 | | | 0.95 |
| C | 0.45 | | 0.6 |
| C2 | 0.48 | | 0.6 |
| D | 6 | | 6.2 |
| E | 6.4 | | 6.6 |
| G | 4.4 | | 4.6 |
| H | 15.9 | | 16.3 |
| L | 9 | | 9.4 |
| L1 | 0.8 | | 1.2 |
| L2 | | 0.8 | 1 |

**Figure 32. TO-251 (IPAK) package dimensions**




## 4.3 TO-252 (DPAK) mechanical data

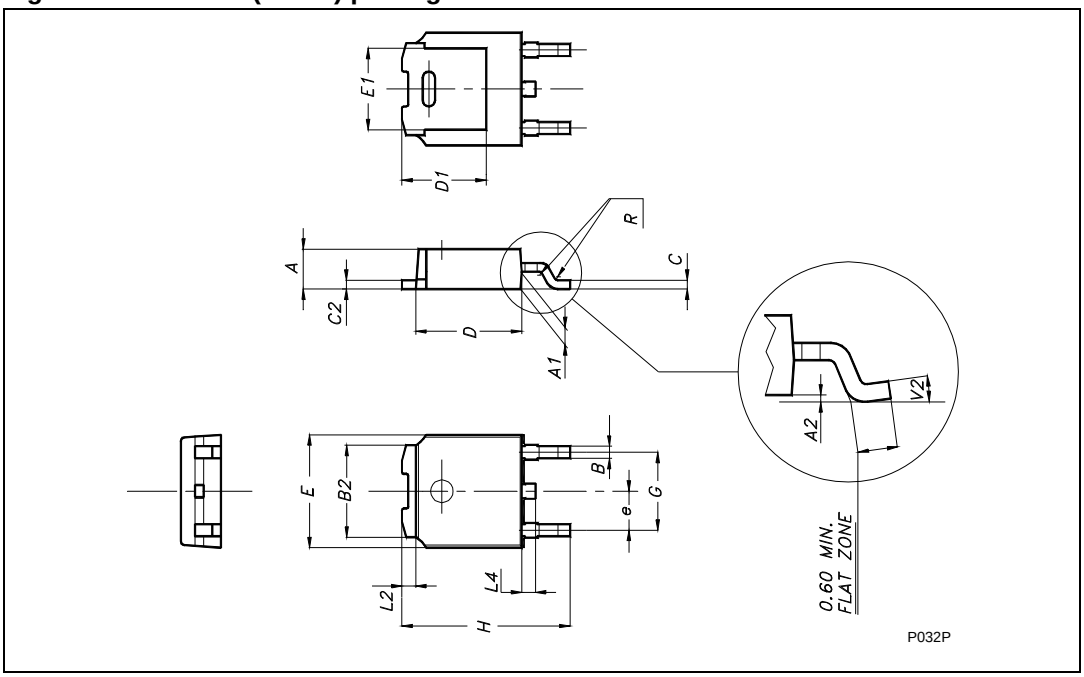
**Table 6. TO-252 (DPAK) mechanical data**

| Symbol | millimeters | | |
|---|---|---|---|
| | 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 |

**Table 6. TO-252 (DPAK) mechanical data (continued)**

| Symbol | millimeters | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| L2 | | 0.8 | |
| L4 | 0.60 | | 1.00 |
| R | | 0.2 | |
| V2 | 0° | 8° | |
| Package Weight | Gr. 0.29 | | |

**Figure 33. TO-252 (DPAK) package dimensions**




## 4.4 SOT-223 mechanical data

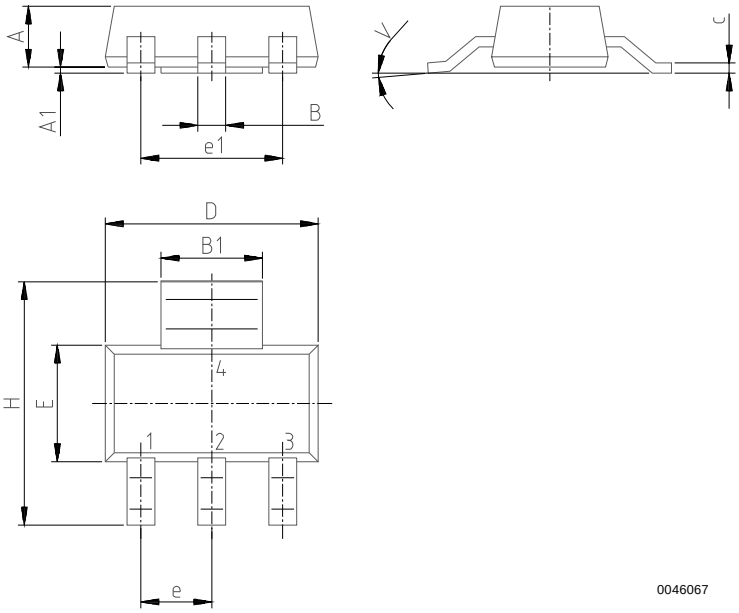
**Table 7. SOT-223 mechanical data**

| Symbol | millimeters | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | | | 1.8 |
| B | 0.6 | 0.7 | 0.85 |
| B1 | 2.9 | 3 | 3.15 |
| c | 0.24 | 0.26 | 0.35 |
| D | 6.3 | 6.5 | 6.7 |
| e | | 2.3 | |

**Table 7. SOT-223 mechanical data (continued)**

| Symbol | millimeters | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| e1 | | 4.6 | |
| E | 3.3 | 3.5 | 3.7 |
| H | 6.7 | 7 | 7.3 |
| V | | 10 (max) | |
| A1 | 0.02 | | 0.1 |

**Figure 34. SOT-223 package dimensions**




## 4.5 SO-8 mechanical data

**Table 8. SO-8 mechanical data**

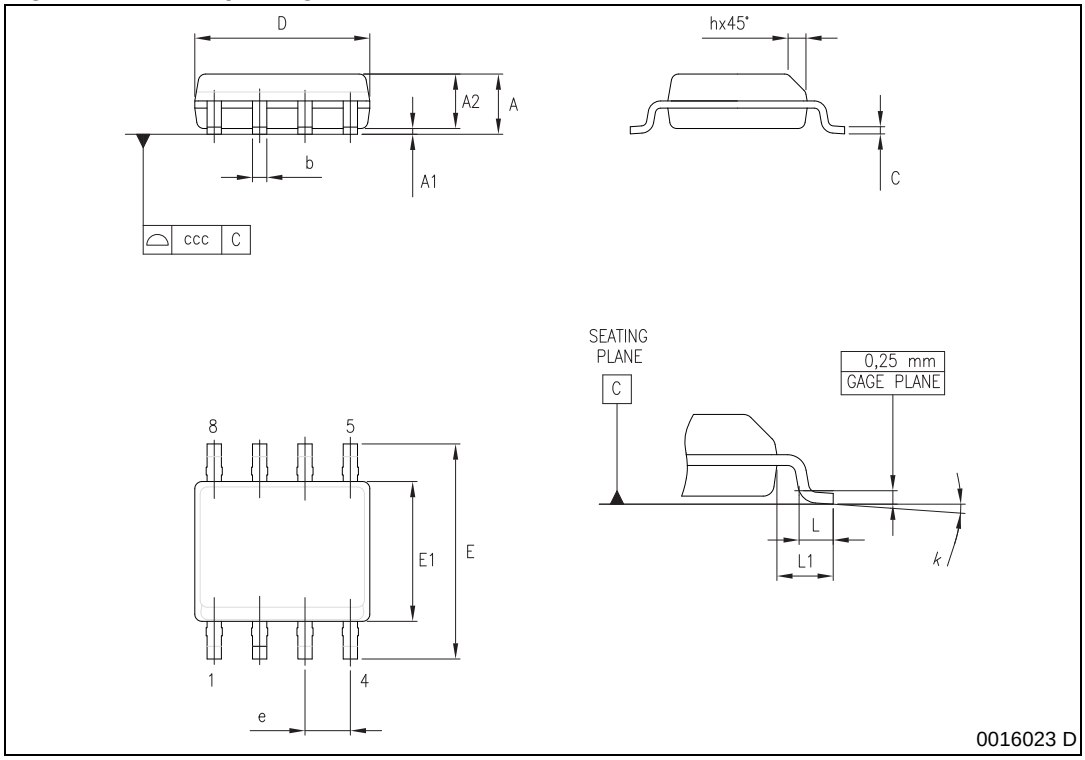
| Symbol | millimeters | | |
|---|---|---|---|
| | Min | Typ | Max |
| A | | | 1.75 |
| a1 | 0.1 | | 0.25 |
| a2 | | | 1.65 |
| a3 | 0.65 | | 0.85 |
| b | 0.35 | | 0.48 |
| A | | | 1.75 |
| A1 | 0.10 | | 0.25 |

**Table 8. SO-8 mechanical data (continued)**

| Symbol | millimeters | | |
|---|---|---|---|
| | Min | Typ | Max |
| A2 | 1.25 | | |
| b | 0.28 | | 0.48 |
| c | 0.17 | | 0.23 |
| D(1) | 4.80 | 4.90 | 5.00 |
| E | 5.80 | 6.00 | 6.20 |
| E1(2) | 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 |

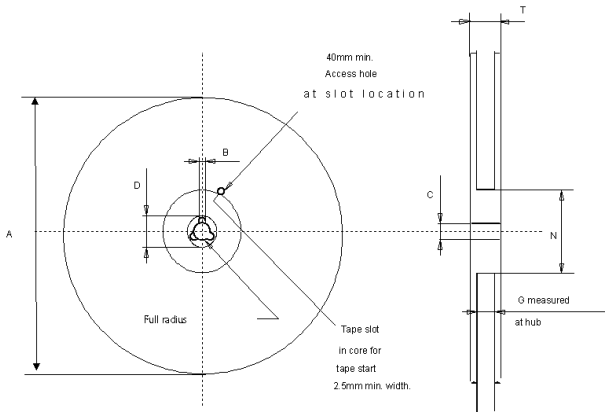
1. Dimension “D” does not include mold flash, protrusions or gate burrs. Mold flash, protrusions or gate burrs shall not exceed 0.15 mm in total (both side).
2. Dimension “E1” does not include interlead flash or protrusions. Interlead flash or protrusions shall not exceed 0.25 mm per side.

**Figure 35. SO-8 package dimensions**



## 4.6 SOT-223 packing information

**Figure 36. SOT-223 tape and reel shipment (suffix “TR”)**




**REEL DIMENSIONS**

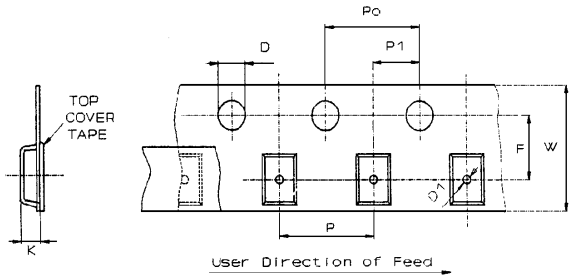
| | |
|---|---|
| **Base Q.ty** | 1000 |
| **Bulk Q.ty** | 1000 |
| **A (max)** | 330 |
| **B (min)** | 1.5 |
| **C (± 0.2)** | 13 |
| **F** | 20.2 |
| **G (+ 2 / -0)** | 12.4 |
| **N (min)** | 60 |
| **T (max)** | 18.4 |

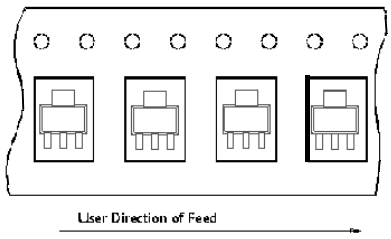
**TAPE DIMENSIONS**

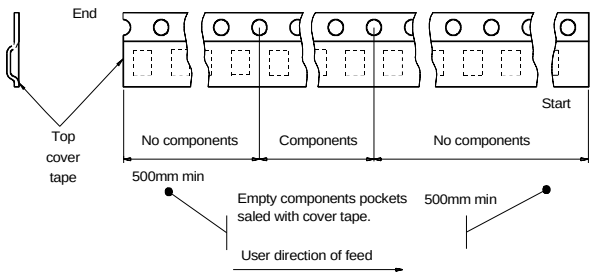
According to Electronic Industries Association (EIA) Standard 481 rev. A, Feb. 1986

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

All dimensions are in mm.

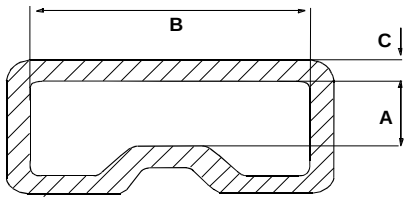


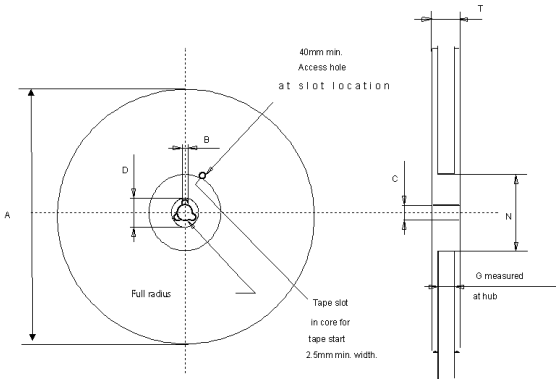
## 4.7 SO-8 packing information

**Figure 37. SO-8 tube shipment (no suffix)**




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

**Figure 38. SO-8 tape and reel shipment (suffix "TR")**




**REEL DIMENSIONS**

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

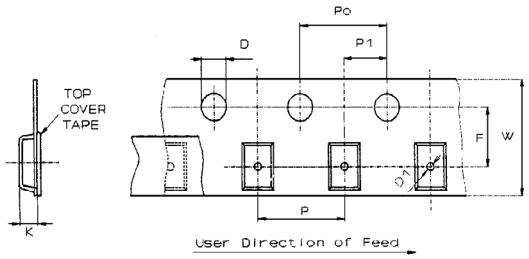
All dimensions are in mm.

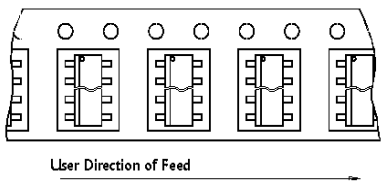
**TAPE DIMENSIONS**

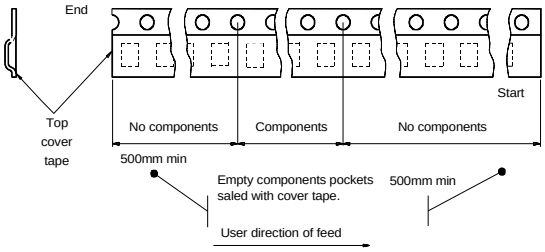
According to Electronic Industries Association (EIA) Standard 481 rev. A, Feb 1986

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

All dimensions are in mm.

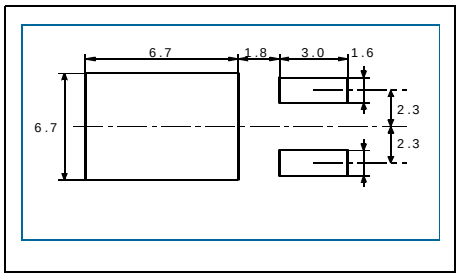


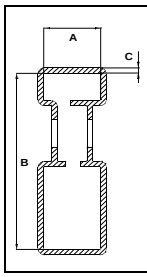



## 4.8 DPAK packing information

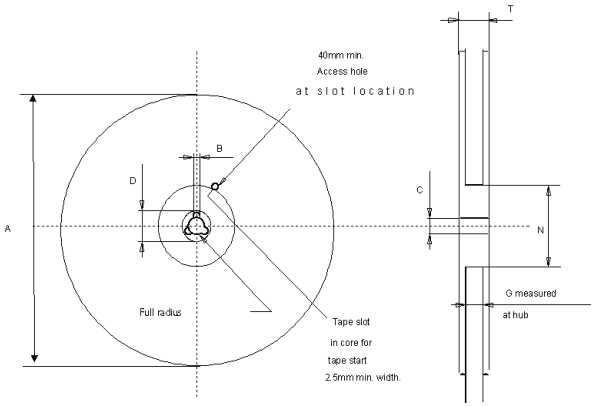
**Figure 39. DPAK footprint and tube shipment (no suffix)**




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

**Figure 40. DPAK tape and reel shipment (suffix "TR")**



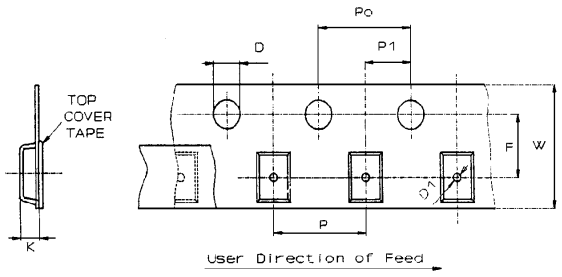

**REEL DIMENSIONS**

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

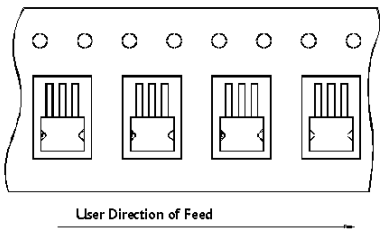
**TAPE DIMENSIONS**

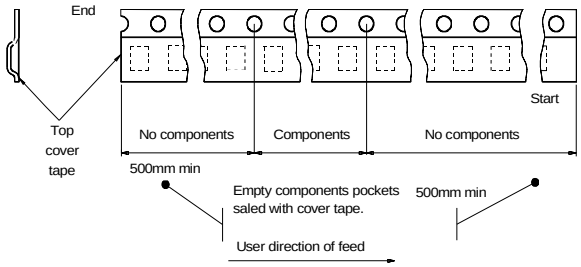
According to Electronic Industries Association (EIA) Standard 481 rev. A, Feb 1986

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



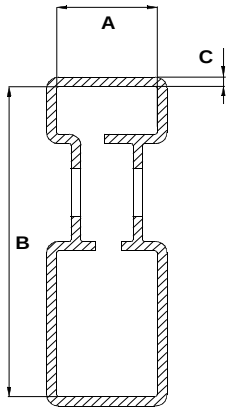

All dimensions are in mm.



## 4.9 IPAK packing information

**Figure 41. IPAK tube shipment (no suffix)**




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

All dimensions are in mm.

# 5 Revision history

**Table 9. Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 01-Feb-2003 | 1 | Initial Release |
| 27-Apr-2009 | 2 | Added *Table 1: Device summary on page 1*<br>Updated *Table 4: Package and packing information on page 16* |
| 05-Apr-2011 | 3 | *Table 2: Absolute maximum ratings*:<br>– $R_{IN\ MIN}$: changed unit from W to Ω<br>Inserted *Section 4.1: ECOPACK®* |
| 20-Sep-2013 | 4 | Updated Disclaimer. |

**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.**

**ST PRODUCTS ARE NOT DESIGNED OR AUTHORIZED FOR USE IN: (A) SAFETY CRITICAL APPLICATIONS SUCH AS LIFE SUPPORTING, ACTIVE IMPLANTED DEVICES OR SYSTEMS WITH PRODUCT FUNCTIONAL SAFETY REQUIREMENTS; (B) AERONAUTIC APPLICATIONS; (C) AUTOMOTIVE APPLICATIONS OR ENVIRONMENTS, AND/OR (D) AEROSPACE APPLICATIONS OR ENVIRONMENTS. WHERE ST PRODUCTS ARE NOT DESIGNED FOR SUCH USE, THE PURCHASER SHALL USE PRODUCTS AT PURCHASER’S SOLE RISK, EVEN IF ST HAS BEEN INFORMED IN WRITING OF SUCH USAGE, UNLESS A PRODUCT IS EXPRESSLY DESIGNATED BY ST AS BEING INTENDED FOR “AUTOMOTIVE, AUTOMOTIVE SAFETY OR MEDICAL” INDUSTRY DOMAINS ACCORDING TO ST PRODUCT DESIGN SPECIFICATIONS. PRODUCTS FORMALLY ESCC, QML OR JAN QUALIFIED ARE DEEMED SUITABLE FOR USE IN AEROSPACE BY THE CORRESPONDING GOVERNMENTAL AGENCY.**

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.



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**