

N-channel 620 V, 2.2  $\Omega$  typ., 4.0 A Power MOSFET  
in DPAK, I<sup>2</sup>PAKFP, TO-220 and IPAK packages

Datasheet – preliminary data

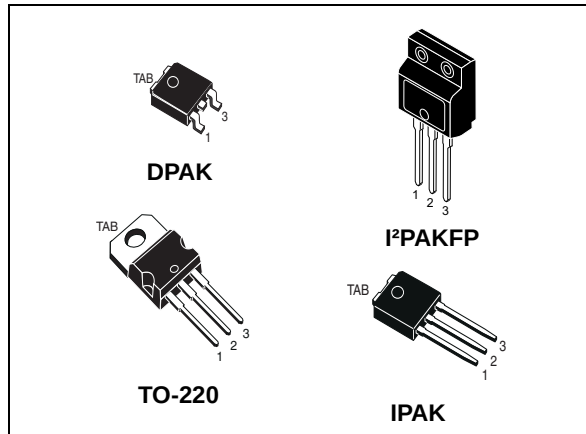
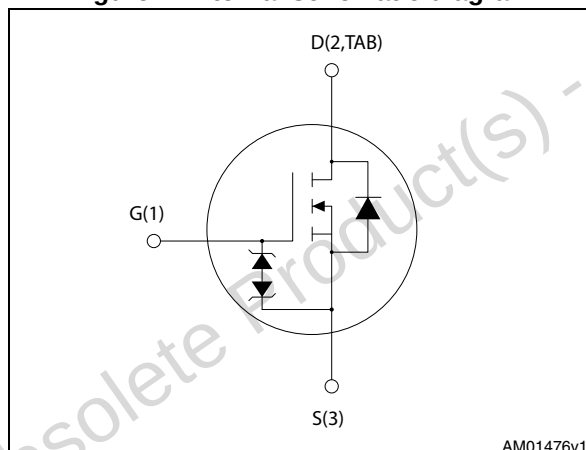


Figure 1. Internal schematic diagram



## Features

| Order codes | V <sub>DS</sub> | R <sub>DS(on)</sub><br>max | I <sub>D</sub> | P <sub>TOT</sub> |
|-------------|-----------------|----------------------------|----------------|------------------|
| STDLED624   | 620 V           | 2.5 $\Omega$               | 4.0 A          | 45 W             |
| STFILED624  |                 |                            |                | 20 W             |
| STPLED624   |                 |                            |                | 45 W             |
| STULED624   |                 |                            |                |                  |

- 100% avalanche tested
- Extremely high dv/dt capability
- Very low intrinsic capacitance
- Improved diode reverse recovery characteristics
- Zener-protected

## Applications

- LED lighting applications

## Description

These Power MOSFETs boast extremely low on-resistance, superior dynamic performance and high avalanche capability, making them suitable for the buck-boost and flyback topology.

Table 1. Device summary

| Order codes | Marking | Package                       | Packaging     |
|-------------|---------|-------------------------------|---------------|
| STDLED624   | LED624  | DPAK                          | Tape and reel |
| STFILED624  |         | I <sup>2</sup> PAKFP (TO-281) | Tube          |
| STPLED624   |         | TO-220                        |               |
| STULED624   |         | IPAK                          |               |

## 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>9</b>  |
| <b>4</b> | <b>Package mechanical data</b> .....      | <b>10</b> |
| <b>5</b> | <b>Packaging mechanical data</b> .....    | <b>19</b> |
| <b>6</b> | <b>Revision history</b> .....             | <b>22</b> |

# 1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol                         | Parameter                                                                                                             | Value         |                      |        | Unit |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------------|---------------|----------------------|--------|------|
|                                |                                                                                                                       | DPAK,<br>IPAK | I <sup>2</sup> PAKFP | TO-220 |      |
| V <sub>DS</sub>                | Drain-source voltage (V <sub>GS</sub> = 0)                                                                            | 620           |                      |        | V    |
| V <sub>GS</sub>                | Gate- source voltage                                                                                                  | ± 30          |                      |        | V    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 25 °C                                                                  | 4.0           | 4.0 <sup>(1)</sup>   | 4.0    | A    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 100 °C                                                                 | 2.5           | 2.5 <sup>(1)</sup>   | 2.5    | A    |
| I <sub>DM</sub> <sup>(2)</sup> | Drain current (pulsed)                                                                                                | 14            | 14 <sup>(1)</sup>    | 14     | A    |
| P <sub>TOT</sub>               | Total dissipation at T <sub>C</sub> = 25 °C                                                                           | 45            | 20                   | 45     | W    |
|                                | Derating factor                                                                                                       | 0.36          | 0.16                 | 0.36   | W/°C |
| ESD                            | Gate-source human body model<br>(C = 100 pF, R = 1.5 kΩ)                                                              | 2.5           |                      |        | kV   |
| dv/dt <sup>(3)</sup>           | Peak diode recovery voltage slope                                                                                     | 9             |                      |        | V/ns |
| V <sub>ISO</sub>               | Insulation withstand voltage (RMS) from all<br>three leads to external heat sink<br>(t = 1 s; T <sub>C</sub> = 25 °C) |               | 2500                 |        | V    |
| T <sub>stg</sub>               | Storage temperature                                                                                                   | -55 to 150    |                      |        | °C   |
| T <sub>j</sub>                 | Max. operating junction temperature                                                                                   | 150           |                      |        | °C   |

1. Limited by package.

2. Pulse width limited by safe operating area.

3. I<sub>SD</sub> ≤ 2.7 A, di/dt ≤ 200 A/μs, V<sub>DD</sub> = 80% V<sub>(BR)DSS</sub>

Table 3. Thermal data

| Symbol                              | Parameter                            | TO-220 | DPAK | IPAK | I <sup>2</sup> PAKFP | Unit |
|-------------------------------------|--------------------------------------|--------|------|------|----------------------|------|
| R <sub>thj-case</sub>               | Thermal resistance junction-case max | 2.78   |      |      | 6.25                 | °C/W |
| R <sub>thj-pcb</sub> <sup>(1)</sup> | Thermal resistance junction-pcb max  |        | 50   |      |                      | °C/W |
| R <sub>thj-amb</sub>                | Thermal resistance junction-amb max  | 62.5   |      |      | 62.5                 | °C/W |

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

Table 4. Avalanche characteristics

| Symbol          | Parameter                                                                                                                     | Max. value | Unit |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------|------------|------|
| I <sub>AR</sub> | Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>j</sub> max)                                   | 2.7        | A    |
| E <sub>AS</sub> | Single pulse avalanche energy<br>(starting T <sub>j</sub> = 25 °C, I <sub>D</sub> = I <sub>AR</sub> , V <sub>DD</sub> = 50 V) | 100        | mJ   |

## 2 Electrical characteristics

( $T_C = 25\text{ }^{\circ}\text{C}$  unless otherwise specified)

**Table 5. On /off states**

| Symbol        | Parameter                                        | Test conditions                                                                          | Min. | Typ. | Max.     | Unit                           |
|---------------|--------------------------------------------------|------------------------------------------------------------------------------------------|------|------|----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage                   | $I_D = 1\text{ mA}$ , $V_{GS} = 0$                                                       | 620  |      |          | V                              |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = 620\text{ V}$<br>$V_{DS} = 620\text{ V}$ , $T_C = 125\text{ }^{\circ}\text{C}$ |      |      | 1<br>50  | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$     | Gate-body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 20\text{ V}$                                                               |      |      | $\pm 10$ | $\mu\text{A}$                  |
| $V_{GS(th)}$  | Gate threshold voltage                           | $V_{DS} = V_{GS}$ , $I_D = 50\text{ }\mu\text{A}$                                        | 3    | 3.6  | 4.5      | V                              |
| $R_{DS(on)}$  | Static drain-source on-resistance                | $V_{GS} = 10\text{ V}$ , $I_D = 1.4\text{ A}$                                            |      | 2.2  | 2.5      | $\Omega$                       |

**Table 6. Dynamic**

| Symbol                              | Parameter                                                               | Test conditions                                                                                                | Min. | Typ.               | Max. | Unit           |
|-------------------------------------|-------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|------|--------------------|------|----------------|
| $g_{fs}$ (1)                        | Forward transconductance                                                | $V_{DS} = 15\text{ V}$ , $I_D = 1.4\text{ A}$                                                                  | -    | 2.1                | -    | S              |
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$ | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{DS} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$                                                     | -    | 395<br>57<br>7     | -    | pF<br>pF<br>pF |
| $C_{OSS\ eq}$ (1)                   | Equivalent output capacitance                                           | $V_{GS} = 0$ , $V_{DS} = 0$ to $496\text{ V}$                                                                  | -    | 33                 | -    | pF             |
| $R_G$                               | Intrinsic gate resistance                                               | $f = 1\text{ MHz}$ open drain                                                                                  | -    | 10                 | -    | $\Omega$       |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$       | Total gate charge<br>Gate-source charge<br>Gate-drain charge            | $V_{DD} = 496\text{ V}$ , $I_D = 2.7\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 17</a> ) | -    | 13.5<br>2.7<br>7.7 | -    | 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. Switching times**

| Symbol       | Parameter           | Test conditions                                                                                                                            | Min. | Typ. | Max. | Unit |
|--------------|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 310\text{ V}$ , $I_D = 1.7\text{ A}$ ,<br>$R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 16</a> ) | -    | 9    | -    | ns   |
| $t_r$        | Rise time           |                                                                                                                                            |      | 6.8  |      | ns   |
| $t_{d(off)}$ | Turn-off-delay time |                                                                                                                                            |      | 22   |      | ns   |
| $t_f$        | Fall time           |                                                                                                                                            |      | 15.6 |      | ns   |

Table 8. Source drain diode

| Symbol          | Parameter                     | Test conditions                                                                                                   | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|-------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $I_{SD}$        | Source-drain current          |                                                                                                                   | -    |      | 2.7  | A    |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                   | -    |      | 10.8 | A    |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 2.7$ A, $V_{GS} = 0$                                                                                    | -    |      | 1.6  | V    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 2.7$ A, $di/dt = 100$ A/ $\mu$ s<br>$V_{DD} = 60$ V (see <a href="#">Figure 21</a> )                    | -    | 190  |      | ns   |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                   |      | 825  |      | nC   |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                   |      | 9    |      | A    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 2.7$ A, $di/dt = 100$ A/ $\mu$ s<br>$V_{DD} = 60$ V, $T_j = 150$ °C<br>(see <a href="#">Figure 21</a> ) | -    | 255  |      | ns   |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                   |      | 1100 |      | nC   |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                   |      | 10   |      | A    |

1. Pulse width limited by safe operating area.

2. Pulsed: Pulse duration = 300  $\mu$ s, duty cycle 1.5%

Table 9. Gate-source Zener diode

| Symbol        | Parameter                     | Test conditions                  | Min. | Typ. | Max. | Unit |
|---------------|-------------------------------|----------------------------------|------|------|------|------|
| $V_{(BR)GSO}$ | Gate-source breakdown voltage | $I_{GS} = \pm 1$ mA (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 for DPAK, TO-220 and IPAK

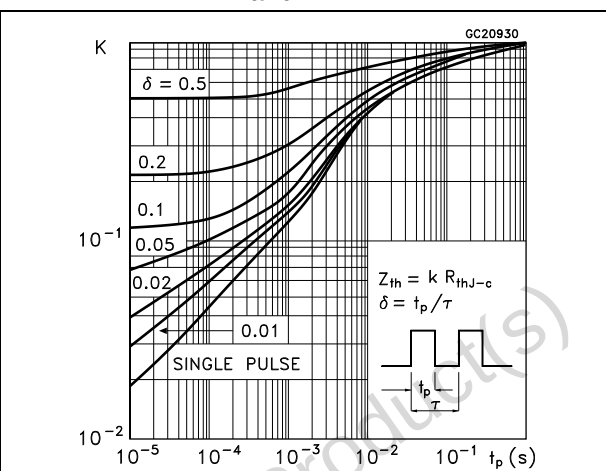
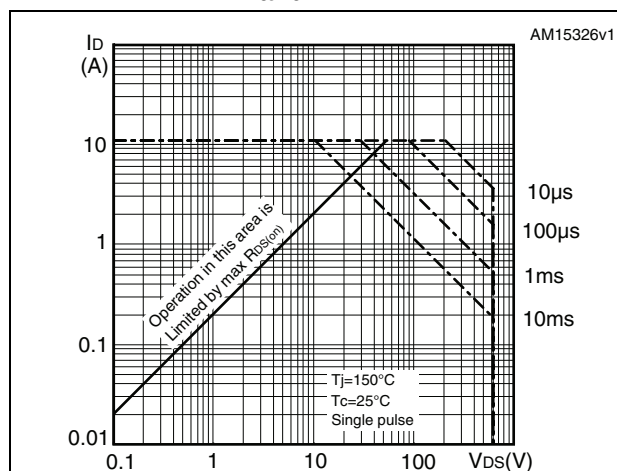


Figure 4. Safe operating area for I<sup>2</sup>PAKFP

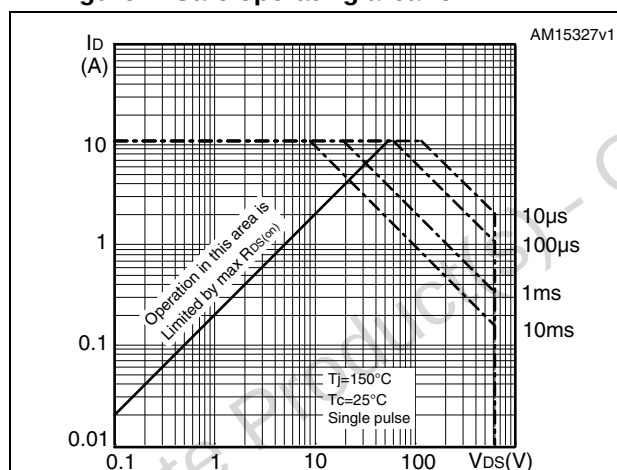


Figure 5. Thermal impedance for I<sup>2</sup>PAKFP

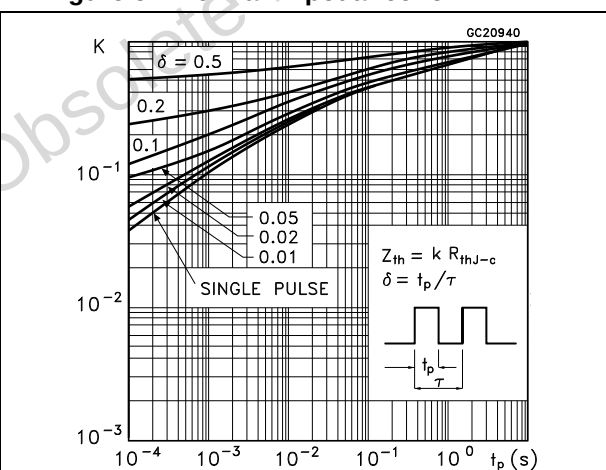


Figure 6. Output characteristics

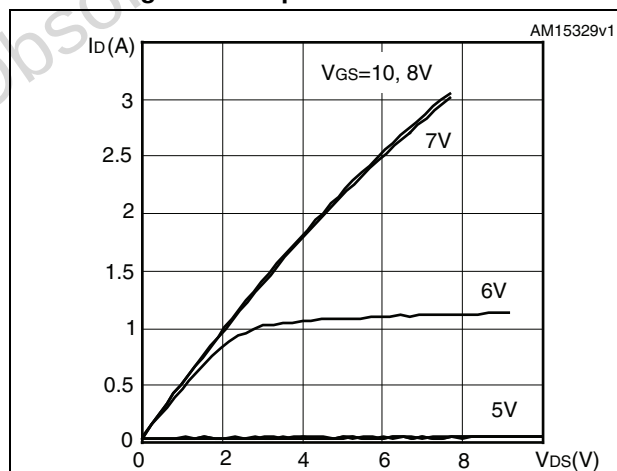


Figure 7. Transfer characteristics

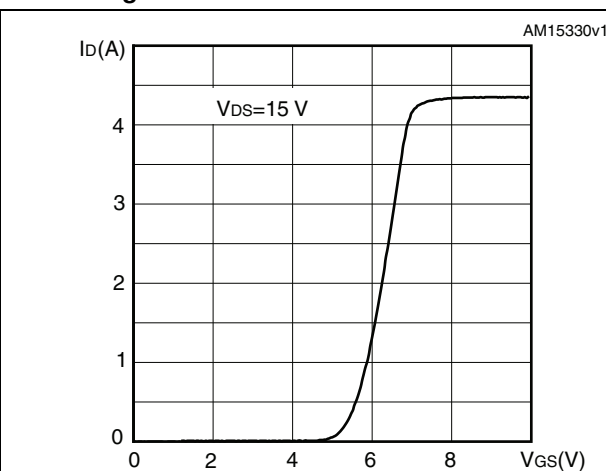


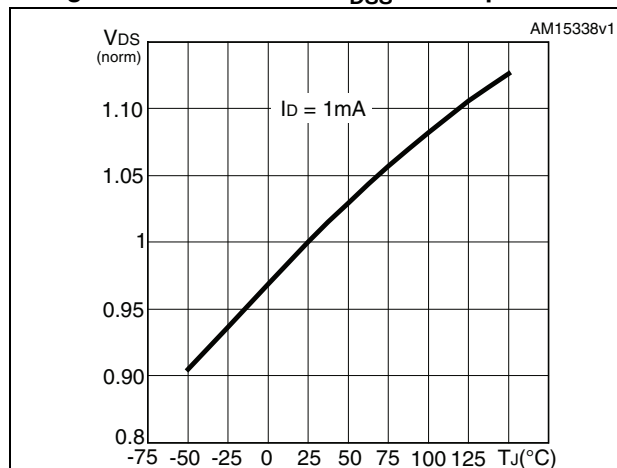
Figure 8. Normalized  $BV_{DSS}$  vs temperature

Figure 9. Static drain-source on-resistance

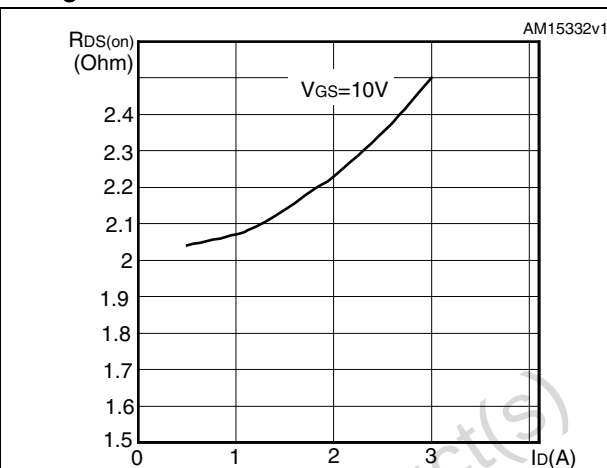


Figure 10. Gate charge vs gate-source voltage

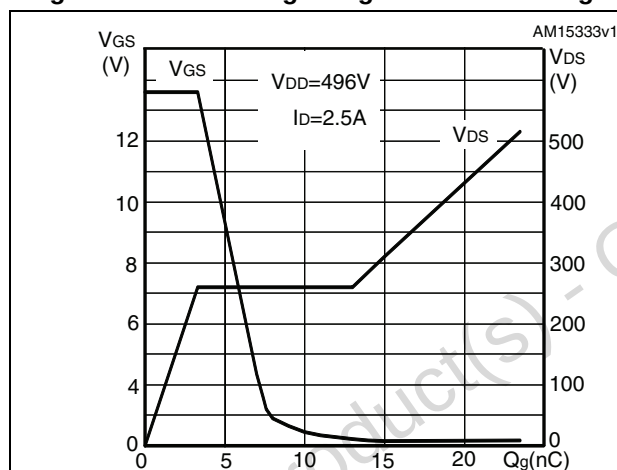


Figure 11. Capacitance variations

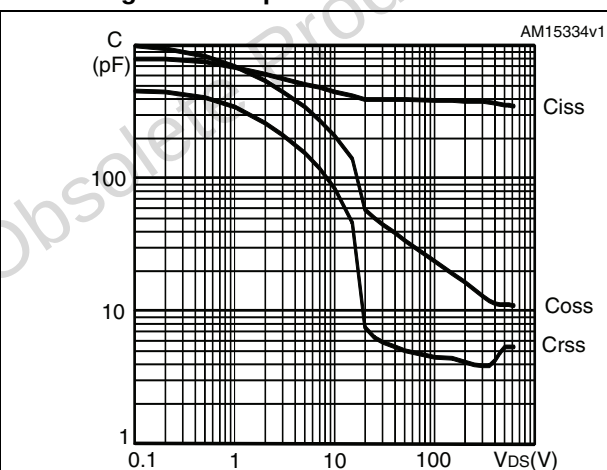


Figure 12. Normalized gate threshold voltage vs temperature

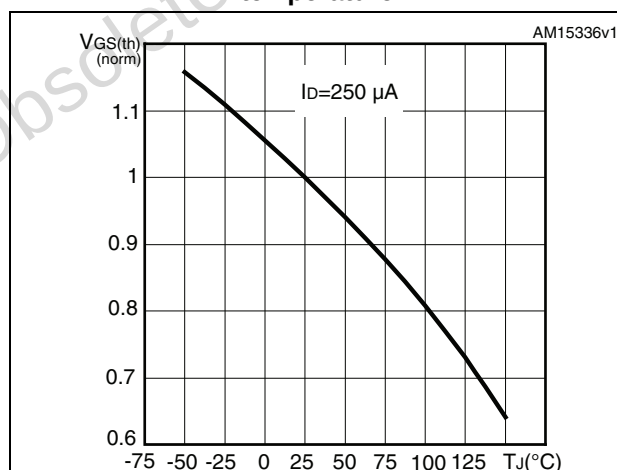


Figure 13. Normalized on-resistance vs temperature

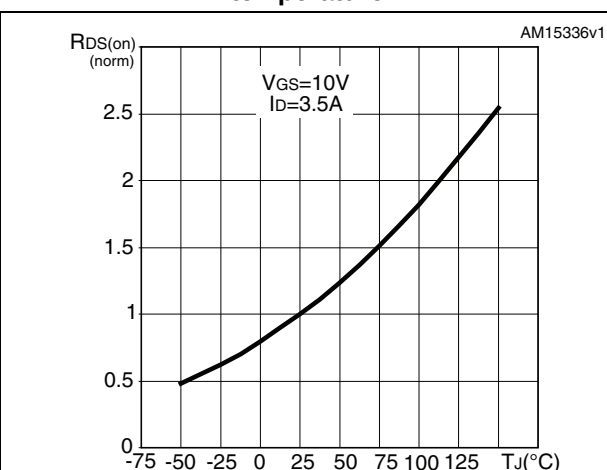


Figure 14. Source-drain diode forward characteristics

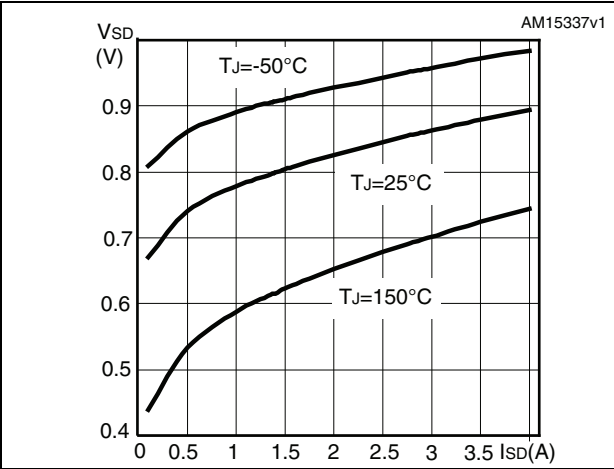
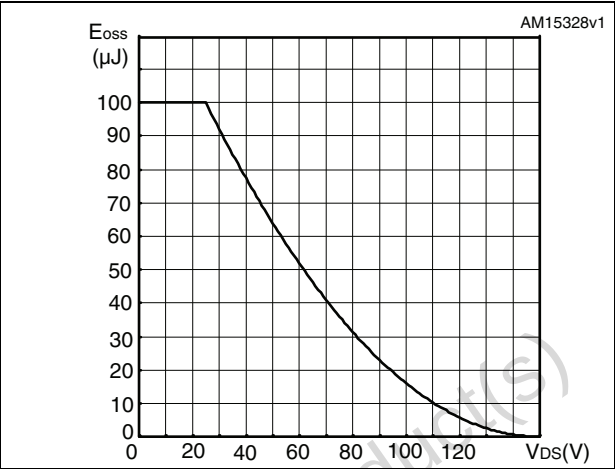


Figure 15. Maximum avalanche energy vs temperature





### 3 Test circuits

Figure 16. Switching times test circuit for resistive load

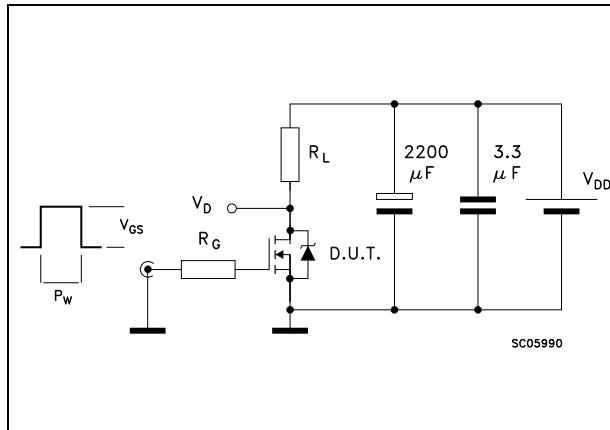


Figure 17. Gate charge test circuit

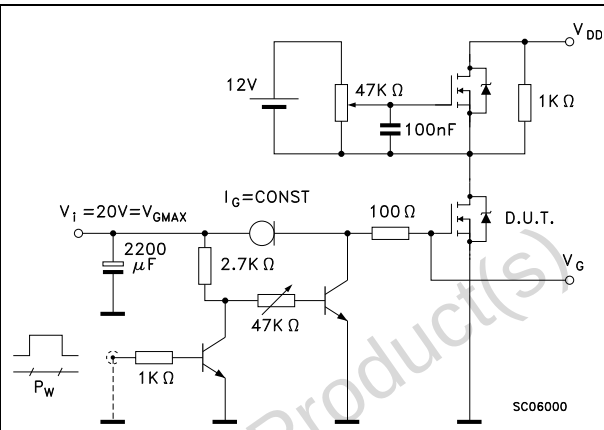


Figure 18. Test circuit for inductive load switching and diode recovery times

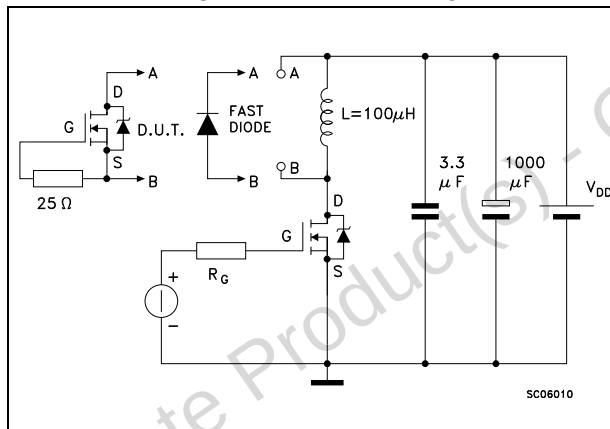


Figure 19. Unclamped Inductive load test circuit

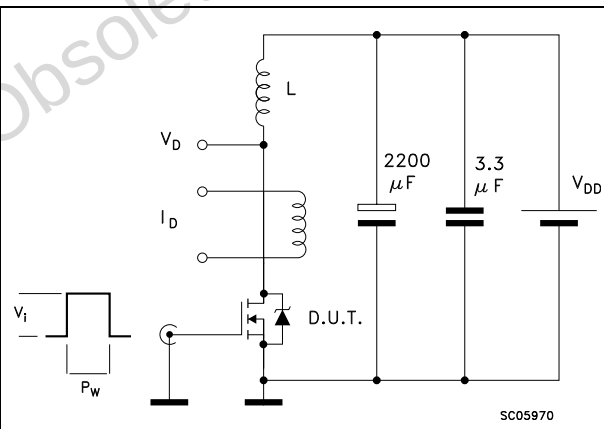


Figure 20. Unclamped inductive waveform

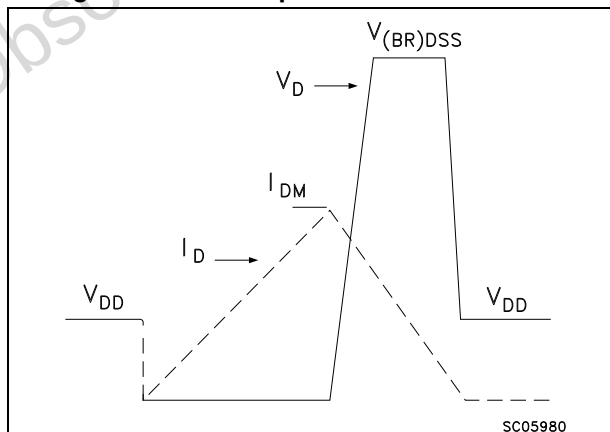
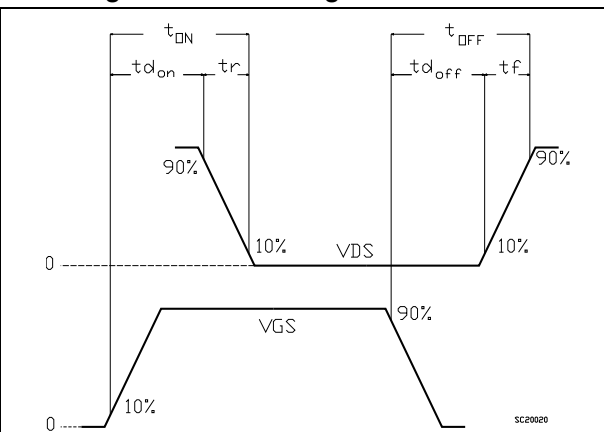


Figure 21. Switching time waveform



## 4 Package mechanical data

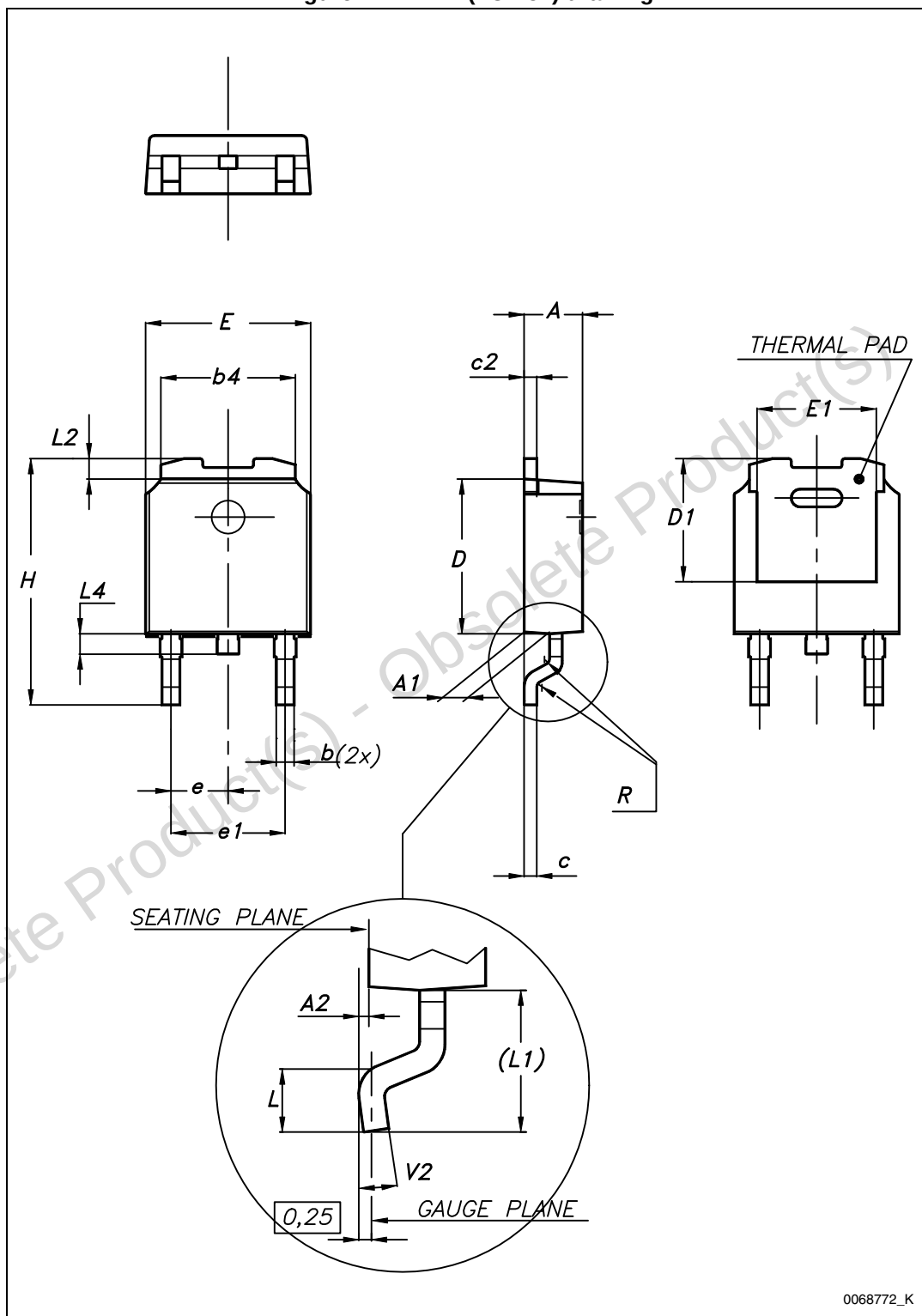
In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK® is an ST trademark.

Obsolete Product(s) - Obsolete Product(s)

Table 10. DPAK (TO-252) mechanical data

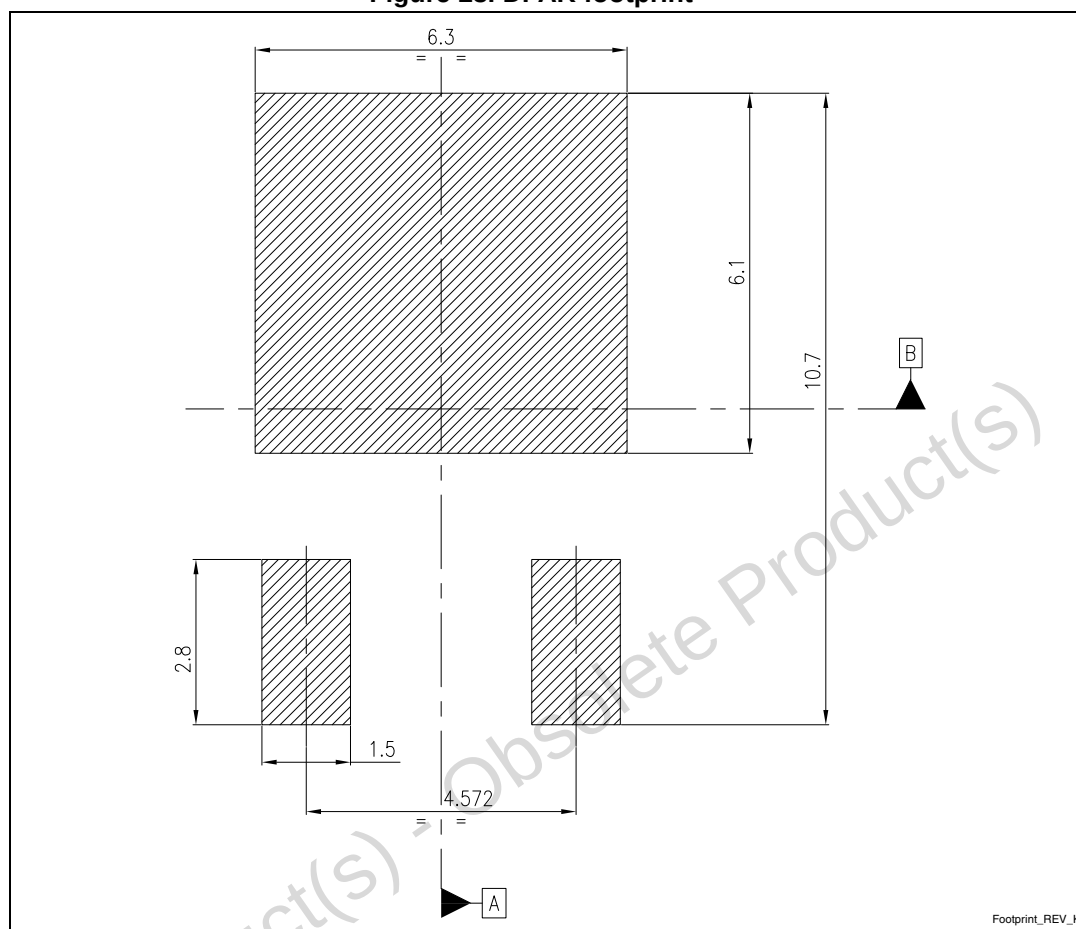
| Dim. | mm   |      |       |
|------|------|------|-------|
|      | Min. | Typ. | Max.  |
| A    | 2.20 |      | 2.40  |
| A1   | 0.90 |      | 1.10  |
| A2   | 0.03 |      | 0.23  |
| b    | 0.64 |      | 0.90  |
| b4   | 5.20 |      | 5.40  |
| c    | 0.45 |      | 0.60  |
| c2   | 0.48 |      | 0.60  |
| D    | 6.00 |      | 6.20  |
| D1   |      | 5.10 |       |
| E    | 6.40 |      | 6.60  |
| E1   |      | 4.70 |       |
| e    |      | 2.28 |       |
| e1   | 4.40 |      | 4.60  |
| H    | 9.35 |      | 10.10 |
| L    | 1.00 |      | 1.50  |
| (L1) |      | 2.80 |       |
| L2   |      | 0.80 |       |
| L4   | 0.60 |      | 1.00  |
| R    |      | 0.20 |       |
| V2   | 0°   |      | 8°    |

Figure 22. DPAK (TO-252) drawing



0068772\_K

Figure 23. DPAK footprint (a)



a. All dimensions are in millimeters

**Table 11. I<sup>2</sup>PAKFP (TO-281) mechanical data**

| Dim. | mm    |      |       |
|------|-------|------|-------|
|      | Min.  | Typ. | Max.  |
| A    | 4.40  | -    | 4.60  |
| B    | 2.50  |      | 2.70  |
| D    | 2.50  |      | 2.75  |
| D1   | 0.65  |      | 0.85  |
| E    | 0.45  |      | 0.70  |
| F    | 0.75  |      | 1.00  |
| F1   |       |      | 1.20  |
| G    | 4.95  |      | 5.20  |
| H    | 10.00 |      | 10.40 |
| L1   | 21.00 |      | 23.00 |
| L2   | 13.20 |      | 14.10 |
| L3   | 10.55 |      | 10.85 |
| L4   | 2.70  |      | 3.20  |
| L5   | 0.85  |      | 1.25  |
| L6   | 7.30  | 7.50 |       |

**Figure 24. I<sup>2</sup>PAKFP (TO-281) drawing**

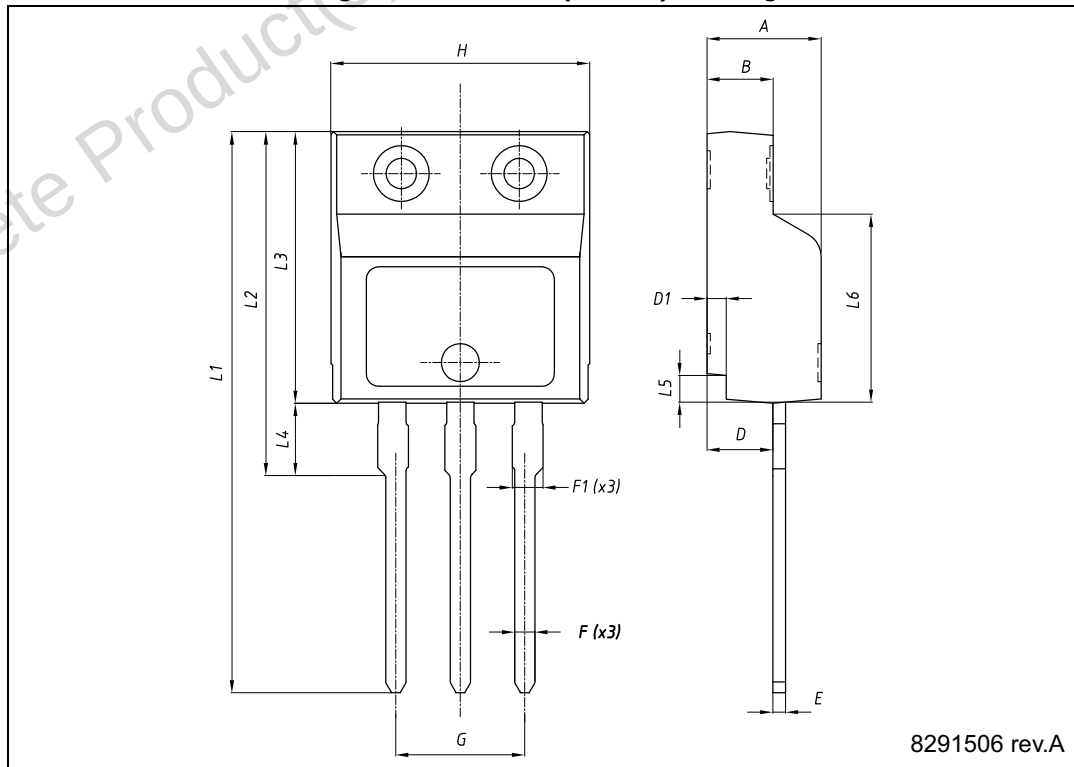


Table 12. TO-220 type A mechanical data

| Dim. | mm    |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.40  |       | 4.60  |
| b    | 0.61  |       | 0.88  |
| b1   | 1.14  |       | 1.70  |
| c    | 0.48  |       | 0.70  |
| D    | 15.25 |       | 15.75 |
| D1   |       | 1.27  |       |
| E    | 10    |       | 10.40 |
| e    | 2.40  |       | 2.70  |
| e1   | 4.95  |       | 5.15  |
| F    | 1.23  |       | 1.32  |
| H1   | 6.20  |       | 6.60  |
| J1   | 2.40  |       | 2.72  |
| L    | 13    |       | 14    |
| L1   | 3.50  |       | 3.93  |
| L20  |       | 16.40 |       |
| L30  |       | 28.90 |       |
| ØP   | 3.75  |       | 3.85  |
| Q    | 2.65  |       | 2.95  |

Figure 25. TO-220 type A drawing

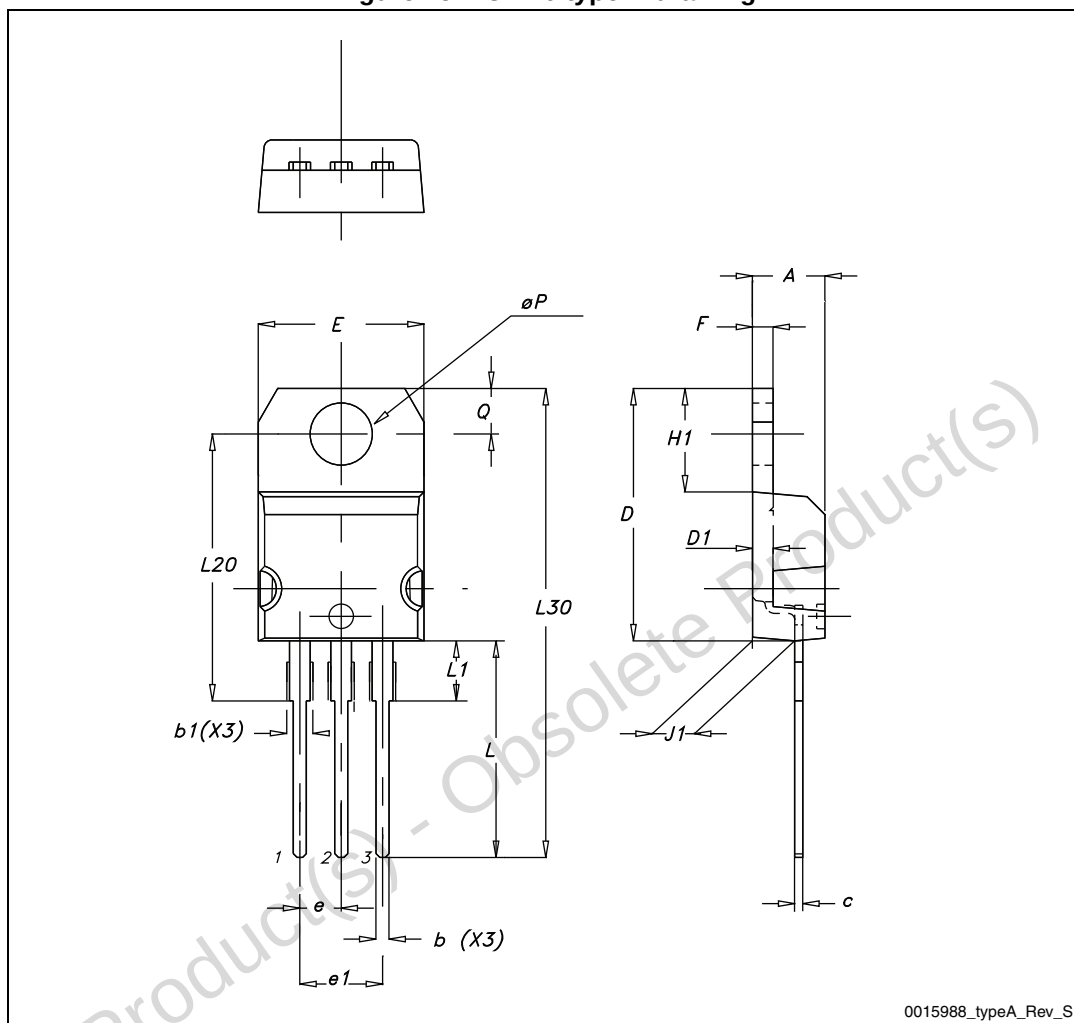
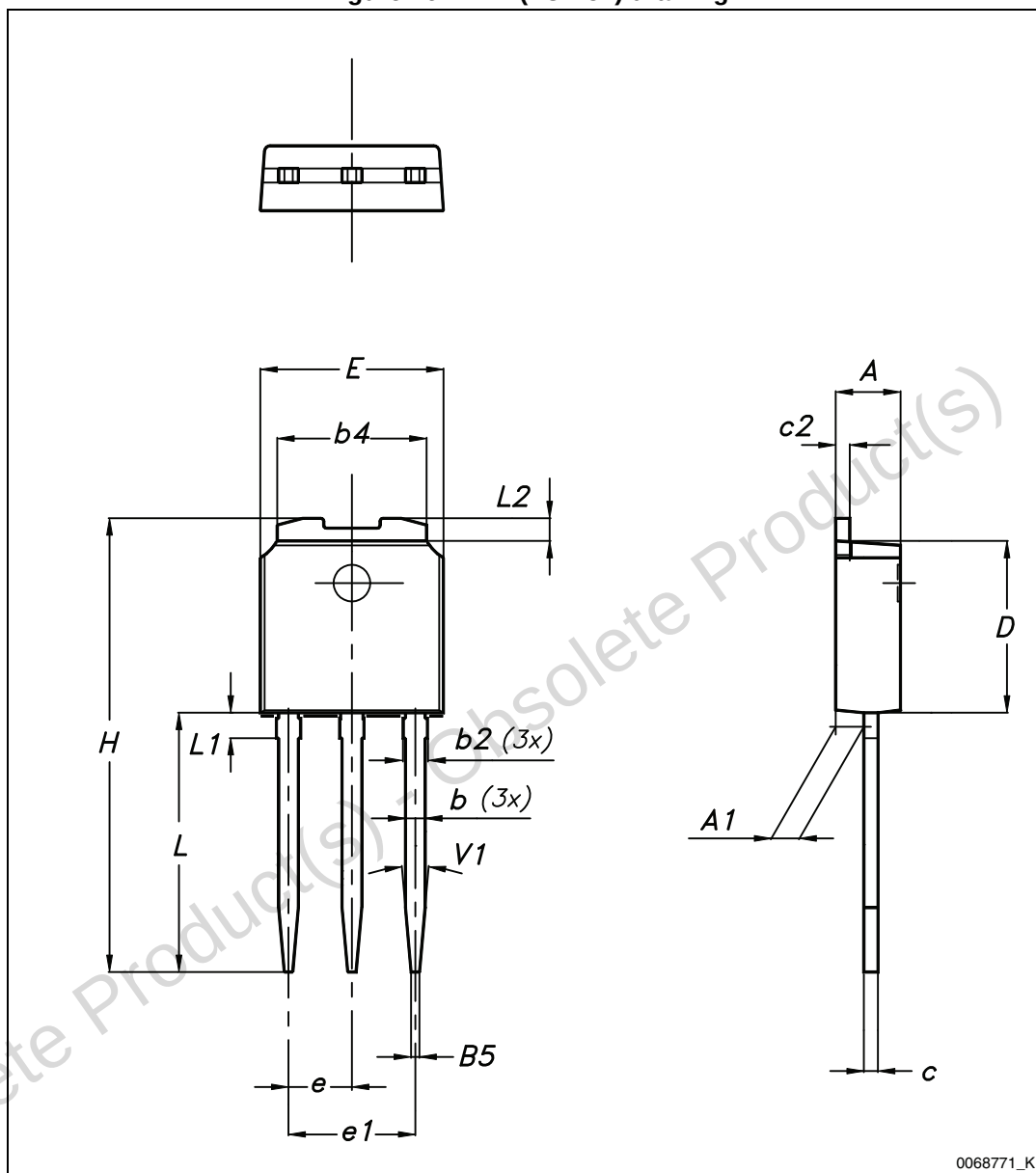




Table 13. IPAK (TO-251) mechanical data

| DIM | mm.  |       |      |
|-----|------|-------|------|
|     | min. | typ.  | max. |
| A   | 2.20 |       | 2.40 |
| A1  | 0.90 |       | 1.10 |
| b   | 0.64 |       | 0.90 |
| b2  |      |       | 0.95 |
| b4  | 5.20 |       | 5.40 |
| B5  |      | 0.30  |      |
| c   | 0.45 |       | 0.60 |
| c2  | 0.48 |       | 0.60 |
| D   | 6.00 |       | 6.20 |
| E   | 6.40 |       | 6.60 |
| e   |      | 2.28  |      |
| e1  | 4.40 |       | 4.60 |
| H   |      | 16.10 |      |
| L   | 9.00 |       | 9.40 |
| L1  | 0.80 |       | 1.20 |
| L2  |      | 0.80  | 1.00 |
| V1  |      | 10°   |      |

Figure 26. IPAK (TO-251) drawing



## 5 Packaging mechanical data

Table 14. DPAK (TO-252) tape and reel mechanical data

| Tape |      |      | Reel      |      |      |
|------|------|------|-----------|------|------|
| Dim. | mm   |      | Dim.      | mm   |      |
|      | Min. | Max. |           | Min. | Max. |
| A0   | 6.8  | 7    | A         |      | 330  |
| B0   | 10.4 | 10.6 | B         | 1.5  |      |
| B1   |      | 12.1 | C         | 12.8 | 13.2 |
| D    | 1.5  | 1.6  | D         | 20.2 |      |
| D1   | 1.5  |      | G         | 16.4 | 18.4 |
| E    | 1.65 | 1.85 | N         | 50   |      |
| F    | 7.4  | 7.6  | T         |      | 22.4 |
| K0   | 2.55 | 2.75 |           |      |      |
| P0   | 3.9  | 4.1  | Base qty. |      | 2500 |
| P1   | 7.9  | 8.1  | Bulk qty. |      | 2500 |
| P2   | 1.9  | 2.1  |           |      |      |
| R    | 40   |      |           |      |      |
| T    | 0.25 | 0.35 |           |      |      |
| W    | 15.7 | 16.3 |           |      |      |

Figure 27. Tape for DPAK (TO-252)

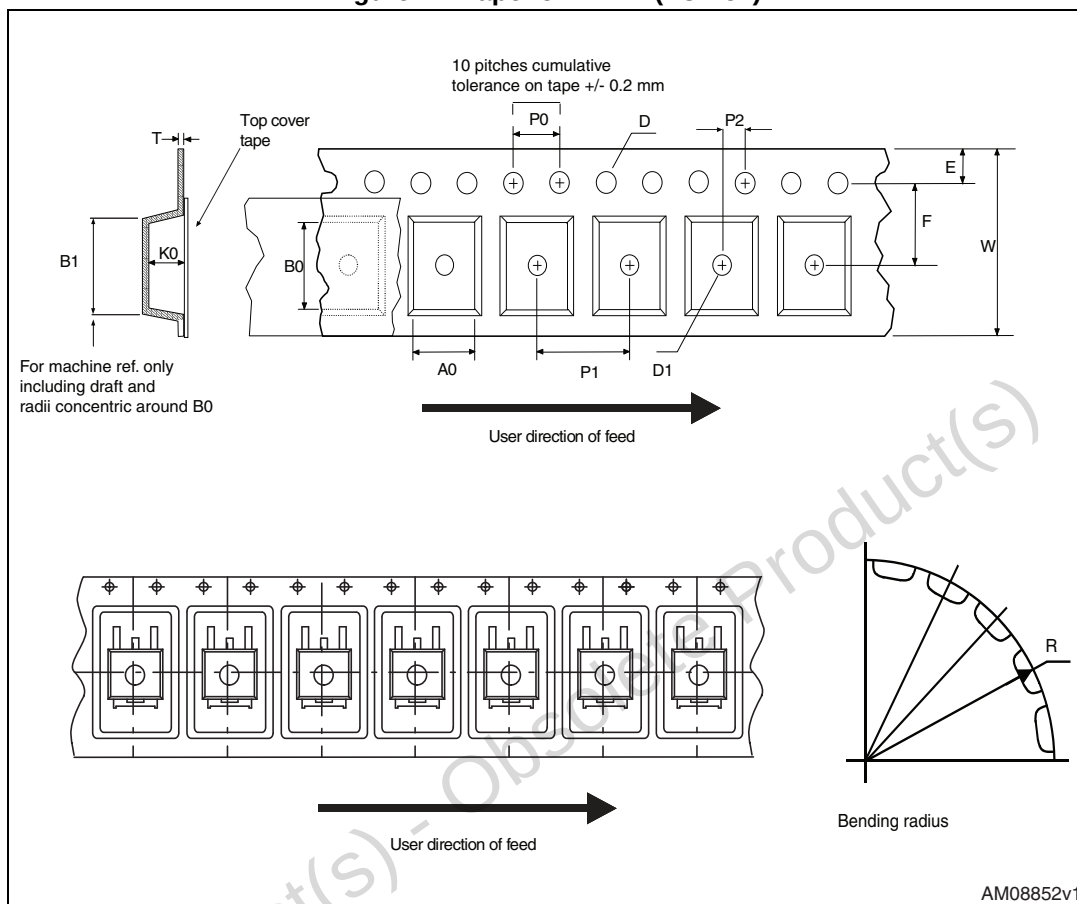
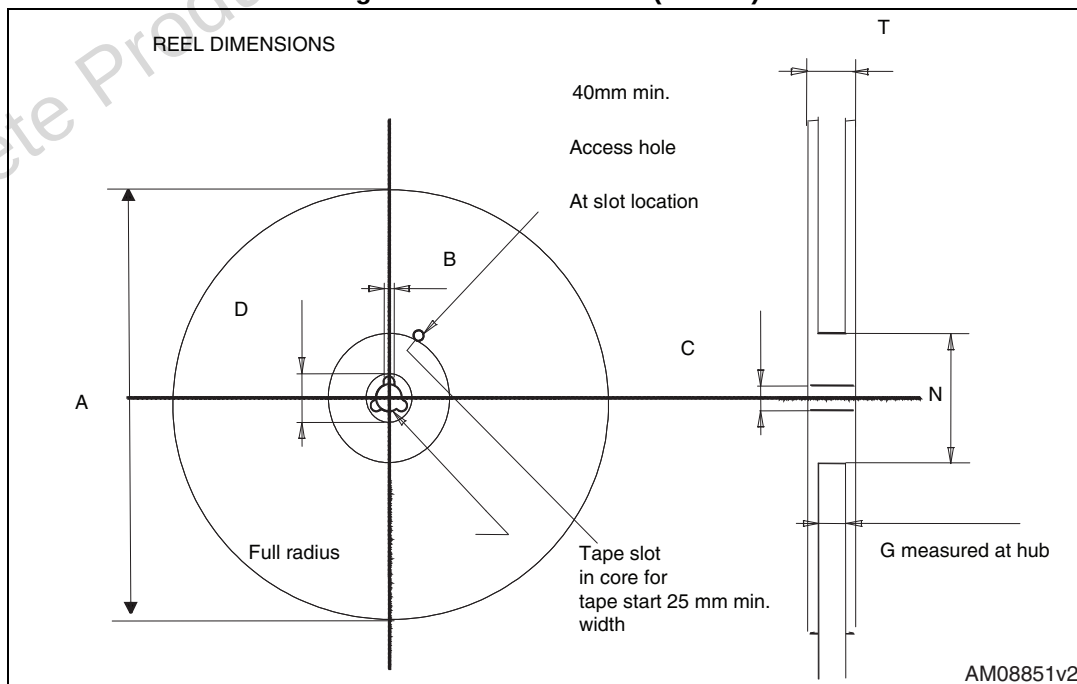


Figure 28. Reel for DPAK (TO-252)



## 6 Revision history

Table 15. Document revision history

| Date        | Revision | Changes        |
|-------------|----------|----------------|
| 21-Mar-2013 | 1        | First release. |

Obsolete Product(s) - Obsolete Product(s)

**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 AUTHORIZED FOR USE IN WEAPONS. NOR ARE ST PRODUCTS 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.

© 2013 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)