



## N-channel 60 V, 0.22 $\Omega$ typ., 38 A STripFET™ II Power MOSFET in a D<sup>2</sup>PAK package

Datasheet — production data

### Features

| Order code  | V <sub>DS</sub> | R <sub>DS(on)</sub><br>max | I <sub>D</sub> |
|-------------|-----------------|----------------------------|----------------|
| STB45NF06T4 | 60 V            | 0.028 $\Omega$             | 38 A           |

- Typical R<sub>DS(on)</sub> = 0.022  $\Omega$
- Exceptional dv/dt capability
- 100% avalanche tested
- Standard threshold drive

### Applications

- Switching applications

### Description

This Power MOSFET has been developed using STMicroelectronics' unique STripFET process, which is specifically designed to minimize input capacitance and gate charge. This renders the device suitable for use as primary switch in advanced high-efficiency isolated DC-DC converters for telecom and computer applications, and applications with low gate charge driving requirements.

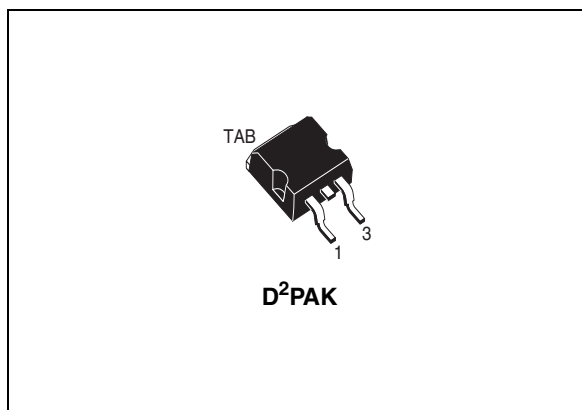


Figure 1. Internal schematic diagram

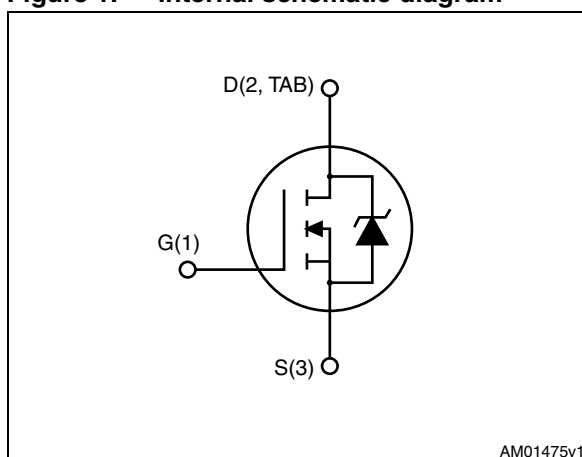


Table 1. Device summary

| Order code  | Marking | Package            | Packaging     |
|-------------|---------|--------------------|---------------|
| STB45NF06T4 | B45NF06 | D <sup>2</sup> PAK | Tape and reel |

# Contents

|          |   |           |
|----------|---|-----------|
| <b>1</b> | <b>Electrical ratings</b> .....           | <b>3</b>  |
| <b>2</b> | <b>Electrical characteristics</b> .....   | <b>4</b>  |
| 2.1      | Electrical characteristics (curves) ..... | 6         |
| <b>3</b> | <b>Test circuits</b> .....                | <b>8</b>  |
| <b>4</b> | <b>Package mechanical data</b> .....      | <b>9</b>  |
| <b>5</b> | <b>Packaging mechanical data</b> .....    | <b>12</b> |
| <b>6</b> | <b>Revision history</b> .....             | <b>14</b> |

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol         | Parameter   | Value       | Unit                |
|----------------|---|-------------|---------------------|
| $V_{DS}$       | Drain-source voltage  | 60          | V                   |
| $V_{DGR}$      | Drain-gate voltage ( $R_{GS}=20\text{ k}\Omega$ )               | 60          | V                   |
| $V_{GS}$       | Gate-source voltage   | $\pm 20$    | V                   |
| $I_D$          | Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$  | 38          | A                   |
| $I_D$          | Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$ | 26          | A                   |
| $I_{DM}^{(1)}$ | Drain current (pulsed)  | 152         | A                   |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ }^\circ\text{C}$           | 80          | W                   |
|                | Derating factor   | 0.53        | W/ $^\circ\text{C}$ |
| $dv/dt^{(2)}$  | Peak diode recovery voltage slope                               | 7           | V/ns                |
| $T_{stg}$      | Storage temperature   | - 65 to 175 | $^\circ\text{C}$    |
| $T_j$          | Max. operating junction temperature                             | 175         | $^\circ\text{C}$    |

1. Pulse width limited by safe operating area

2.  $I_{SD} \leq 38\text{ A}$ ,  $di/dt \leq 300\text{ A}/\mu\text{s}$ ;  $V_{DS(\text{peak})} < V_{(BR)DSS}$ ,  $V_{DD}=80\% V_{(BR)DSS}$

**Table 3. Thermal data**

| Symbol                     | Parameter                               | Value | Unit                      |
|----------------------------|---|-------|---------------------------|
| $R_{thj\text{-case}}$      | Thermal resistance junction-case max    | 1.88  | $^\circ\text{C}/\text{W}$ |
| $R_{thj\text{-amb}}^{(1)}$ | Thermal resistance junction-ambient max | 35    | $^\circ\text{C}/\text{W}$ |

1. When mounted on 1 inch<sup>2</sup> FR-4, 2 Oz copper board.

**Table 4. Avalanche characteristics**

| Symbol   | Parameter  | Value | Unit |
|----------|--|-------|------|
| $I_{AR}$ | Avalanche current, repetitive or not repetitive (pulse width limited by $T_{j\text{max}}$ )                        | 38    | A    |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_J = 25\text{ }^\circ\text{C}$ , $I_D = I_{AR}$ ; $V_{DD}=50\text{ V}$ ) | 135   | mJ   |

## 2 Electrical characteristics

( $T_C = 25\text{ °C}$  unless otherwise specified).

**Table 5. On /off states**

| Symbol        | Parameter  | Test conditions  | Min. | Typ.  | Max.      | Unit                           |
|---------------|--|--|------|-------|-----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage                   | $I_D = 250\text{ mA}$ , $V_{GS} = 0$                                     | 60   |       |           | V                              |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = 60\text{ V}$<br>$V_{DS} = 60\text{ V}$ , $T_C = 125\text{ °C}$ |      |       | 1<br>10   | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$     | Gate-body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 20\text{ V}$   |      |       | $\pm 100$ | nA                             |
| $V_{GS(th)}$  | Gate threshold voltage                           | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                       | 2    | 3     | 4         | V                              |
| $R_{DS(on)}$  | Static drain-source on-resistance                | $V_{GS} = 10\text{ V}$ , $I_D = 19\text{ A}$                             |      | 0.022 | 0.028     | $\Omega$                       |

**Table 6. Dynamic**

| Symbol                              | Parameter   | Test conditions  | Min. | Typ.              | Max. | Unit           |
|-------------------------------------|---|--|------|-------------------|------|----------------|
| $g_{fs}^{(1)}$                      | Forward transconductance  | $V_{DS} > I_{D(on)} * R_{DS(on)max}$ , $I_D = 19\text{ A}$               |      | 24                |      | S              |
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$ | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{DS} = 25\text{ V}$ , $f = 1\text{ MHz}$ ,<br>$V_{GS} = 0$            | -    | 1730<br>215<br>63 | -    | pF<br>pF<br>pF |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$       | Total gate charge<br>Gate-source charge<br>Gate-drain charge            | $V_{DD} = 48\text{ V}$ , $I_D = 38\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$ | -    | 43<br>9<br>15     | 58   | ns<br>ns<br>ns |

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

**Table 7. Switching times**

| Symbol                         | Parameter   | Test conditions   | Min. | Typ.           | Max. | Unit           |
|--------------------------------|---|---|------|----------------|------|----------------|
| $t_{d(on)}$<br>$t_r$           | Turn-on delay time<br>Voltage rise time               | $V_{DD} = 30\text{ V}$ , $I_D = 19\text{ A}$ ,<br>$R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 14</a> )    | -    | 20<br>100      | -    | ns<br>ns       |
| $t_{d(off)}$<br>$t_f$          | Turn-off delay time<br>Fall time                      |   | -    | 50<br>20       | -    | ns<br>ns       |
| $t_{d(off)}$<br>$t_f$<br>$t_c$ | Off-voltage rise time<br>Fall time<br>Cross-over time | $V_{clamp} = 48\text{ V}$ , $I_D = 38\text{ A}$ ,<br>$R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 16</a> ) | -    | 45<br>42<br>60 | -    | ns<br>ns<br>ns |

**Table 8. Source drain diode**

| Symbol          | Parameter                     | Test conditions  | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|--|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |  | -    |      | 38   | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |  | -    |      | 152  | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 38 \text{ A}, V_{GS} = 0$                        | -    |      | 1.5  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 38 \text{ A}, di/dt = 100 \text{ A}/\mu\text{s}$ | -    | 95   |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       | $V_{DD} = 100 \text{ V}, T_j = 150 \text{ }^\circ\text{C}$ | -    | 260  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      | (see <a href="#">Figure 16</a> )                           | -    | 5.5  |      | A             |

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

2. Pulse width limited by safe operating area.

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area

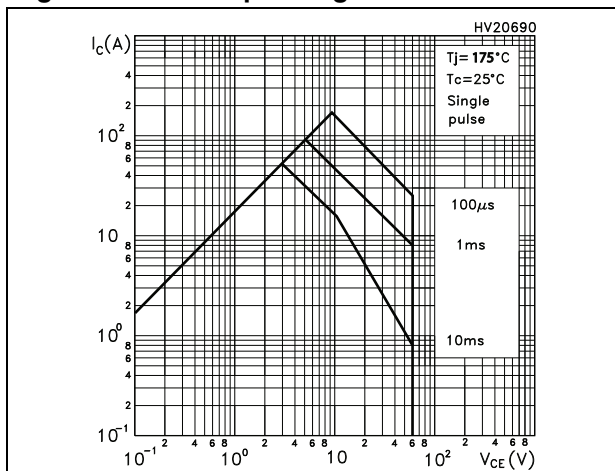


Figure 3. Thermal impedance

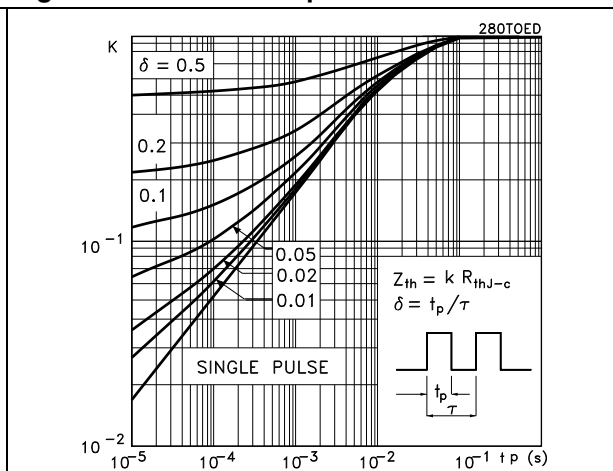


Figure 4. Output characteristics

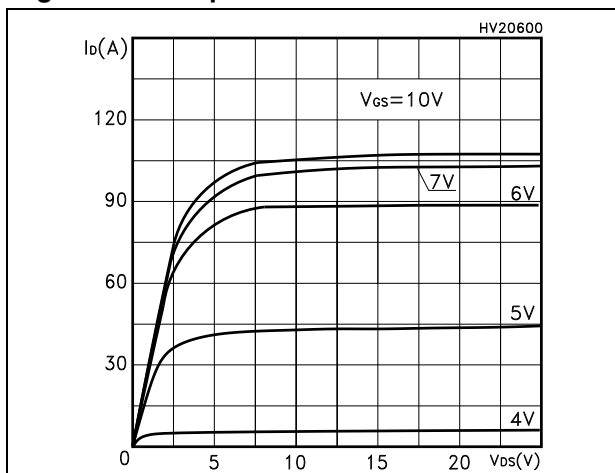


Figure 5. Transfer characteristics

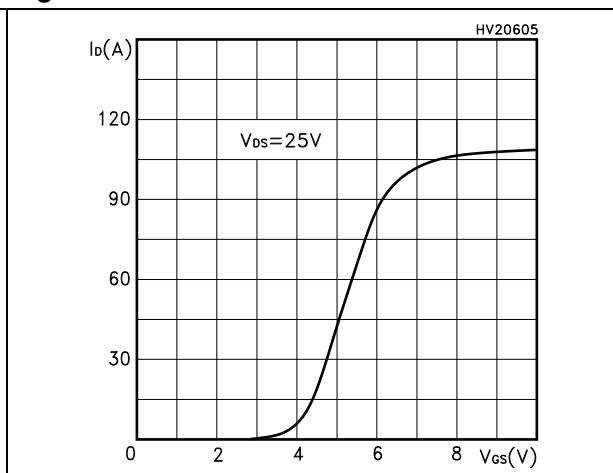


Figure 6. Transconductance

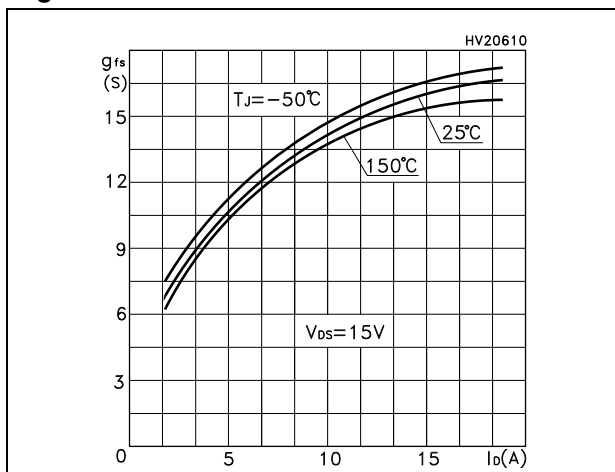


Figure 7. Static drain-source on-resistance

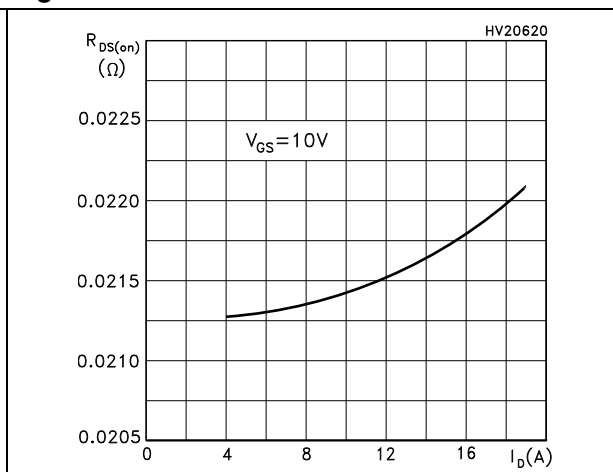


Figure 8. Gate charge vs gate-source voltage Figure 9. Capacitance variations

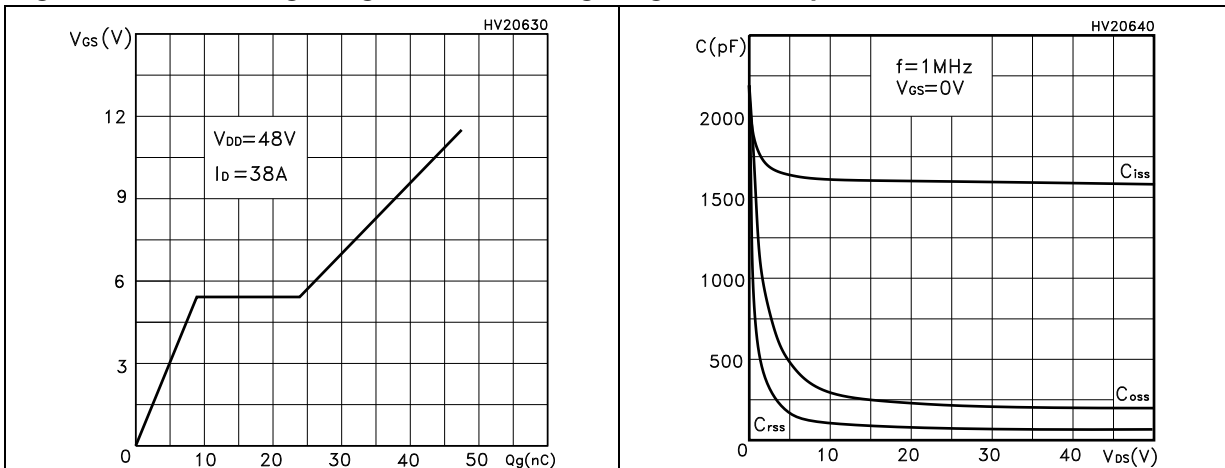


Figure 10. Normalized gate threshold voltage vs temperature Figure 11. Normalized on-resistance vs temperature

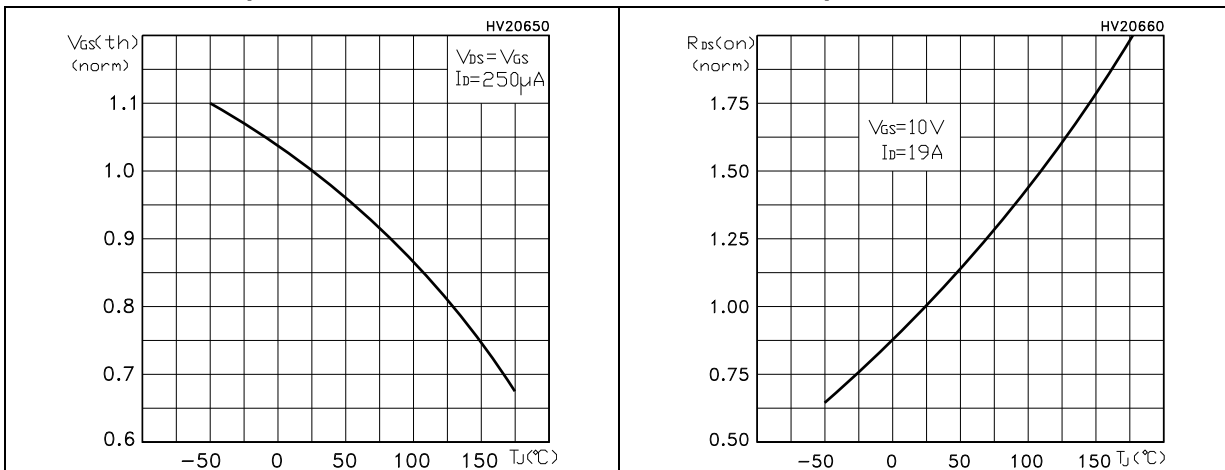
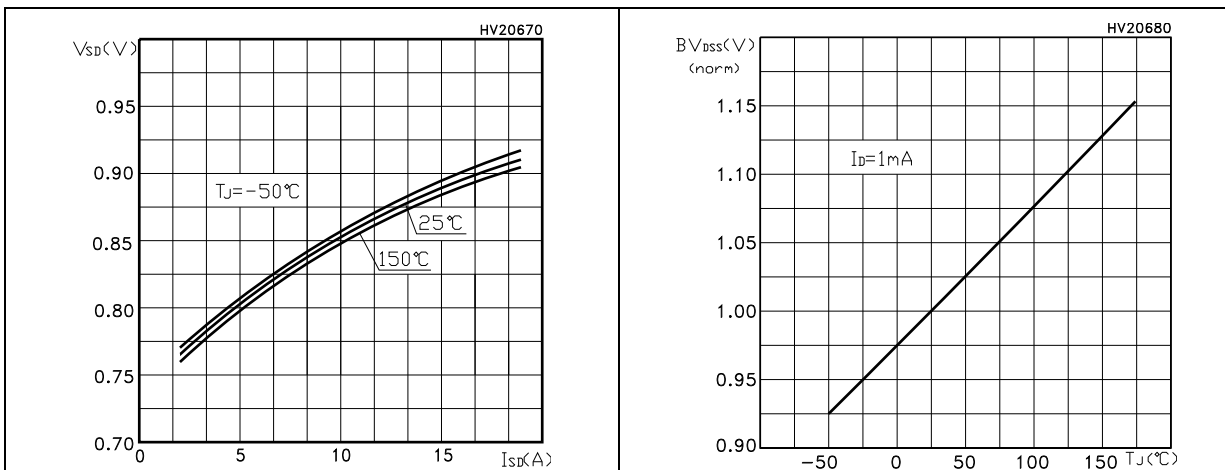
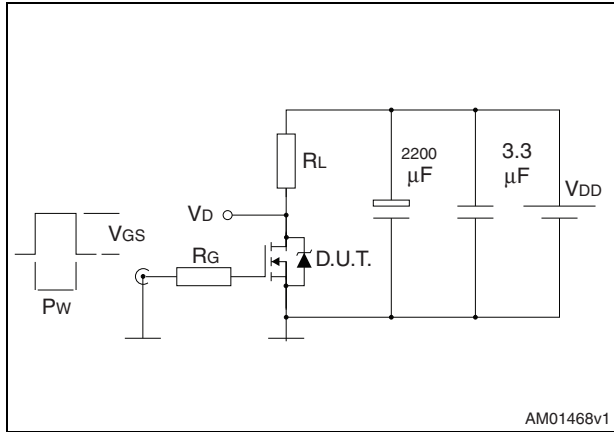


Figure 12. Source-drain diode forward characteristics Figure 13. Normalized  $B_{V_{DS}}$  vs temperature

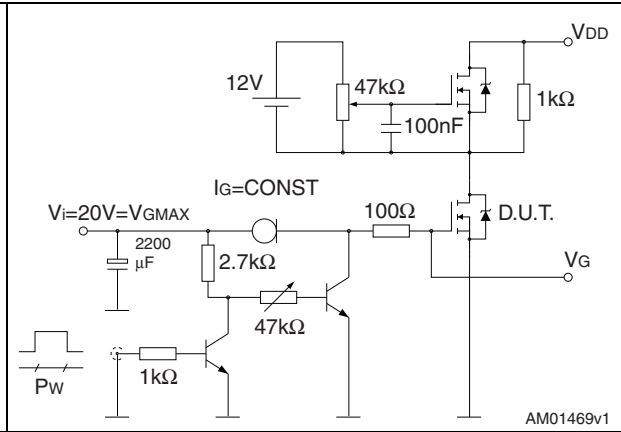


### 3 Test circuits

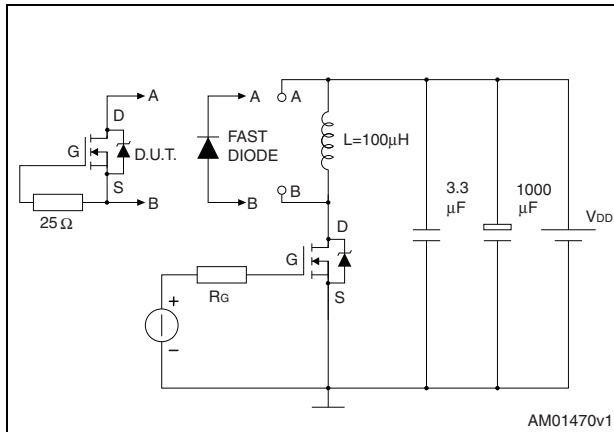
**Figure 14. Switching times test circuit for resistive load**



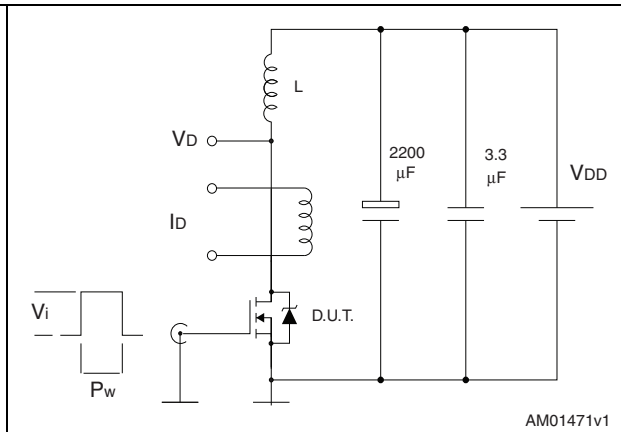
**Figure 15. Gate charge test circuit**



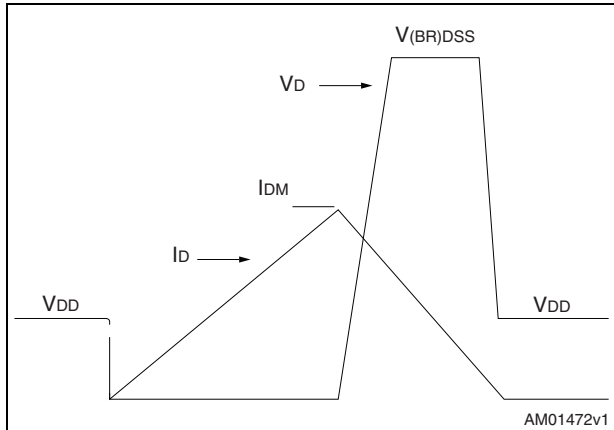
**Figure 16. Test circuit for inductive load switching and diode recovery times**



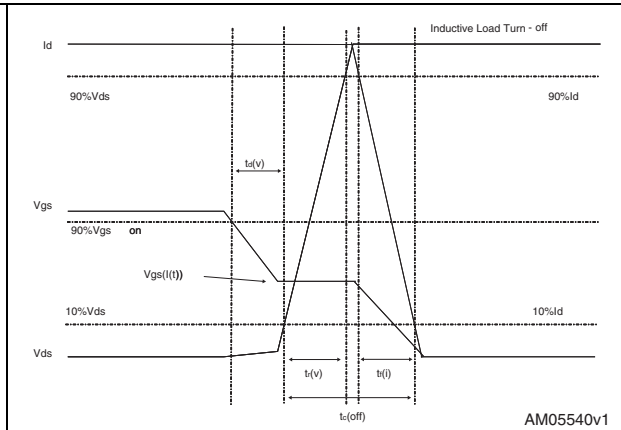
**Figure 17. Unclamped inductive load test circuit**



**Figure 18. Unclamped inductive waveform**



**Figure 19. Switching time waveform**





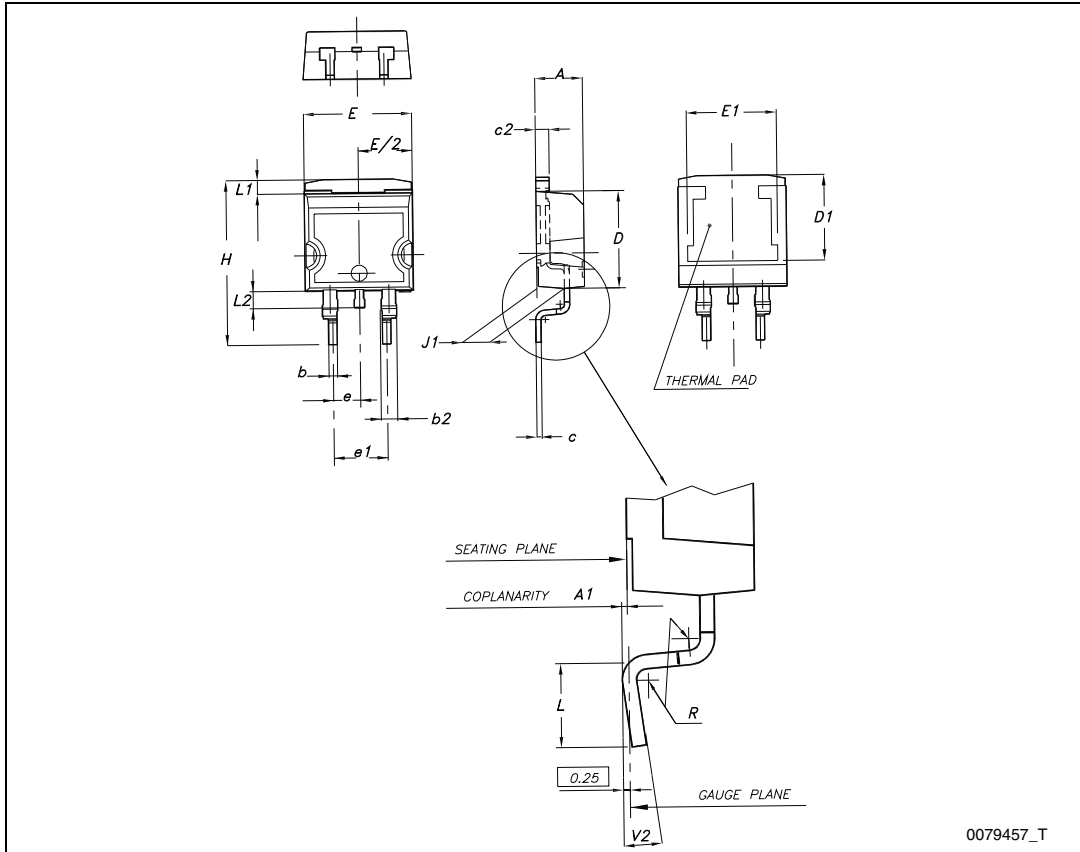
## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<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.

Table 9. D<sup>2</sup>PAK (TO-263) mechanical data

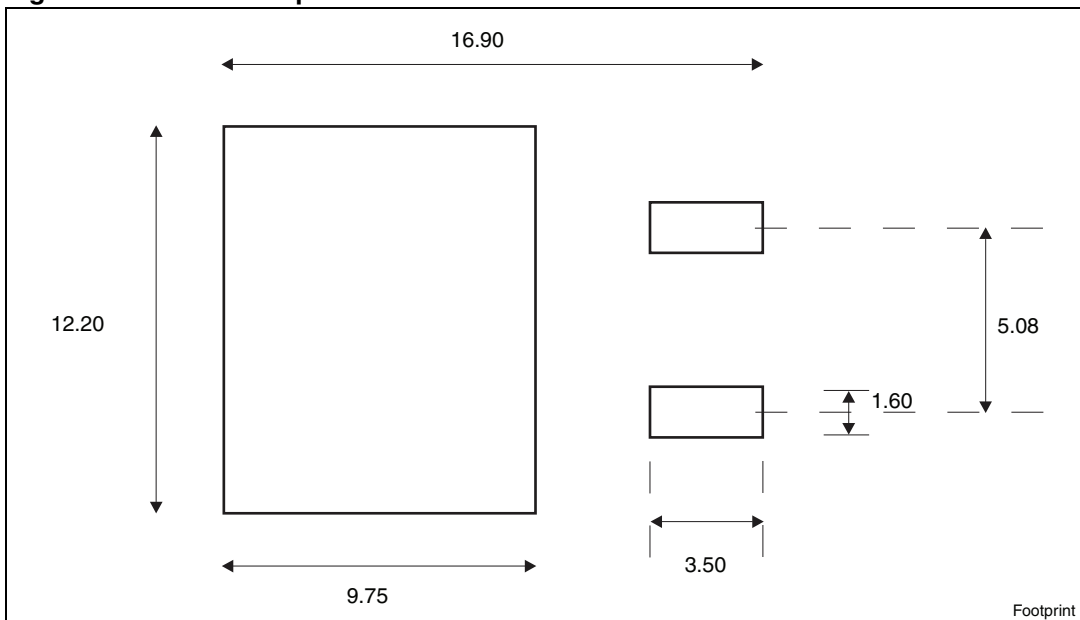
| Dim. | mm   |      |       |
|------|------|------|-------|
|      | Min. | Typ. | Max.  |
| A    | 4.40 |      | 4.60  |
| A1   | 0.03 |      | 0.23  |
| b    | 0.70 |      | 0.93  |
| b2   | 1.14 |      | 1.70  |
| c    | 0.45 |      | 0.60  |
| c2   | 1.23 |      | 1.36  |
| D    | 8.95 |      | 9.35  |
| D1   | 7.50 |      |       |
| E    | 10   |      | 10.40 |
| E1   | 8.50 |      |       |
| e    |      | 2.54 |       |
| e1   | 4.88 |      | 5.28  |
| H    | 15   |      | 15.85 |
| J1   | 2.49 |      | 2.69  |
| L    | 2.29 |      | 2.79  |
| L1   | 1.27 |      | 1.40  |
| L2   | 1.30 |      | 1.75  |
| R    |      | 0.4  |       |
| V2   | 0°   |      | 8°    |

Figure 20. D<sup>2</sup>PAK (TO-263) drawing



0079457\_T

Figure 21. D<sup>2</sup>PAK footprint<sup>(a)</sup>



Footprint

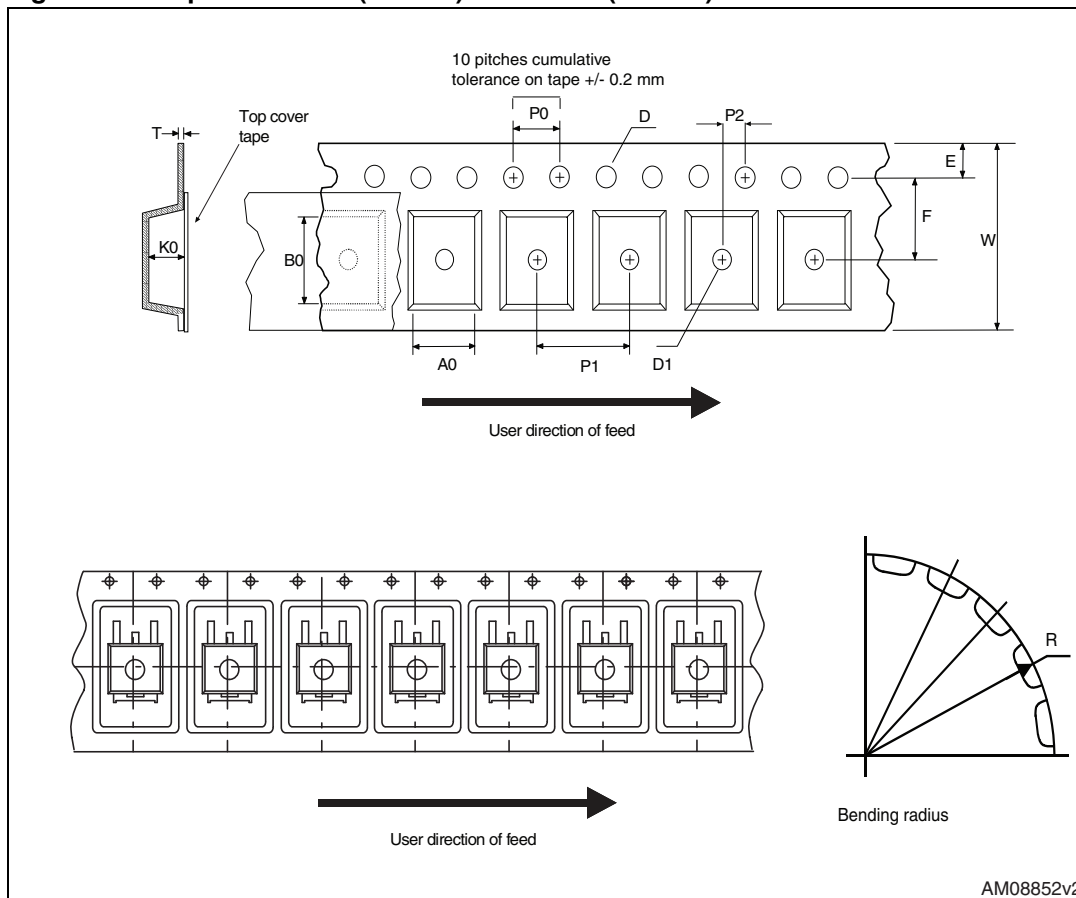
a. All dimensions are in millimeters

## 5 Packaging mechanical data

Table 10. D<sup>2</sup>PAK (TO-263) tape and reel mechanical data

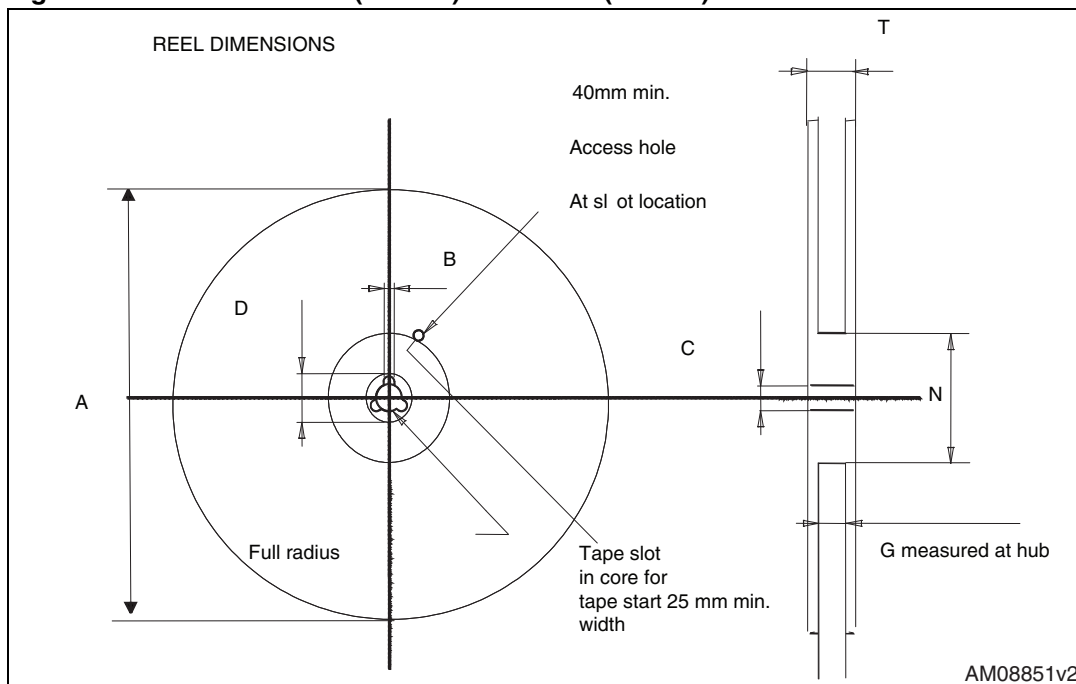
| Tape |      |      | Reel     |      |      |
|------|------|------|----------|------|------|
| Dim. | mm   |      | Dim.     | mm   |      |
|      | Min. | Max. |          | Min. | Max. |
| A0   | 10.5 | 10.7 | A        |      | 330  |
| B0   | 15.7 | 15.9 | B        | 1.5  |      |
| D    | 1.5  | 1.6  | C        | 12.8 | 13.2 |
| D1   | 1.59 | 1.61 | D        | 20.2 |      |
| E    | 1.65 | 1.85 | G        | 24.4 | 26.4 |
| F    | 11.4 | 11.6 | N        | 100  |      |
| K0   | 4.8  | 5.0  | T        |      | 30.4 |
| P0   | 3.9  | 4.1  |          |      |      |
| P1   | 11.9 | 12.1 | Base qty |      | 1000 |
| P2   | 1.9  | 2.1  | Bulk qty |      | 1000 |
| R    | 50   |      |          |      |      |
| T    | 0.25 | 0.35 |          |      |      |
| W    | 23.7 | 24.3 |          |      |      |

Figure 22. Tape for D<sup>2</sup>PAK (TO-263) and DPAK (TO-252)



AM08852v2

Figure 23. Reel for D<sup>2</sup>PAK (TO-263) and DPAK (TO-252)



AM08851v2

## 6 Revision history

Table 11. Document revision history

| Date        | Revision | Changes  |
|-------------|----------|--|
| 27-Sep-2012 | 1        | First release.   |
| 16-Nov-2012 | 2        | <ul style="list-style-type: none"><li>– <math>R_{thj-case}</math> has been updated in table 3</li><li>– Updated <a href="#">Section 4: Package mechanical data</a>.</li><li>– Minor text changes on cover page</li></ul> |

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

