

N-channel 950 V, 3 Ω typ., 4 A Zener-protected SuperMESH3™ Power MOSFET in DPAK, TO-220FP, TO-220 and IPAK packages

Datasheet – production data

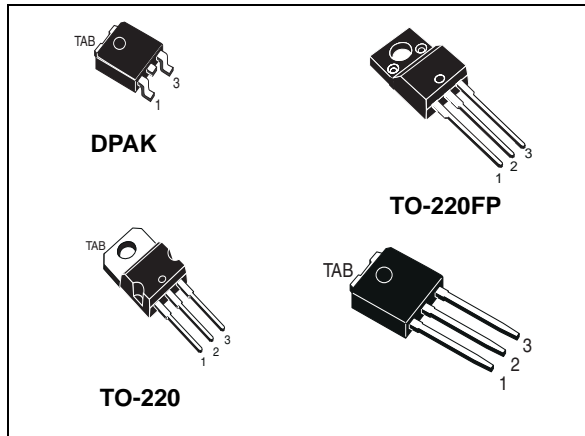
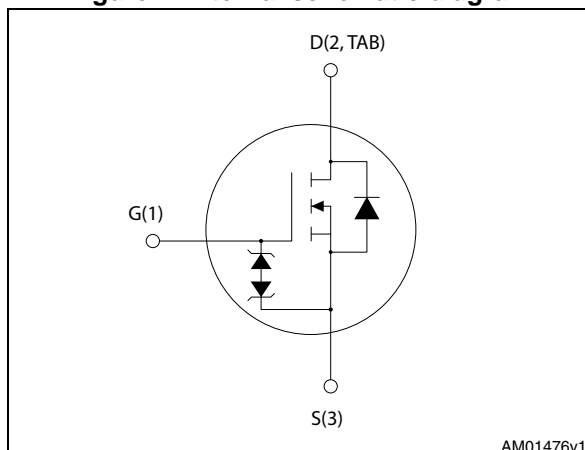


Figure 1. Internal schematic diagram



Features

| Order codes | V _{DS} | R _{DS(on)} max | I _D | P _{TOT} |
|-------------|-----------------|-------------------------|----------------|------------------|
| STD5N95K3 | 950 V | 3.5 Ω | 4 A | 90 W |
| STF5N95K3 | | | | 25 W |
| STP5N95K3 | | | | 90 W |
| STU5N95K3 | | | | 90 W |

- 100% avalanche tested
- Extremely large avalanche performance
- Gate charge minimized
- Very low intrinsic capacitances
- Zener-protected

Applications

- Switching applications

Description

These SuperMESH3™ Power MOSFETs are the result of improvements applied to STMicroelectronics' SuperMESH™ technology, combined with a new optimized vertical structure. These devices boast an extremely low on-resistance, superior dynamic performance and high avalanche capability, rendering them suitable for the most demanding applications.

Table 1. Device summary

| Order codes | Marking | Package | Packaging |
|-------------|---------|----------|---------------|
| STD5N95K3 | 5N95K3 | DPAK | Tape and reel |
| STF5N95K3 | | TO-220FP | Tube |
| STP5N95K3 | | TO-220 | |
| STU5N95K3 | | IPAK | |

Contents

| | | |
|----------|---|-----------|
| 1 | Electrical ratings | 3 |
| 2 | Electrical characteristics | 4 |
| 2.1 | Electrical characteristics (curves) | 6 |
| 3 | Test circuits | 9 |
| 4 | Package mechanical data | 10 |
| 5 | Packaging mechanical data | 20 |
| 6 | Revision history | 22 |

1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | | | | Unit |
|--------------------|---|------------|-------------------|--------|------|------|
| | | DPAK | TO-220FP | TO-220 | IPAK | |
| V_{GS} | Gate- source voltage | ±30 | | | | V |
| I_D | Drain current (continuous) at $T_C = 25\text{ °C}$ | 4 | 4 ⁽¹⁾ | 4 | | A |
| I_D | Drain current (continuous) at $T_C = 100\text{ °C}$ | 3 | 3 ⁽¹⁾ | 3 | | A |
| $I_{DM}^{(2)}$ | Drain current (pulsed) | 16 | 16 ⁽¹⁾ | 16 | | A |
| P_{TOT} | Total dissipation at $T_C = 25\text{ °C}$ | 90 | 25 | 90 | | W |
| I_{AR} | Avalanche current, repetitive or not-repetitive (pulse width limited by T_J max) | 4 | | | | A |
| E_{AS} | Single pulse avalanche energy (starting $T_J = 25\text{ °C}$, $I_D = I_{AR}$, $V_{DD} = 50\text{ V}$) | 100 | | | | mJ |
| $dv/dt^{(3)}$ | Peak diode recovery voltage slope | 5 | | | | V/ns |
| V_{ISO} | Insulation withstand voltage (RMS) from all three leads to external heat sink ($t = 1\text{ s}$, $T_C = 25\text{ °C}$) | | 2500 | | | V |
| T_J T_{stg} | Operating junction temperature Storage temperature | -55 to 150 | | | | °C |

1. Limited by maximum junction temperature
2. Pulse width limited by safe operating area
3. $I_{SD} \leq 4\text{ A}$, $di/dt \leq 100\text{ A}/\mu\text{s}$, peak $V_{DS} \leq V_{(BR)DSS}$

Table 3. Thermal data

| Symbol | Parameter | Value | | | | Unit |
|---------------------|---|-------|----------|--------|------|------|
| | | DPAK | TO-220FP | TO-220 | IPAK | |
| $R_{thj-case}$ | Thermal resistance junction-case max | 1.39 | 5 | 1.39 | | °C/W |
| $R_{thj-amb}$ | Thermal resistance junction-ambient max | | 62.5 | | 100 | °C/W |
| $R_{thj-pcb}^{(1)}$ | Thermal resistance junction-pcb max | 50 | | | | °C/W |

1. When mounted on 1inch² FR-4 board, 2 oz Cu

2 Electrical characteristics

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

Table 4. 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 | 950 | | | V |
| I _{DSS} | Zero gate voltage drain current (V _{GS} = 0) | V _{DS} = 950 V V _{DS} = 950 V, T _C = 125 °C | | | 1 50 | μA 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 | 4 | 5 | V |
| R _{DS(on)} | Static drain-source on-resistance | V _{GS} = 10 V, I _D = 2 A | | 3 | 3.5 | Ω |

Table 5. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------------------------|---------------------------------------|---|------|------|------|------|
| C _{iss} | Input capacitance | V _{DS} = 25 V, f = 1 MHz, V _{GS} = 0 | - | 460 | - | pF |
| C _{oss} | Output capacitance | | - | 38 | - | pF |
| C _{rss} | Reverse transfer capacitance | | - | 1 | - | pF |
| C _{o(tr)} ⁽¹⁾ | Equivalent capacitance time related | V _{DS} = 0 to 760 V, V _{GS} = 0 | - | 970 | - | pF |
| C _{o(er)} ⁽²⁾ | Equivalent capacitance energy related | V _{DS} = 0 to 760 V, V _{GS} = 0 | - | 15 | - | pF |
| R _g | Gate input resistance | f = 1 MHz, I _D = 0 | - | 5.5 | - | Ω |
| Q _g | Total gate charge | V _{DD} = 760 V, I _D = 4 A, | - | 19 | - | nC |
| Q _{gs} | Gate-source charge | V _{GS} = 10 V | - | 4.7 | - | nC |
| Q _{gd} | Gate-drain charge | (see Figure 20) | - | 12 | - | nC |

1. Time related 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}
2. Energy related is defined as a constant equivalent capacitance giving the same stored energy as C_{oss} when V_{DS} increases from 0 to 80% V_{DSS}

Table 6. Switching times

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------------|---------------------|---|------|------|------|------|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD} = 475\text{ V}$, $I_D = 2\text{ A}$, $R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$ (see Figure 19) | - | 17 | - | ns |
| t_r | Rise time | | - | 7 | - | ns |
| $t_{d(off)}$ | Turn-off-delay time | | - | 32 | - | ns |
| t_f | Fall time | | - | 18 | - | ns |

Table 7. Source drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|---|------|------|------|---------------|
| I_{SD} | Source-drain current | | - | | 4 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | - | | 16 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD} = 4\text{ A}$, $V_{GS} = 0$ | - | | 1.6 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 4\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$ (see Figure 21) | - | 410 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 3.5 | | μC |
| I_{RRM} | Reverse recovery current | | - | 17 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 4\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$ $T_J = 150\text{ }^\circ\text{C}$ (see Figure 21) | - | 516 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 4.1 | | μC |
| I_{RRM} | Reverse recovery current | | - | 16 | | A |

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

Table 8. Gate-source Zener diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------|-------------------------------|--|------|------|------|------|
| $V_{(BR)GSO}$ | Gate-source breakdown voltage | $I_{GS} = \pm 1\text{ mA}$, $I_D = 0$ | 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 IPAK, DPAK

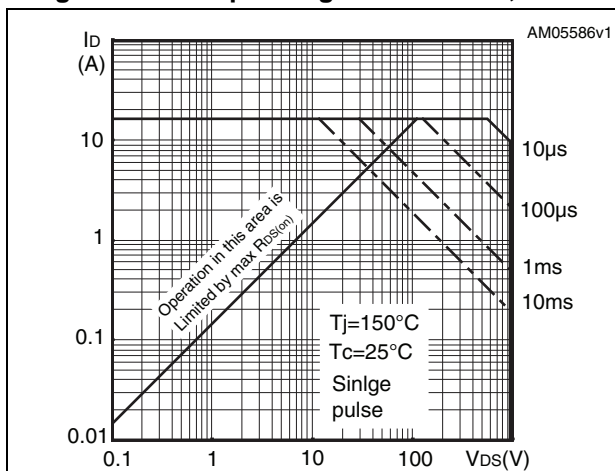


Figure 3. Thermal impedance for IPAK, DPAK

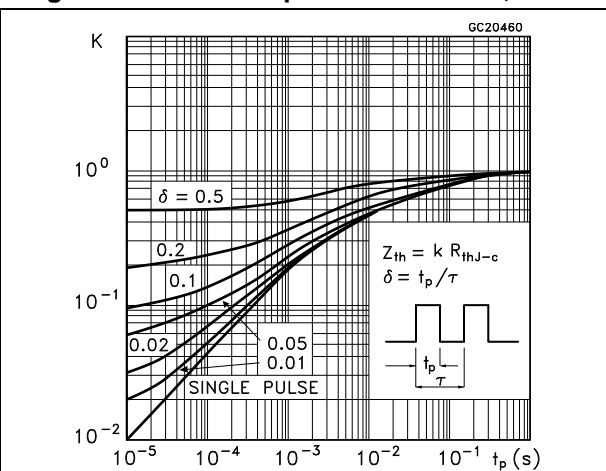


Figure 4. Safe operating area for TO-220FP

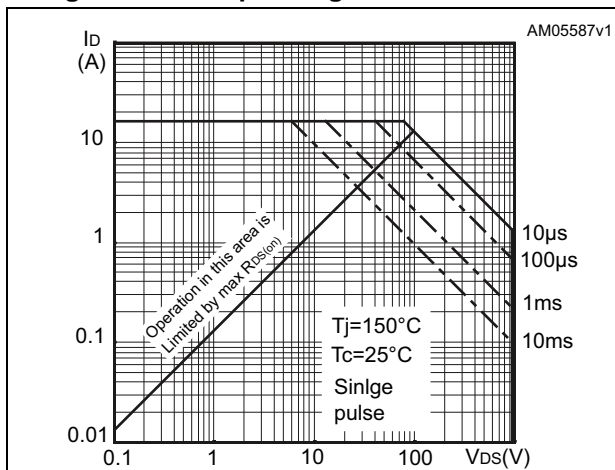


Figure 5. Thermal impedance for TO-220FP

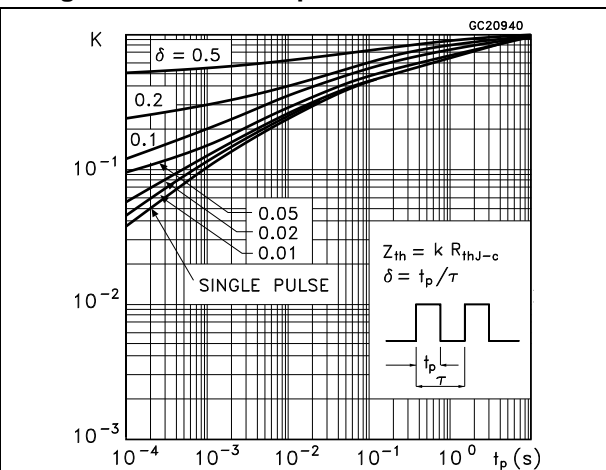


Figure 6. Safe operating area for TO-220

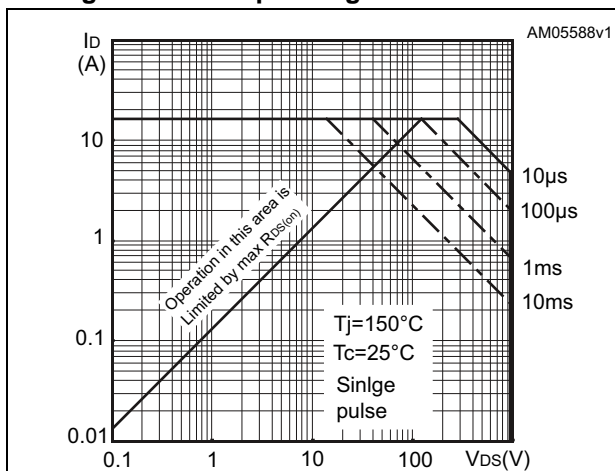


Figure 7. Thermal impedance for TO-220

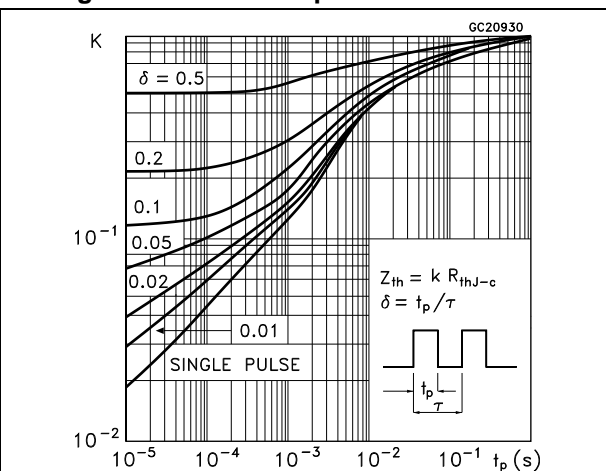


Figure 8. Output characteristics

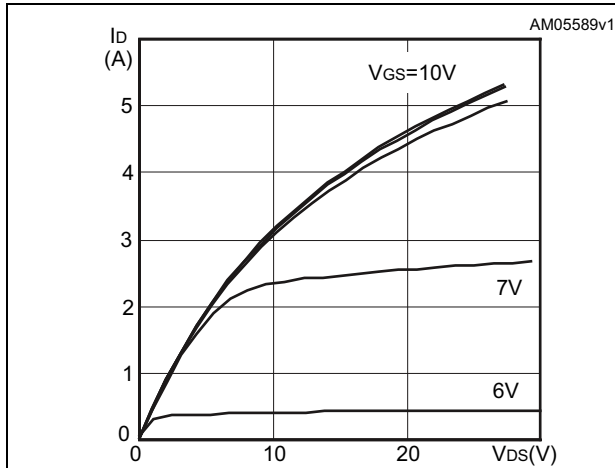


Figure 9. Transfer characteristics

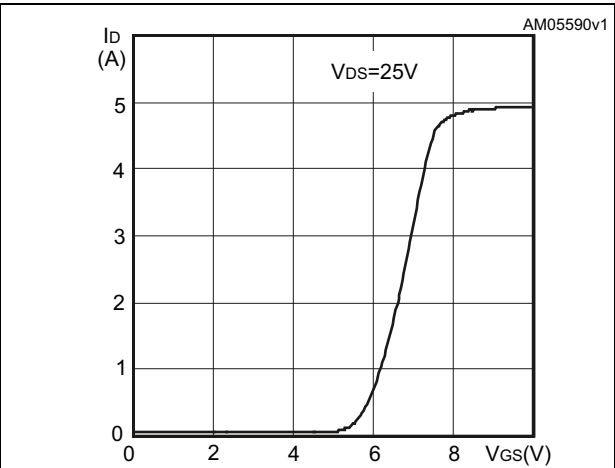


Figure 10. Gate charge vs gate-source voltage

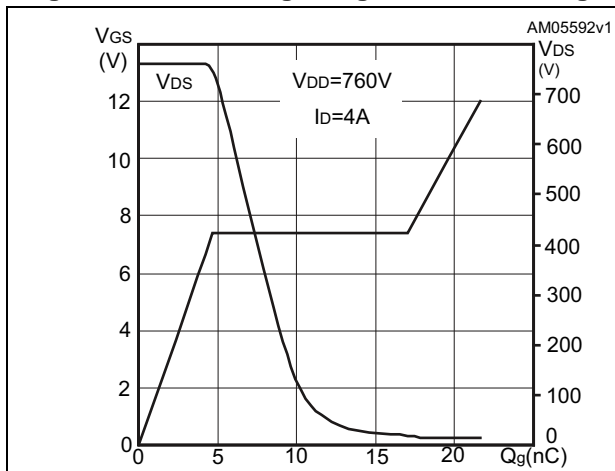


Figure 11. Static drain-source on-resistance

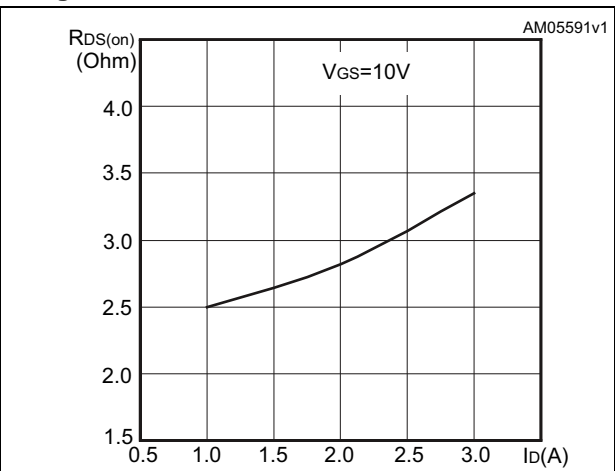


Figure 12. Capacitance variations

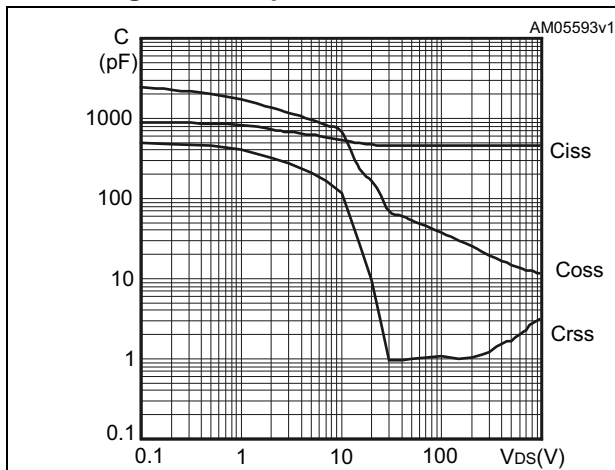


Figure 13. Output capacitance stored energy

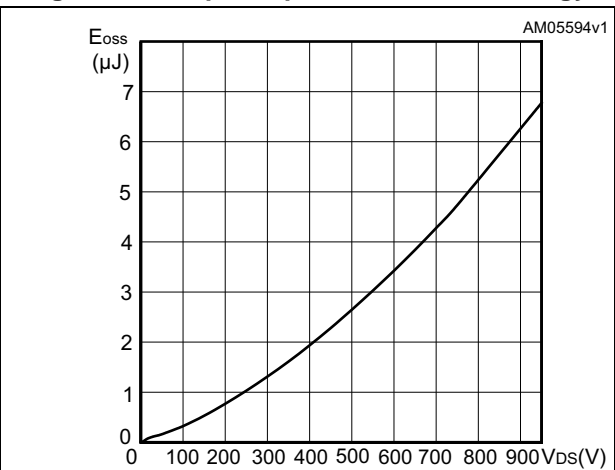


Figure 14. Normalized gate threshold voltage vs temperature

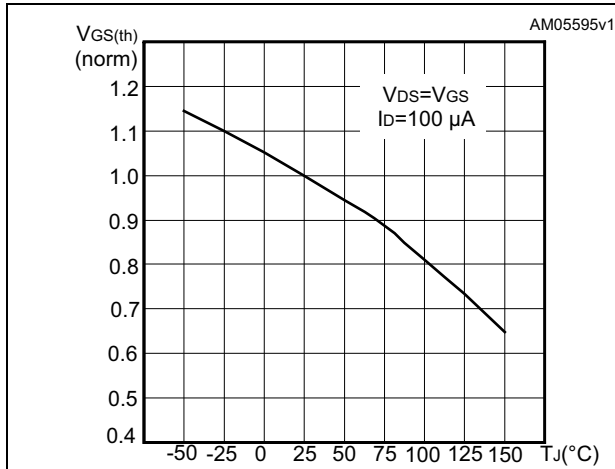


Figure 15. Normalized on-resistance vs temperature

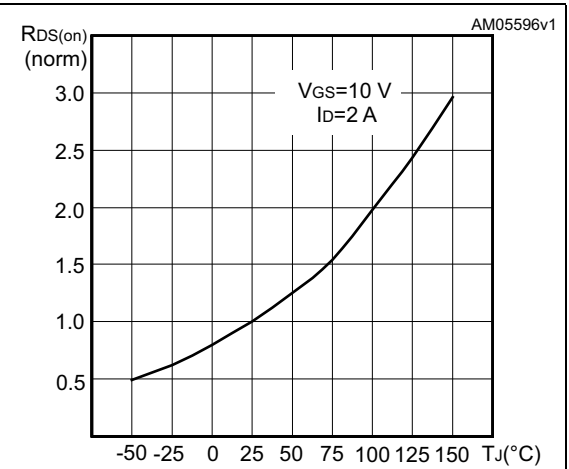


Figure 16. Source-drain diode forward characteristics

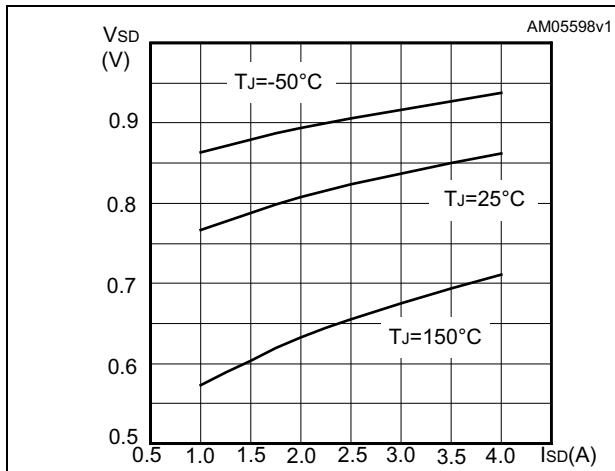


Figure 17. Normalized B_{VDS} vs temperature

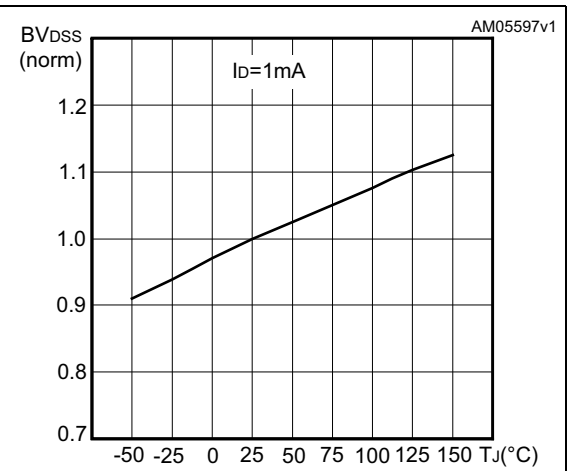
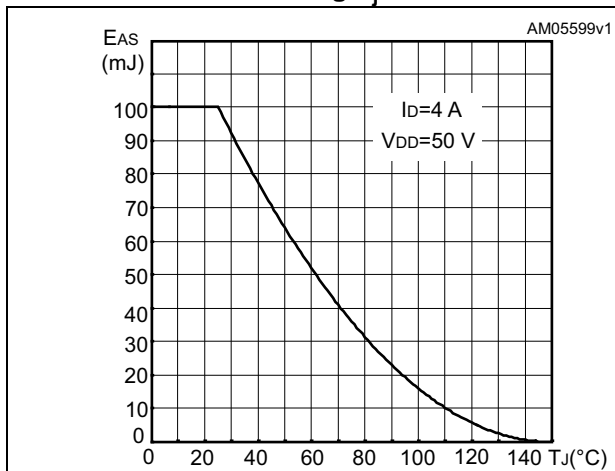


Figure 18. Maximum avalanche energy vs starting T_j



3 Test circuits

Figure 19. Switching times test circuit for resistive load



Figure 20. Gate charge test circuit

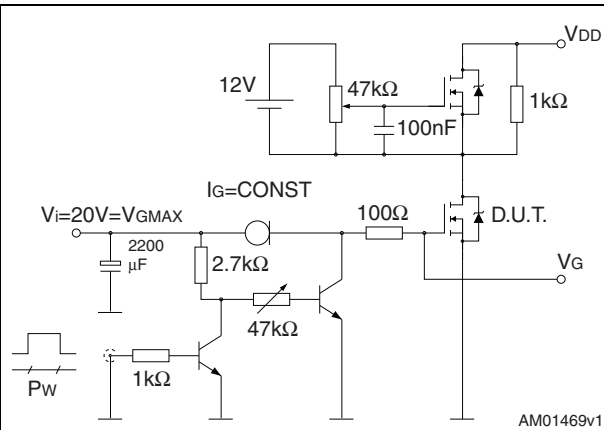


Figure 21. Test circuit for inductive load switching and diode recovery times

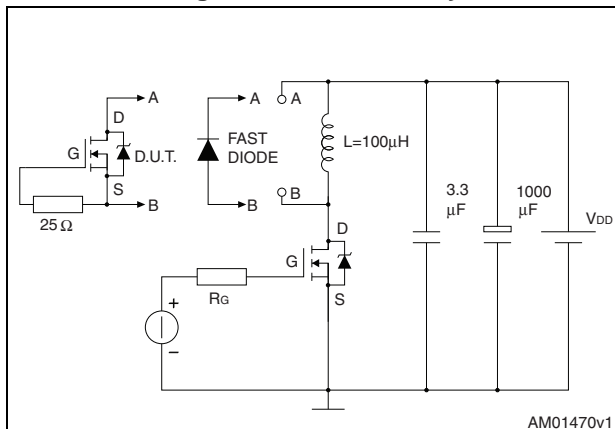


Figure 22. Unclamped inductive load test circuit

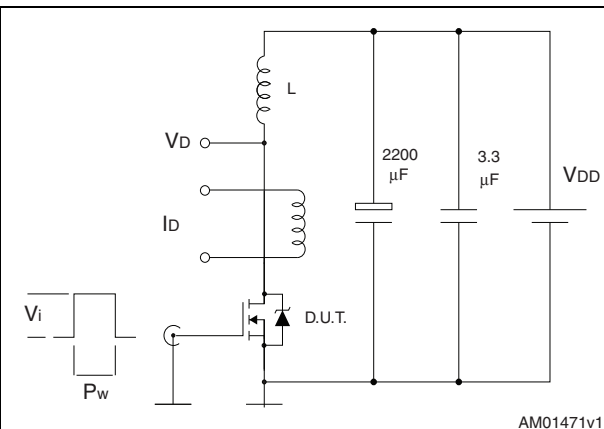


Figure 23. Unclamped inductive waveform

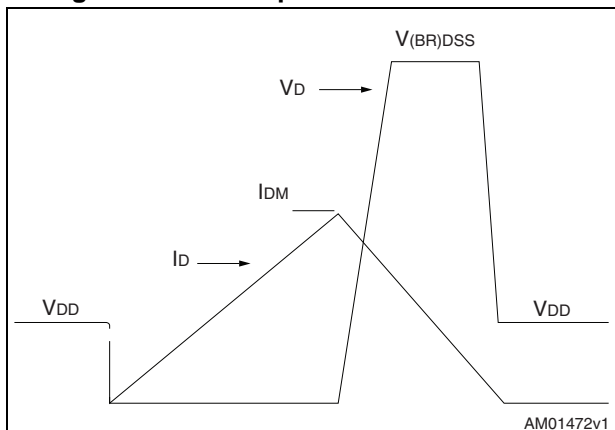
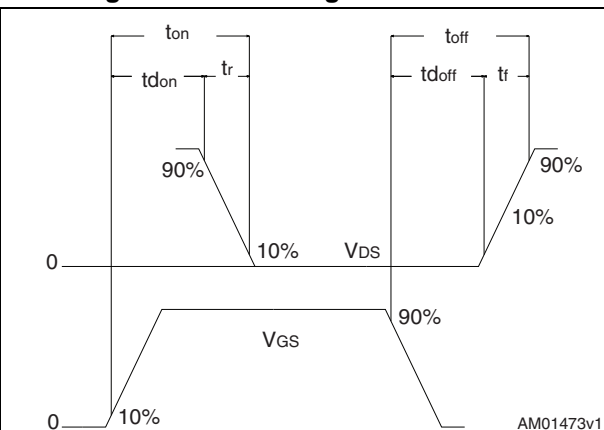


Figure 24. Switching time waveform



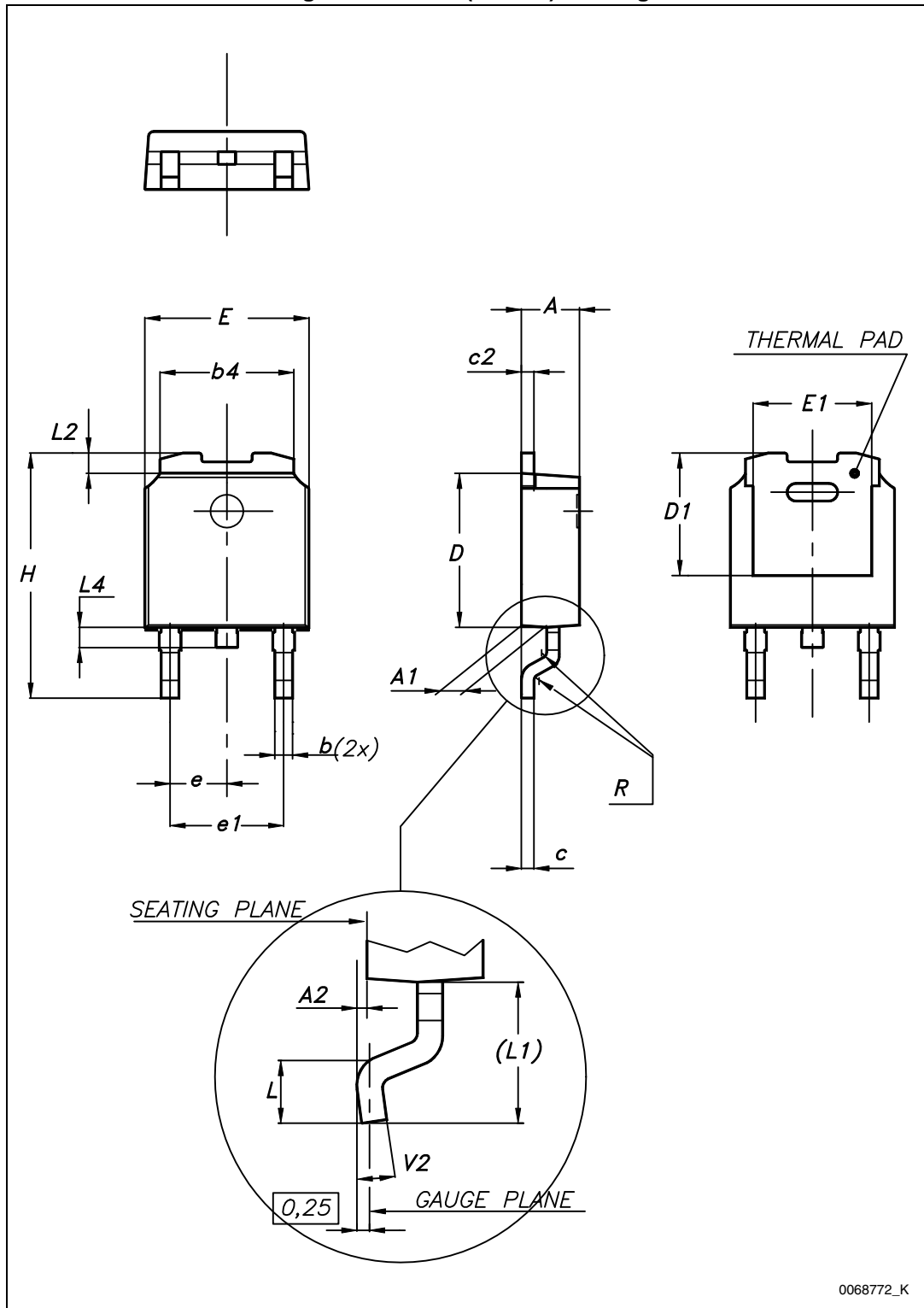
4 Package mechanical data

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. DPAK (TO-252) mechanical data

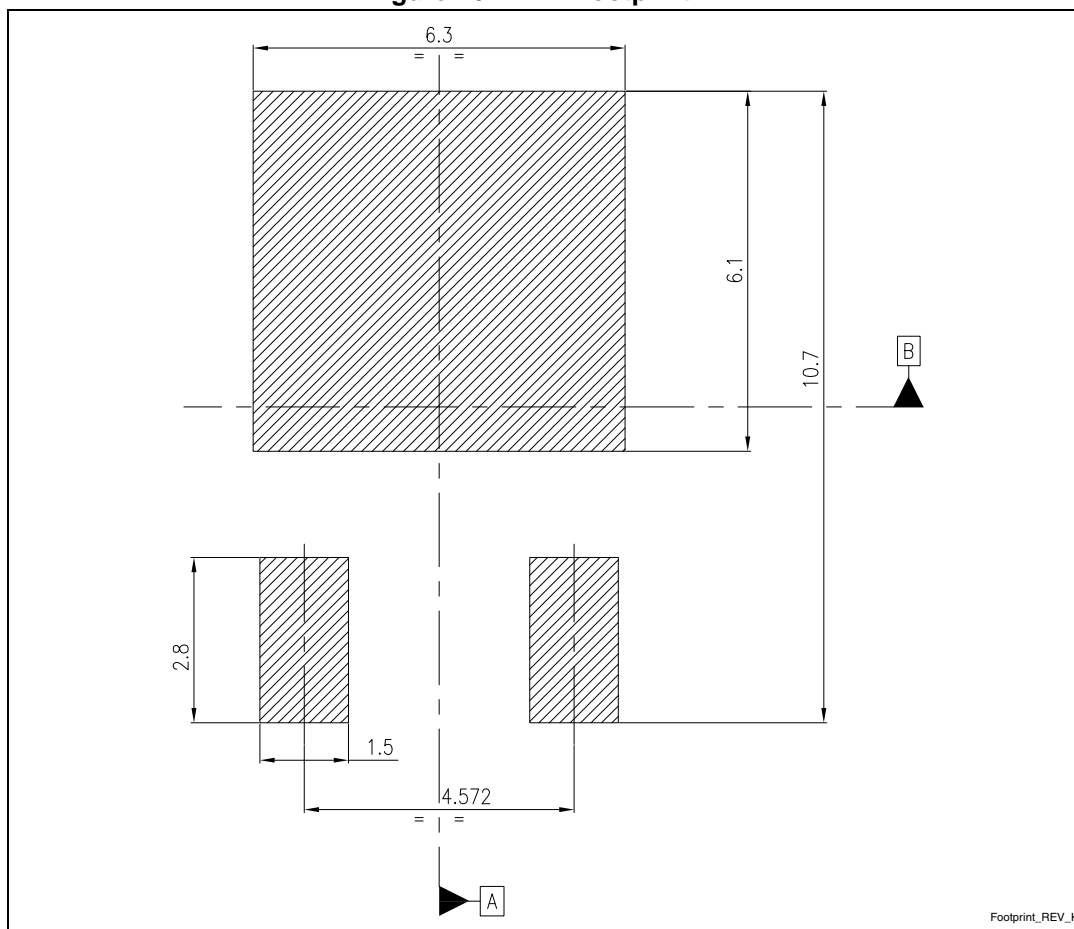
| Dim. | mm | | |
|------|------|------|-------|
| | Min. | Typ. | Max. |
| A | 2.20 | | 2.40 |
| A1 | 0.90 | | 1.10 |
| A2 | 0.03 | | 0.23 |
| b | 0.64 | | 0.90 |
| b4 | 5.20 | | 5.40 |
| c | 0.45 | | 0.60 |
| c2 | 0.48 | | 0.60 |
| D | 6.00 | | 6.20 |
| D1 | | 5.10 | |
| E | 6.40 | | 6.60 |
| E1 | | 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 25. DPAK (TO-252) drawing



0068772_K

Figure 26. DPAK footprint (a)



a. All dimensions are in millimeters

Table 10. TO-220FP mechanical data

| Dim. | mm | | |
|------|------|------|------|
| | Min. | Typ. | Max. |
| A | 4.4 | | 4.6 |
| B | 2.5 | | 2.7 |
| D | 2.5 | | 2.75 |
| E | 0.45 | | 0.7 |
| F | 0.75 | | 1 |
| F1 | 1.15 | | 1.70 |
| F2 | 1.15 | | 1.70 |
| G | 4.95 | | 5.2 |
| G1 | 2.4 | | 2.7 |
| H | 10 | | 10.4 |
| L2 | | 16 | |
| L3 | 28.6 | | 30.6 |
| L4 | 9.8 | | 10.6 |
| L5 | 2.9 | | 3.6 |
| L6 | 15.9 | | 16.4 |
| L7 | 9 | | 9.3 |
| Dia | 3 | | 3.2 |

Figure 27. TO-220FP drawing

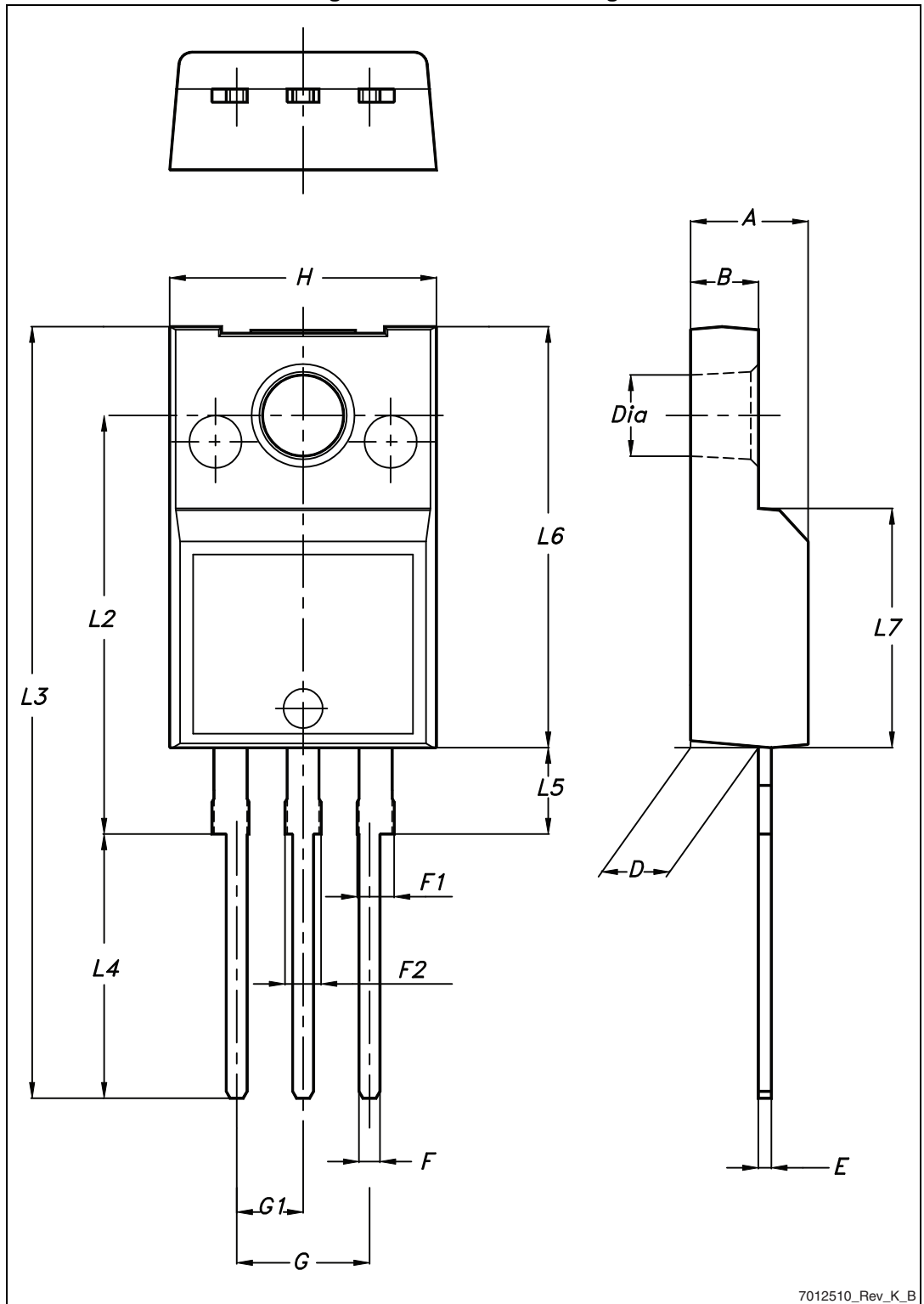


Table 11. TO-220 type A mechanical data

| 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 28. TO-220 type A drawing

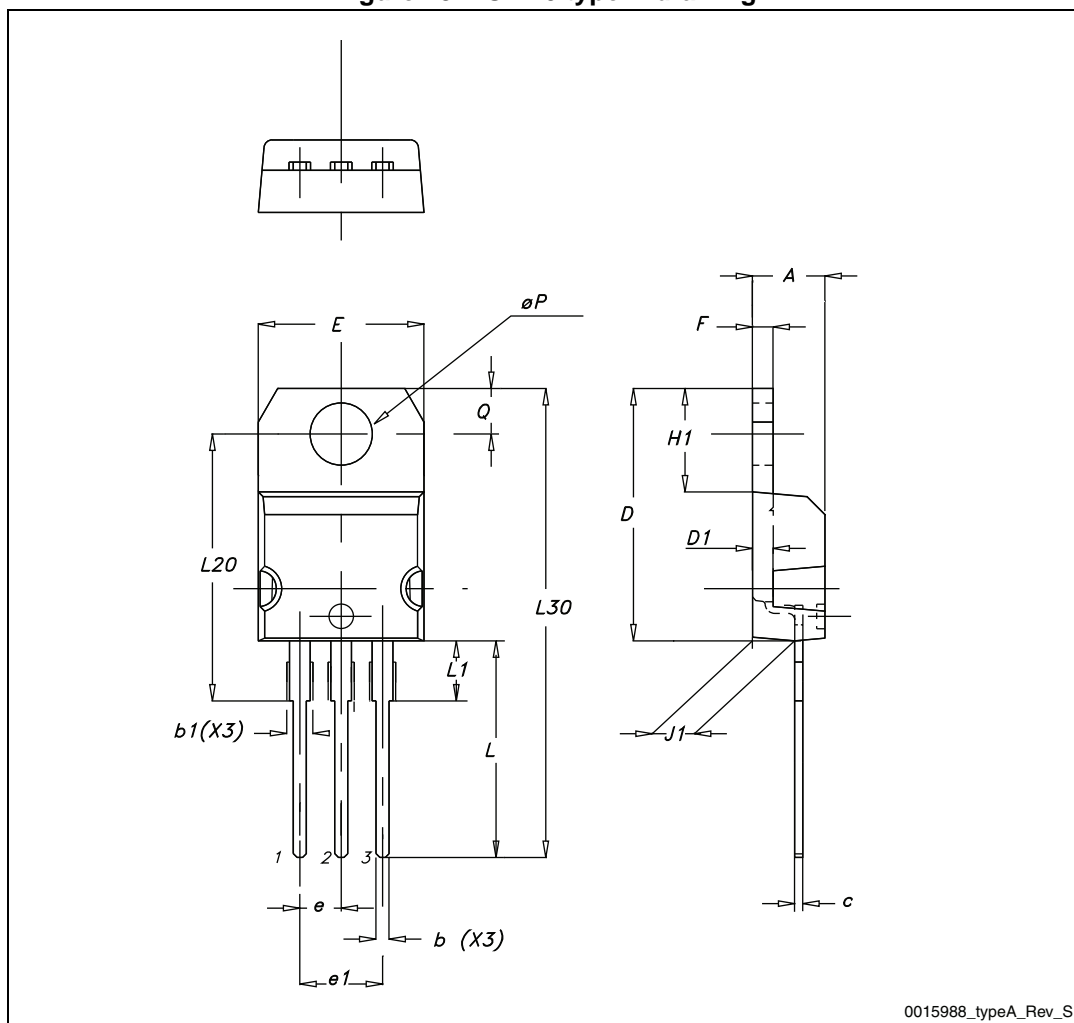
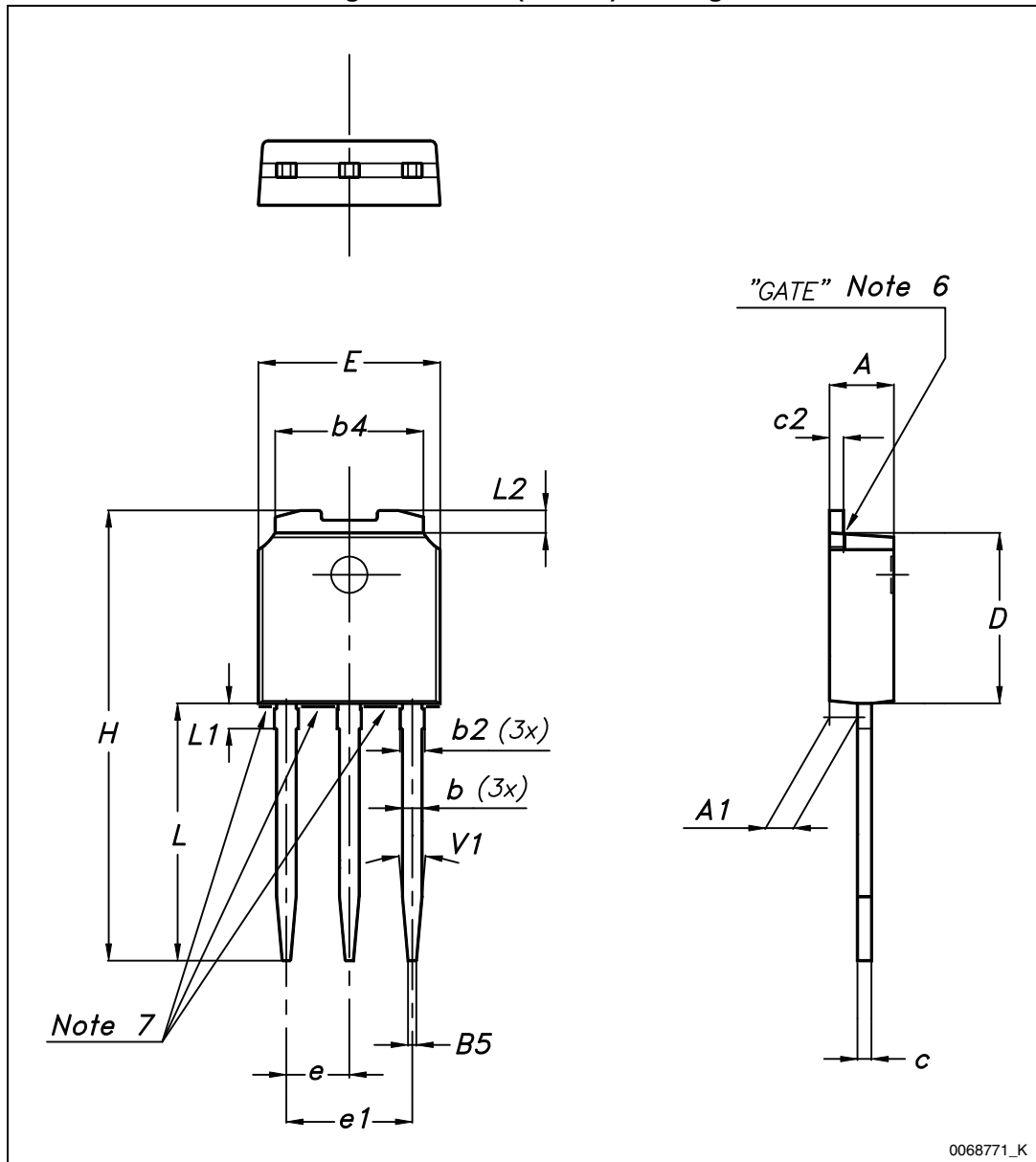


Table 12. IPAK (TO-251) mechanical data

| DIM | mm. | | |
|-----|------|-------|------|
| | min. | typ. | max. |
| A | 2.20 | | 2.35 |
| 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 | | 6.15 |
| E | 6.40 | | 6.55 |
| 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 29. IPAK (TO-251) drawing



5 Packaging mechanical data

Table 13. 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 30. Tape for DPAK (TO-252)

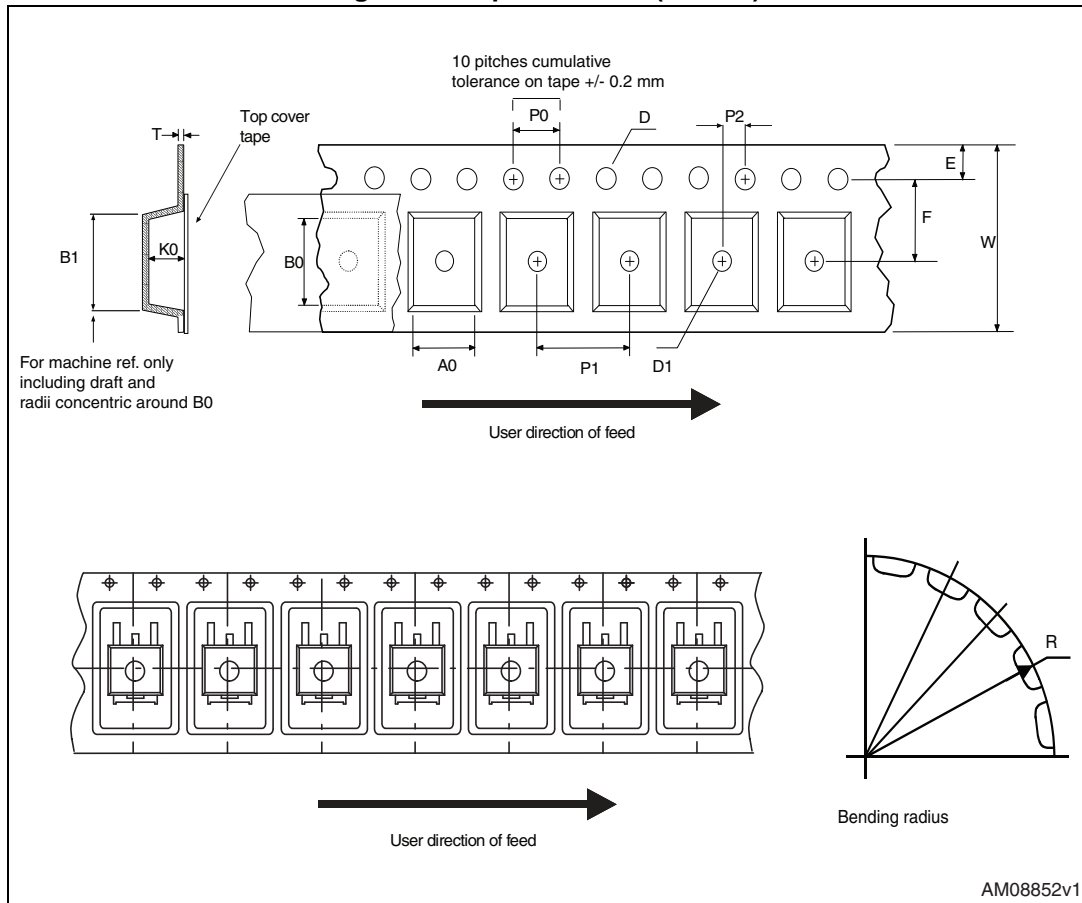
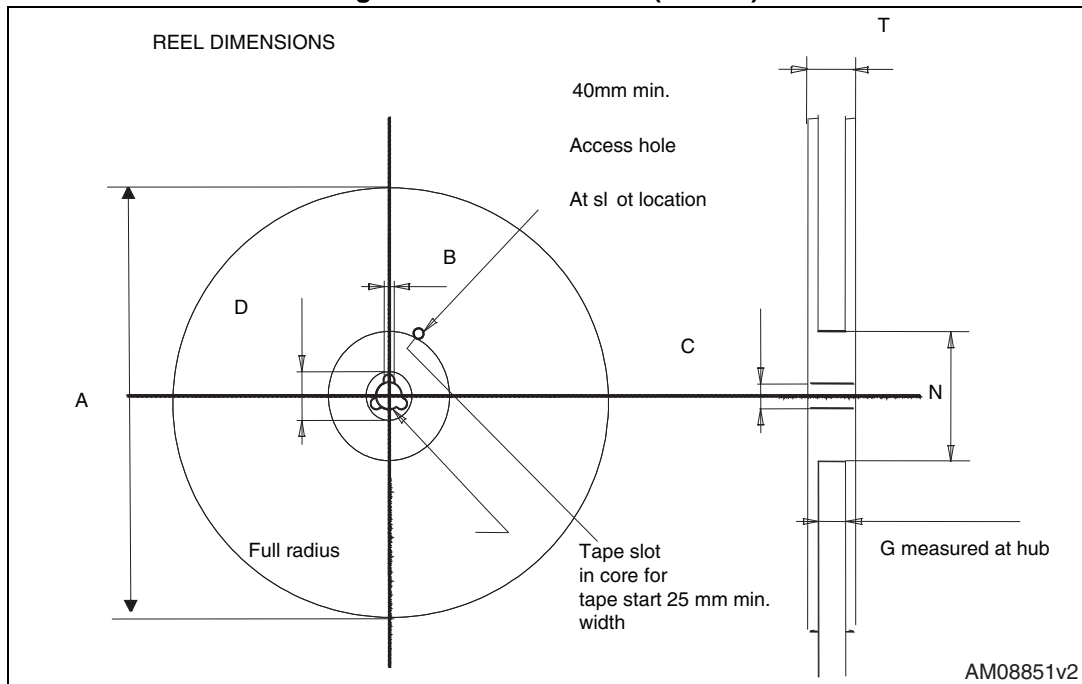


Figure 31. Reel for DPAK (TO-252)



6 Revision history

Table 14. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 12-May-2009 | 1 | First release |
| 11-Dec-2009 | 2 | Document status promoted from preliminary data to datasheet |
| 15-May-2013 | 3 | <ul style="list-style-type: none">– Updated: Section 4: Package mechanical data– Minor text change on the cover page. |

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



Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

[STMicroelectronics:](#)

[STD5N95K3](#) [STF5N95K3](#) [STU5N95K3](#)