**EN:** This Datasheet/Document is presented by the manufacturer.

Please visit our website for pricing and availability at www.hestore.hu.

# STW20NK50Z

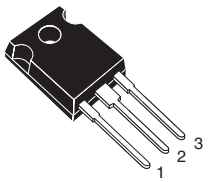
## N-channel 500 V, 0.23 Ω, 20 A SuperMESH™ Power MOSFET Zener-protected in TO-247 package

**Datasheet — production data**

## Features

| Order code | $V_{DSS}$ | $R_{DS(on)}$ max | $I_D$ | $P_W$ |
|---|---|---|---|---|
| STW20NK50Z | 500 V | < 0.27 Ω | 20 A | 190 W |

- Extremely high dv/dt capability
- 100% avalanche tested
- Gate charge minimized
- Very low intrinsic capacitance




**TO-247**

## Application

Switching applications

## Description

This device is an N-channel Zener-protected Power MOSFET developed using STMicroelectronics' SuperMESH™ technology, achieved through optimization of ST's well established strip-based PowerMESH™ layout. In addition to a significant reduction in on-resistance, this device is designed to ensure a high level of dv/dt capability for the most demanding applications.

**Figure 1. Internal schematic diagram**

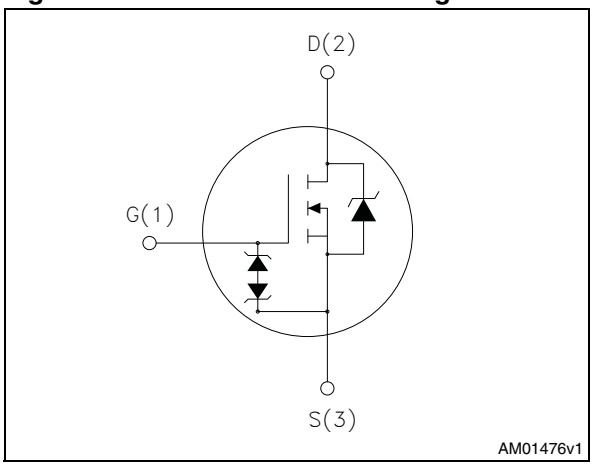



**Table 1. Device summary**

| Order code | Marking | Package | Packaging |
|---|---|---|---|
| STW20NK50Z | W20NK50Z | TO-247 | Tube |



This is information on a product in full production. www.st.com

# Contents

1 Electrical ratings . . . . . 3

2 Electrical characteristics . . . . . 4

2.1 Electrical characteristics (curves) . . . . . 6

3 Test circuits . . . . . 8

4 Package mechanical data . . . . . 9

5 Revision history . . . . . 11

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{DS}$ | Drain-source voltage | 500 | V |
| $V_{GS}$ | Gate-source voltage | ± 30 | V |
| $I_D$ | Drain current (continuous) at $T_C$ = 25 °C | 20 | A |
| $I_D$ | Drain current (continuous) at $T_C$ = 100 °C | 12.6 | A |
| $I_{DM}$ (1) | Drain current (pulsed) | 68 | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25 °C | 190 | W |
| | Derating factor | 1.52 | W/°C |
| ESD | Gate-source human body model (R=1.5 kΩ, C=100 pF) | 6 | kV |
| dv/dt (2) | Peak diode recovery voltage slope | 4.5 | V/ns |
| $T_{stg}$ | Storage temperature | -55 to 150 | °C |
| $T_j$ | Max operating junction temperature | 150 | °C |

1. Pulse width limited by safe operating area.
2. $I_{SD}$ ≤17 A, di/dt ≤ 200 A/µs, $V_{DS}$ peak ≤ $V_{(BR)DSS}$, $V_{DD}$ ≤ $V_{(BR)DSS}$, $T_j$ ≤ $T_{JMAX}$.

**Table 3. Thermal data**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{thj\text{-}case}$ | Thermal resistance junction-case max | 0.66 | °C/W |
| $R_{thj\text{-}amb}$ | Thermal resistance junction-ambient max | 50 | °C/W |

**Table 4. Avalanche characteristics**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $I_{AR}$ | Avalanche current, repetitive or not-repetitive (pulse width limited by Tj Max) | 17 | A |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_J$=25 °C, $I_D$=$I_{AR}$, $V_{DD}$=50 V) | 850 | mJ |

# 2 Electrical characteristics

($T_{CASE}$ = 25 °C unless otherwise specified)

**Table 5. On/off states**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $I_D$ =1 mA, $V_{GS}$ = 0 | 500 | | | V |
| $I_{DSS}$ | Zero gate voltage drain current ($V_{GS}$ = 0)<br>$V_{DS}$ = 500 V<br>$V_{DS}$ = 500 V, $T_C$ = 125 °C | | | | 1<br>50 | µA<br>µA |
| $I_{GSS}$ | Gate-body leakage current ($V_{DS}$ = 0) | $V_{GS}$ = ± 20 V | | | ± 10 | µA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 100 µA | 3 | 3.75 | 4.5 | V |
| $R_{DS(on)}$ | Static drain-source on-resistance | $V_{GS}$ = 10 V, $I_D$ = 8.5 A | | 0.23 | 0.27 | Ω |

**Table 6. Dynamic**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$ | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{DS}$ = 25 V, f = 1 MHz, $V_{GS}$ = 0 | - | 2600<br>328<br>72 | | pF<br>pF<br>pF |
| $C_{oss\ eq.}$ (1) | Equivalent output capacitance | $V_{DS}$ =0, $V_{DS}$ = 0 to 640 V | - | 187 | | pF |
| $t_{d(on)}$<br>$t_r$<br>$t_{d(off)}$<br>$t_f$ | Turn-on delay time<br>Rise time<br>Turn-off delay time<br>Fall time | $V_{DD}$ = 250 V, $I_D$ = 8.5 A, $R_G$ = 4.7 Ω, $V_{GS}$ = 10 V (see *Figure 14*) | - | 28<br>20<br>70<br>15 | | ns<br>ns<br>ns<br>ns |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$ | Total gate charge<br>Gate-source charge<br>Gate-drain charge | $V_{DD}$ = 400 V, $I_D$ = 17 A, $V_{GS}$ = 10 V (see *Figure 15*) | - | 85<br>15.5<br>42 | 119 | nC<br>nC<br>nC |

1. $C_{oss\ eq.}$ is defined as a constant equivalent capacitance giving the same charging time as $C_{oss}$ when $V_{DS}$ increases from 0 to 80% $V_{DSS}$.

**Table 7. Source drain diode**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{SD}$<br>$I_{SDM}$(1) | Source-drain current<br>Source-drain current (pulsed) | | - | | 20<br>68 | A<br>A |
| $V_{SD}$(2) | Forward on voltage | $I_{SD}$ = 17 A, $V_{GS}$ = 0 | - | | 1.6 | V |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_{SD}$ = 17 A,<br>di/dt = 100 A/µs<br>$V_R$ = 100 V<br>(see *Figure 16*) | - | 355<br>3.90<br>22 | | ns<br>µC<br>A |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_{SD}$ = 17 A,<br>di/dt = 100 A/µs<br>$V_R$ = 100 V, Tj = 150 °C<br>(see *Figure 16*) | - | 440<br>5.72<br>26 | | ns<br>µC<br>A |

1. Pulsed: pulse duration = 300 µs, duty cycle 1.5%
2. Pulse width limited by safe operating area.

**Table 8. Gate-source Zener diode**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $BV_{GSO}$ | Gate-source breakdown voltage | Igs=± 1mA (open drain) | 30 | - | | V |

The built-in back-to-back Zener diodes have specifically been designed to enhance not only the device's ESD capability, but also to make them safely absorb possible voltage transients that may occasionally be applied from gate to source. In this respect the Zener voltage is appropriate to achieve an efficient and cost-effective intervention to protect the device's integrity. These integrated Zener diodes thus avoid the usage of external components.

## 2.1 Electrical characteristics (curves)

**Figure 2. Safe operating area**

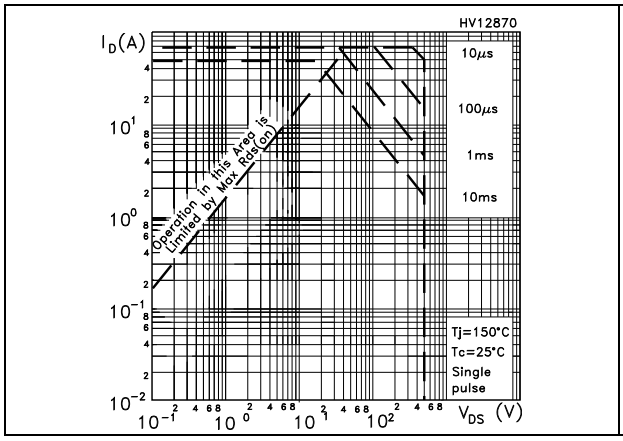



**Figure 3. Thermal impedance**

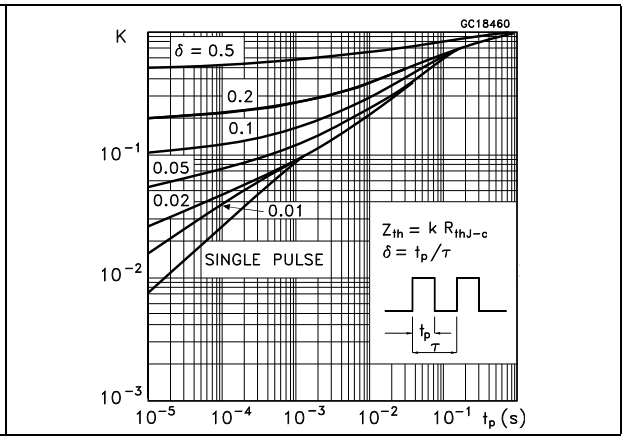



**Figure 4. Output characteristics**

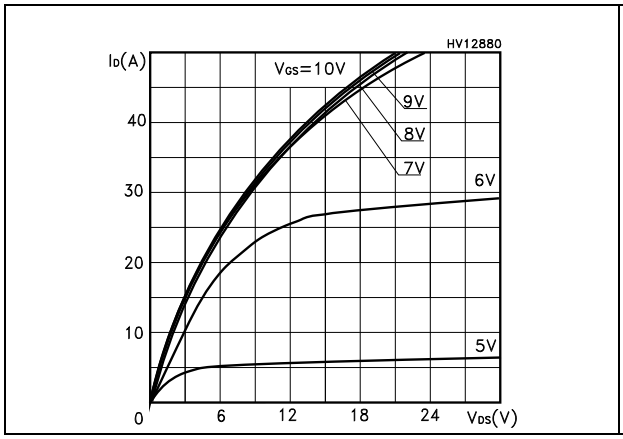



**Figure 5. Transfer characteristics**

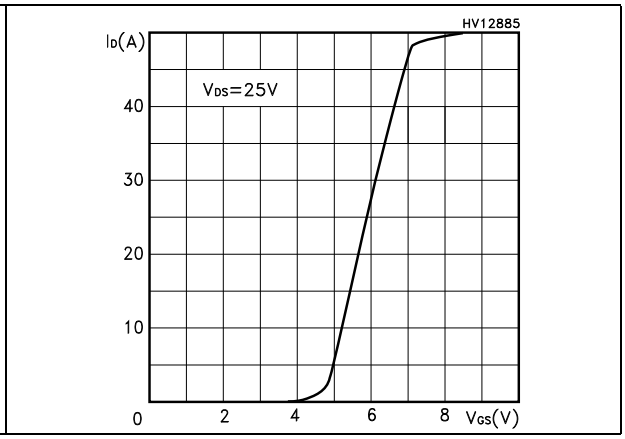



**Figure 6. Normalized $B_{VDSS}$ vs temperature**

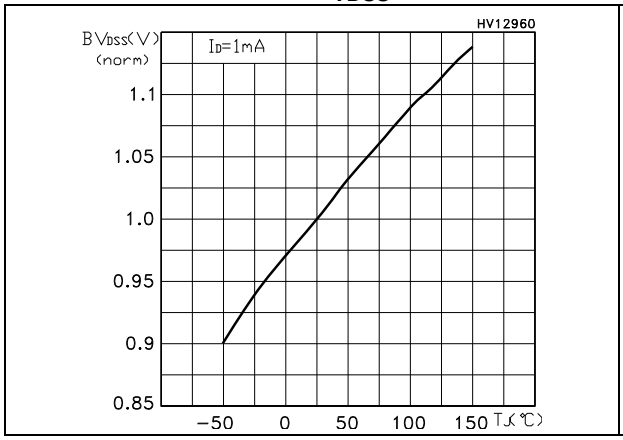



**Figure 7. Static drain-source on-resistance**

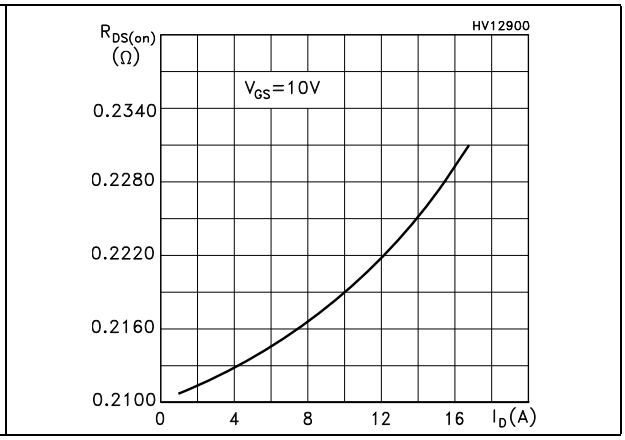


**Figure 8. Gate charge vs gate-source voltage**

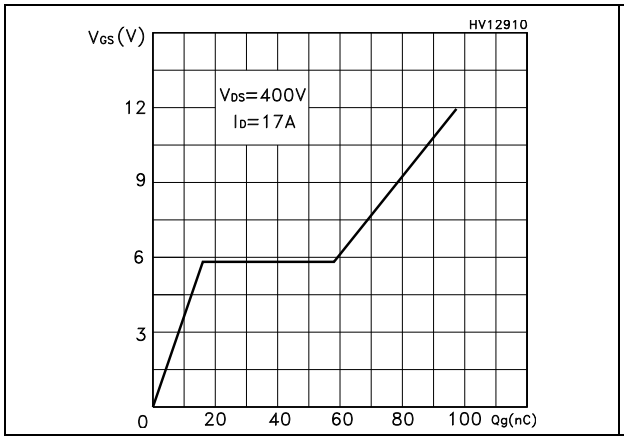



**Figure 9. Capacitance variations**

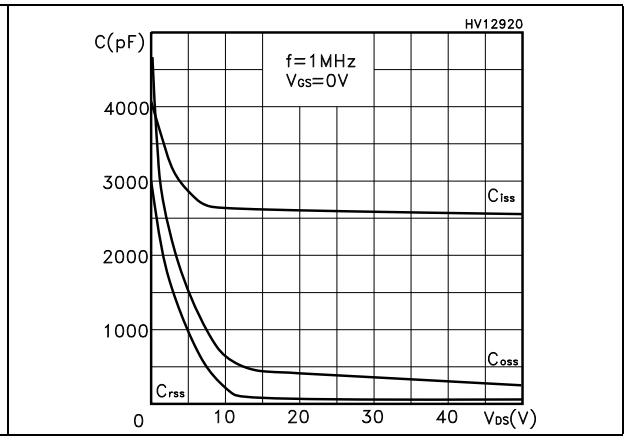



**Figure 10. Normalized gate threshold voltage vs temperature**

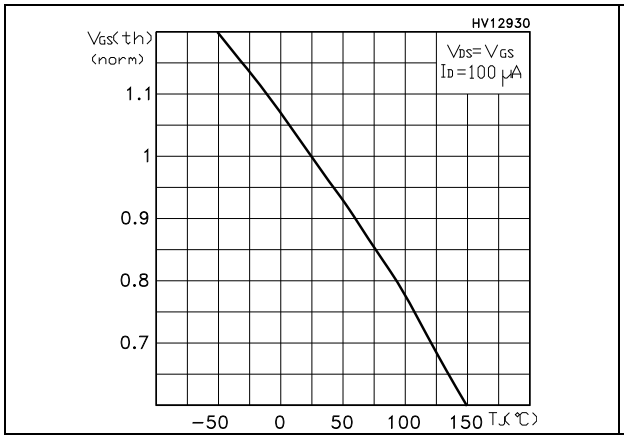



**Figure 11. Normalized on-resistance vs temperature**

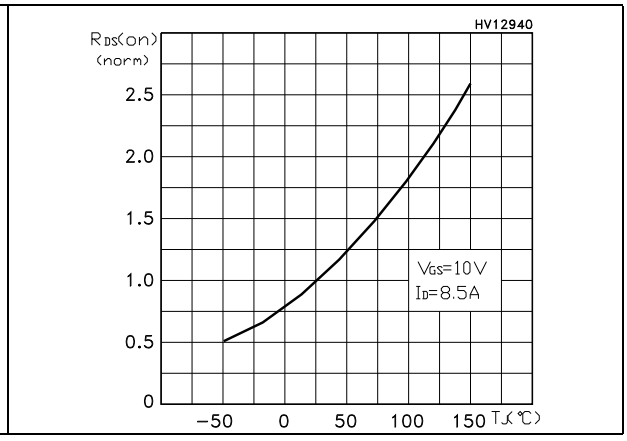



**Figure 12. Maximum avalanche energy vs temperature**

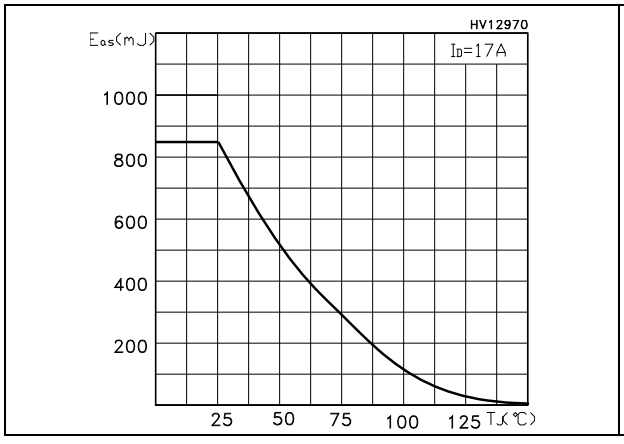
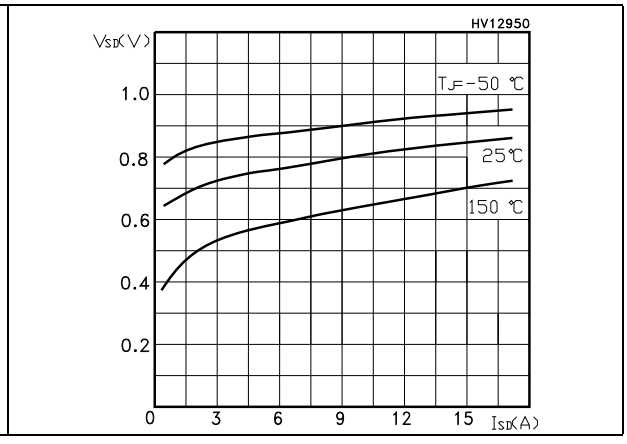



**Figure 13. Source-drain diode forward characteristic**



# 3 Test circuits

**Figure 14. Switching times test circuit for resistive load**

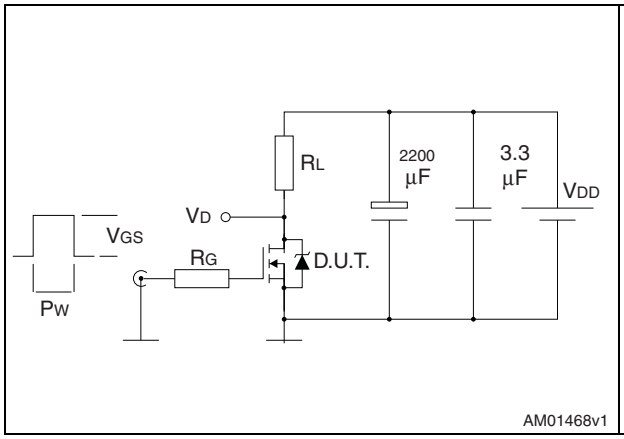



**Figure 15. Gate charge test circuit**

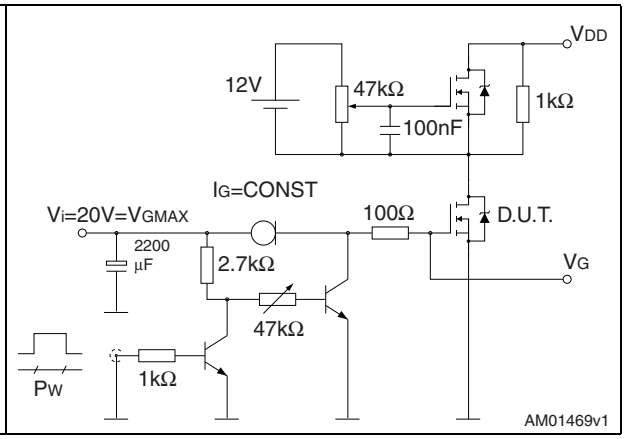



**Figure 16. Test circuit for inductive load switching and diode recovery times**

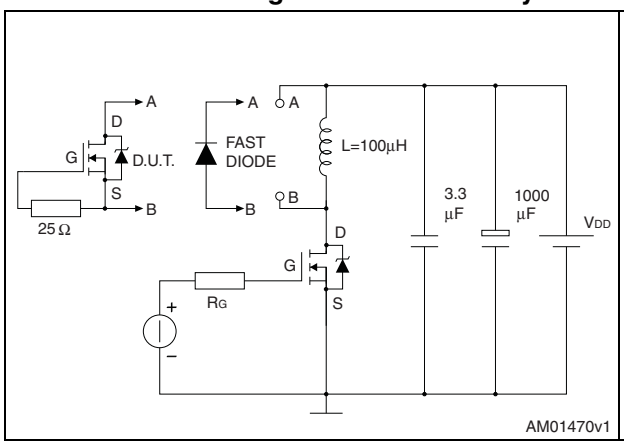



**Figure 17. Unclamped inductive load test circuit**

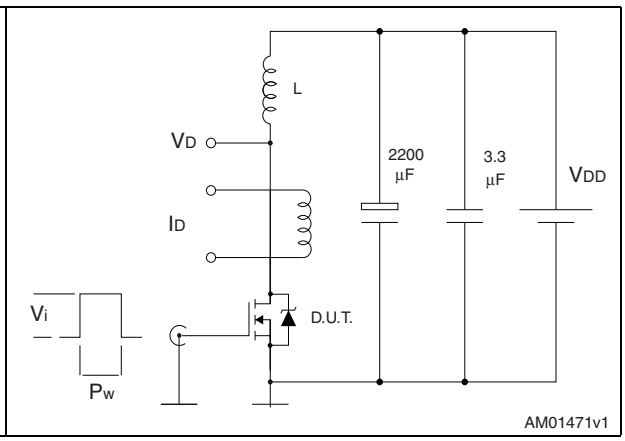



**Figure 18. Unclamped inductive waveform**

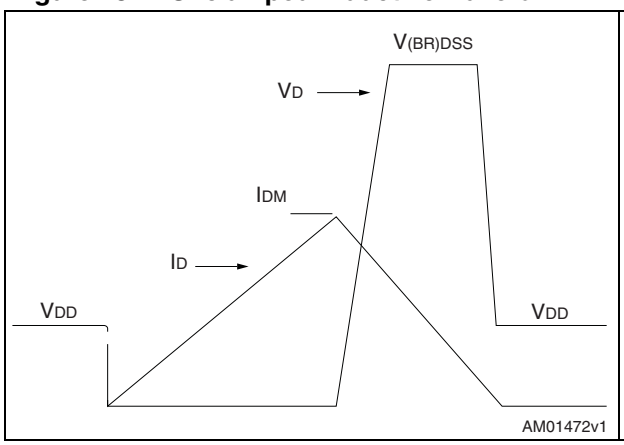
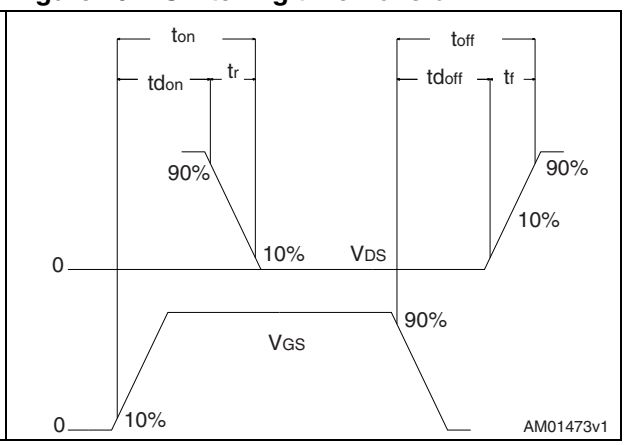



**Figure 19. Switching time waveform**



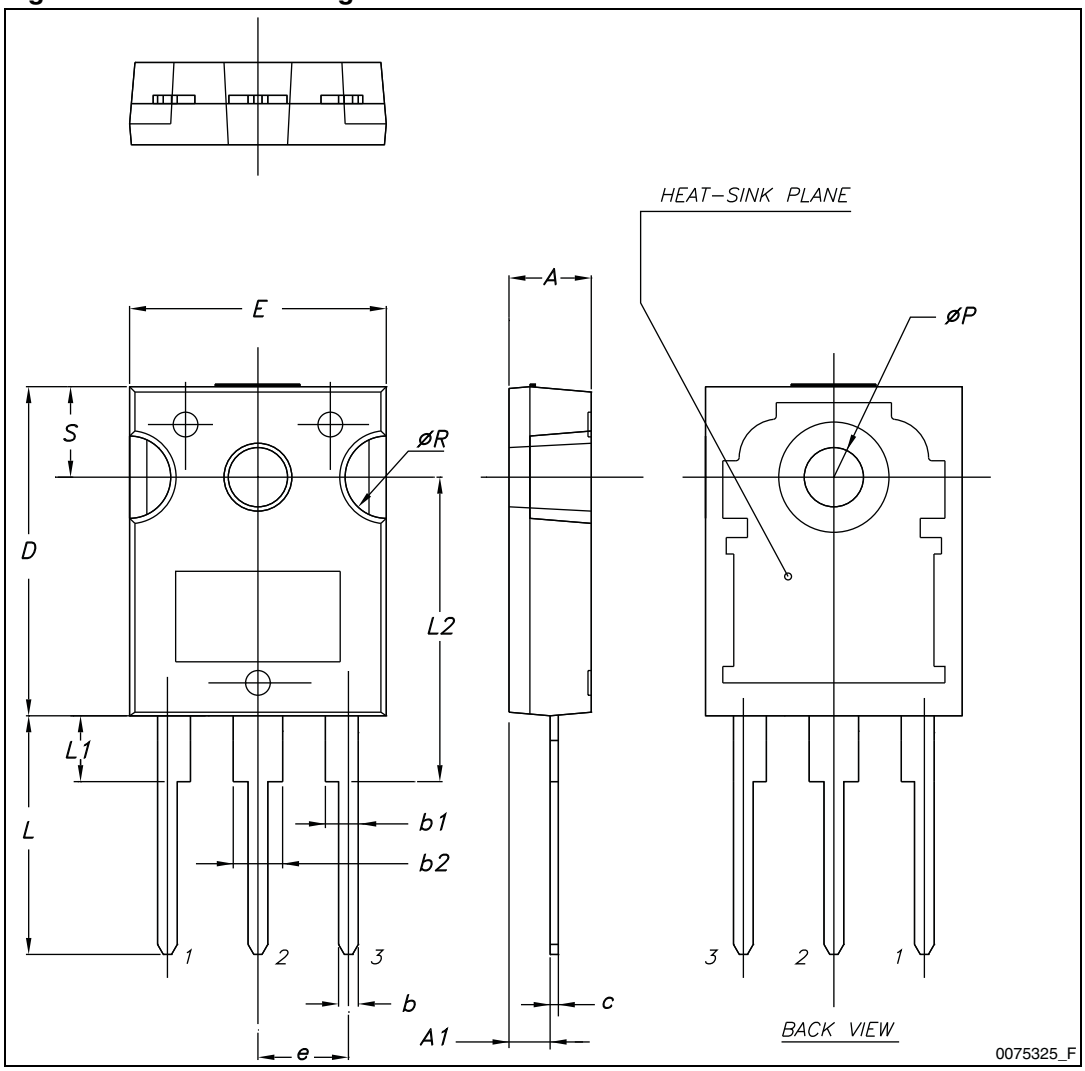
# 4 Package mechanical data

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.

**Table 9. TO-247 mechanical data**

| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 4.85 | | 5.15 |
| A1 | 2.20 | | 2.60 |
| b | 1.0 | | 1.40 |
| b1 | 2.0 | | 2.40 |
| b2 | 3.0 | | 3.40 |
| c | 0.40 | | 0.80 |
| D | 19.85 | | 20.15 |
| E | 15.45 | | 15.75 |
| e | | 5.45 | |
| L | 14.20 | | 14.80 |
| L1 | 3.70 | | 4.30 |
| L2 | | 18.50 | |
| ∅P | 3.55 | | 3.65 |
| ∅R | 4.50 | | 5.50 |
| S | | 5.50 | |

**Figure 20. TO-247 drawing**



# 5 Revision history

Table 10. Document revision history

| Date | Revision | Changes |
|---|---|---|
| 05-Apr-2012 | 1 | First release. |

**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 TWO AUTHORIZED ST REPRESENTATIVES, 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.

© 2012 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**