

N-channel 650 V, 0.073 Ω , 30 A MDmesh™ V Power MOSFET
in D²PAK, TO-220FP, TO-220 and TO-247 packages

Datasheet - production data

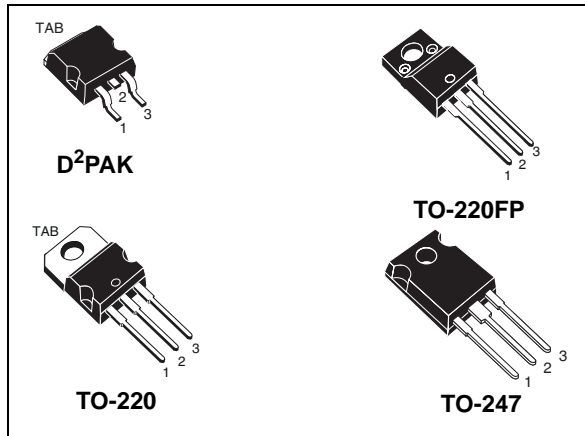
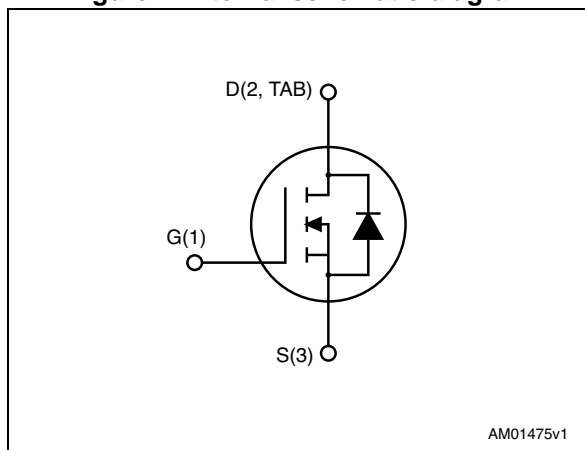


Figure 1. Internal schematic diagram



Features

| Order code | V_{DS} @ T_{Jmax} | $R_{DS(on)}$ max | I_D |
|------------|--------------------------|---------------------|-------|
| STB38N65M5 | 710 V | < 0.095 Ω | 30 A |
| STF38N65M5 | | | |
| STP38N65M5 | | | |
| STW38N65M5 | | | |

- Worldwide best $R_{DS(on)}$ * area
- Higher V_{DS} rating and high dv/dt capability
- Excellent switching performance
- 100% avalanche tested

Applications

- Switching applications

Description

These devices are N-channel MDmesh™ V Power MOSFETs based on an innovative proprietary vertical process technology, which is combined with STMicroelectronics' well-known PowerMESH™ horizontal layout structure. The resulting product has extremely low on-resistance, which is unmatched among silicon-based Power MOSFETs, making it especially suitable for applications which require superior power density and outstanding efficiency.

Table 1. Device summary

| Order code | Marking | Package | Packaging |
|------------|---------|--------------------|---------------|
| STB38N65M5 | 38N65M5 | D ² PAK | Tape and reel |
| STF38N65M5 | | TO-220FP | Tube |
| STP38N65M5 | | TO-220 | |
| STW38N65M5 | | TO-247 | |

Contents

| | | |
|----------|---|-----------|
| 1 | Electrical ratings | 3 |
| 2 | Electrical characteristics | 5 |
| 2.1 | Electrical characteristics (curves) | 7 |
| 3 | Test circuits | 10 |
| 4 | Package mechanical data | 11 |
| 5 | Packaging mechanical data | 19 |
| 6 | Revision history | 21 |



1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | | Unit |
|--------------------------------|---|--|--------------------|------|
| | | D ² PAK TO-220 TO-247 | TO-220FP | |
| V _{GS} | Gate-source voltage | ± 25 | | V |
| I _D | Drain current (continuous) at T _C = 25 °C | 30 | 30 ⁽¹⁾ | A |
| I _D | Drain current (continuous) at T _C = 100 °C | 19 | 19 ⁽¹⁾ | A |
| I _{DM} ⁽¹⁾ | Drain current (pulsed) | 120 | 120 ⁽¹⁾ | A |
| P _{TOT} | Total dissipation at T _C = 25 °C | 190 | 35 | W |
| dv/dt ⁽²⁾ | Peak diode recovery voltage slope | 15 | | V/ns |
| dv/dt ⁽³⁾ | MOSFET dv/dt ruggedness | 50 | | V/ns |
| V _{ISO} | Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T _C = 25 °C) | 2500 | | V |
| T _{stg} | Storage temperature | - 55 to 150 | | °C |
| T _j | Max. operating junction temperature | 150 | | °C |

- Limited by maximum junction temperature.
- I_{SD} ≤ 30 A, di/dt ≤ 400 A/μs; V_{Peak} < V_{(BR)DSS}, V_{DD} = 400 V
- V_{DS} ≤ 480 V

Table 3. Thermal data

| Symbol | Parameter | Value | | | | Unit |
|-----------------------|--|--------------------|----------|--------|--------|------|
| | | D ² PAK | TO-220FP | TO-220 | TO-247 | |
| R _{thj-case} | Thermal resistance junction-case max | 0.66 | 3.6 | 0.66 | | °C/W |
| R _{thj-pcb} | Thermal resistance junction-pcb max ⁽¹⁾ | 30 | | | | °C/W |
| R _{thj-amb} | Thermal resistance junction-ambient max | | 62.5 | | 50 | °C/W |

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

Table 4. Avalanche characteristics

| Symbol | Parameter | Value | Unit |
|----------|---|-------|------|
| I_{AR} | Avalanche current, repetitive or not repetitive (pulse width limited by T_{jmax}) | 8 | A |
| E_{AS} | Single pulse avalanche energy (starting $t_j = 25^\circ\text{C}$, $I_d = I_{AR}$; $V_{dd} = 50\text{V}$) | 660 | 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 | $I_D = 1\text{ mA}$, $V_{GS} = 0$ | 650 | | | V |
| I_{DSS} | Zero gate voltage drain current ($V_{GS} = 0$) | $V_{DS} = 650\text{ V}$ $V_{DS} = 650\text{ V}$, $T_C = 125\text{ °C}$ | | | 1 100 | μA μA |
| I_{GSS} | Gate-body leakage current ($V_{DS} = 0$) | $V_{GS} = \pm 25\text{ V}$ | | | ± 100 | nA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS} = V_{GS}$, $I_D = 250\text{ }\mu\text{A}$ | 3 | 4 | 5 | V |
| $R_{DS(on)}$ | Static drain-source on-resistance | $V_{GS} = 10\text{ V}$, $I_D = 15\text{ A}$ | | 0.073 | 0.095 | Ω |

Table 6. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------------------------------------|---|---|------|-------------------|------|----------------|
| C_{iss} C_{oss} C_{riss} | Input capacitance Output capacitance Reverse transfer capacitance | $V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0$ | - | 3000 74 5.8 | - | pF pF pF |
| $C^{o(tr)(1)}$ | Equivalent capacitance time related | $V_{DS} = 0\text{ to }520\text{ V}$, $V_{GS} = 0$ | - | 244 | - | pF |
| $C^{o(er)(2)}$ | Equivalent capacitance energy related | | - | 70 | - | pF |
| R_G | Intrinsic gate resistance | $f = 1\text{ MHz}$ open drain | - | 2.4 | - | Ω |
| Q_g Q_{gs} Q_{gd} | Total gate charge Gate-source charge Gate-drain charge | $V_{DD} = 520\text{ V}$, $I_D = 15\text{ A}$, $V_{GS} = 10\text{ V}$ (see Figure 20) | - | 71 18 30 | - | nC nC 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 7. Switching times

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------------|--------------------|---|------|------|------|------|
| $t_d (v)$ | Voltage delay time | $V_{DD} = 400 \text{ V}$, $I_D = 20 \text{ A}$, | | 66 | | ns |
| $t_r (v)$ | Voltage rise time | $R_G = 4.7 \ \Omega$, $V_{GS} = 10 \text{ V}$ | - | 9 | - | ns |
| $t_f (i)$ | Current fall time | (see Figure 21 and | | 9 | | ns |
| $t_{c(off)}$ | Crossing time | Figure 24) | | 13 | | ns |

Table 8. Source drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|---|------|------|------|---------------|
| I_{SD} | Source-drain current | | | | 30 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | - | | 120 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD} = 30 \text{ A}$, $V_{GS} = 0$ | - | | 1.5 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 30 \text{ A}$, $di/dt = 100 \text{ A}/\mu\text{s}$ | | 382 | | ns |
| Q_{rr} | Reverse recovery charge | $V_{DD} = 100 \text{ V}$ (see Figure 24) | - | 6.6 | | μC |
| I_{RRM} | Reverse recovery current | | | 35 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 30 \text{ A}$, $di/dt = 100 \text{ A}/\mu\text{s}$ | | 522 | | ns |
| Q_{rr} | Reverse recovery charge | $V_{DD} = 100 \text{ V}$, $T_j = 150 \text{ }^\circ\text{C}$ | - | 10.3 | | μC |
| I_{RRM} | Reverse recovery current | (see Figure 24) | | 40 | | A |

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

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for D²PAK and TO-220

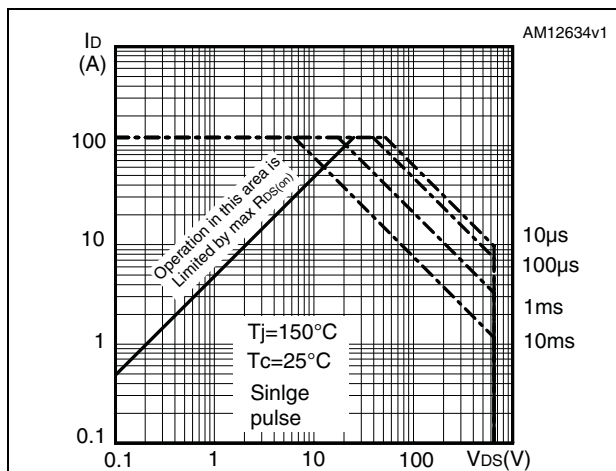


Figure 3. Thermal impedance for D²PAK and TO-220

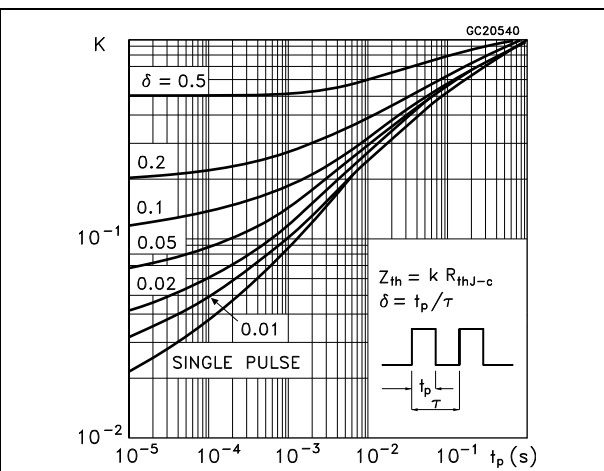


Figure 4. Safe operating area for TO-220FP

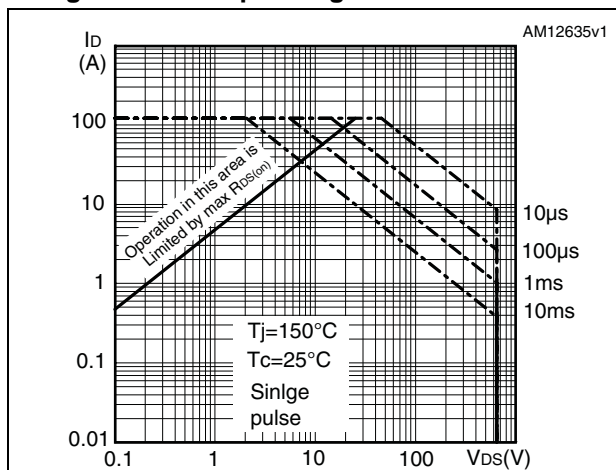


Figure 5. Thermal impedance for TO-220FP

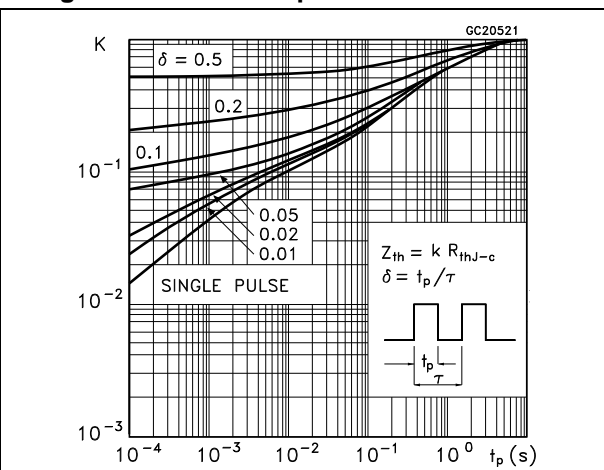


Figure 6. Safe operating area for TO-247

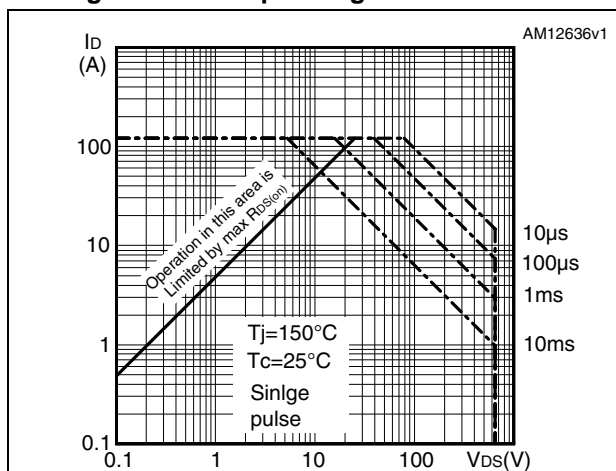


Figure 7. Thermal impedance for TO-247

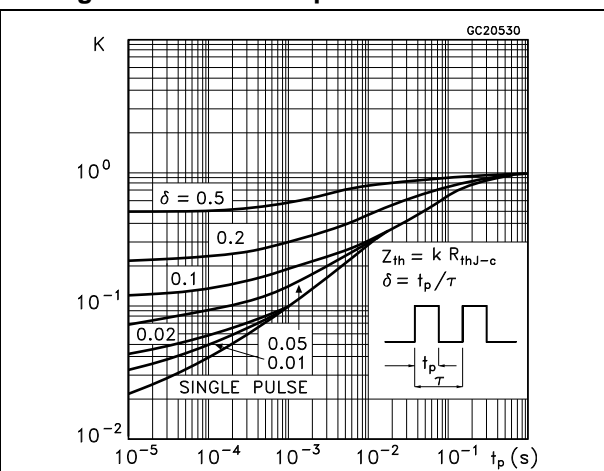


Figure 8. Output characteristics

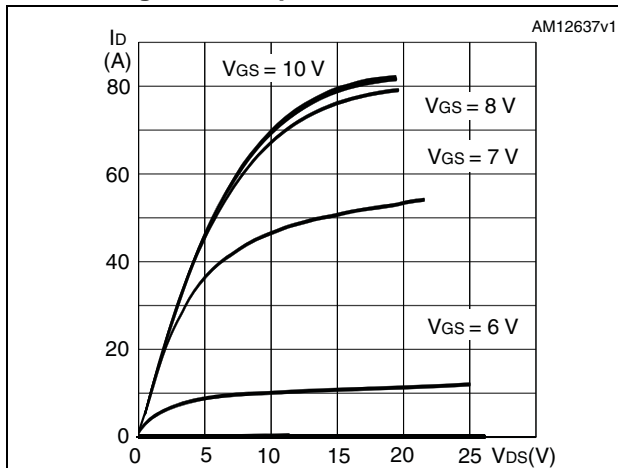


Figure 9. Transfer characteristics

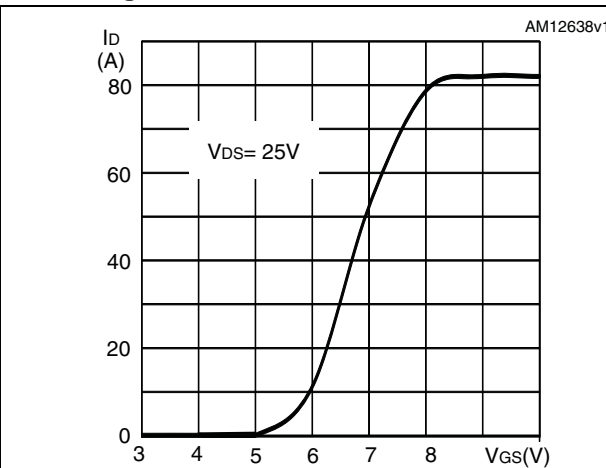


Figure 10. Gate charge vs gate-source voltage

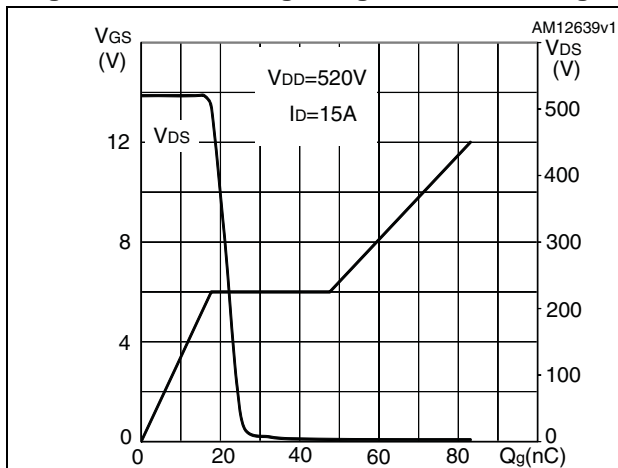


Figure 11. Static drain-source on-resistance

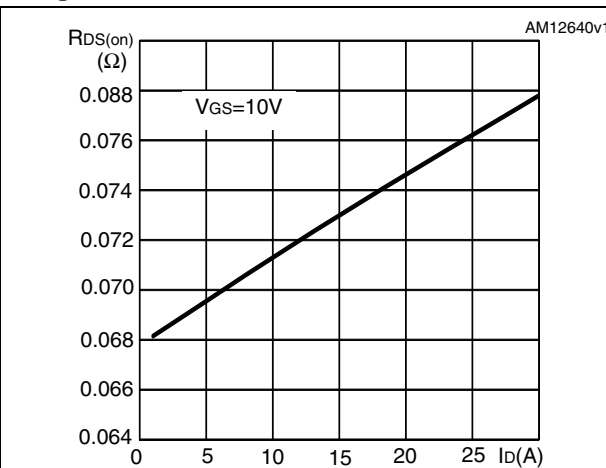


Figure 12. Capacitance variations

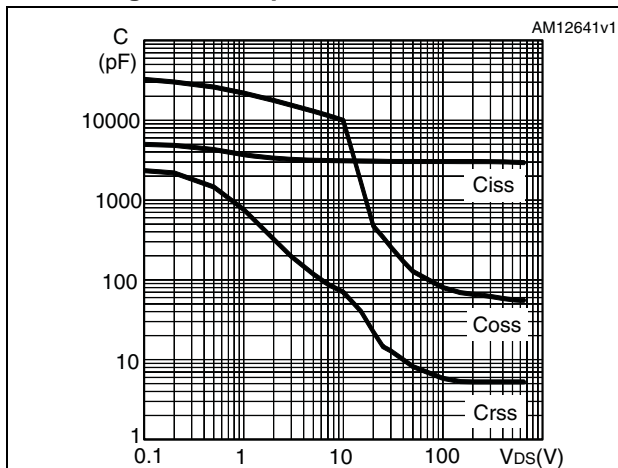


Figure 13. Output capacitance stored energy

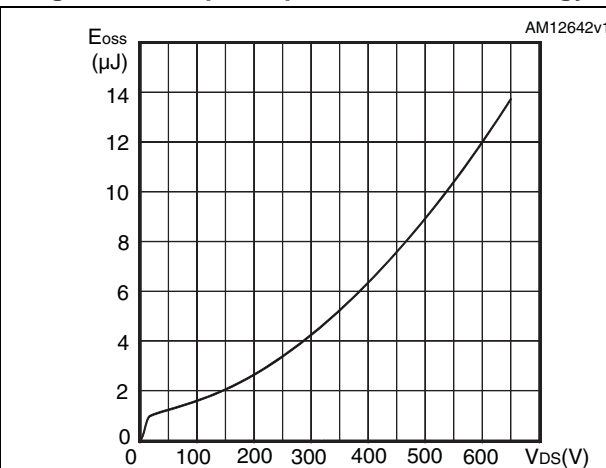


Figure 14. Normalized gate threshold voltage vs temperature

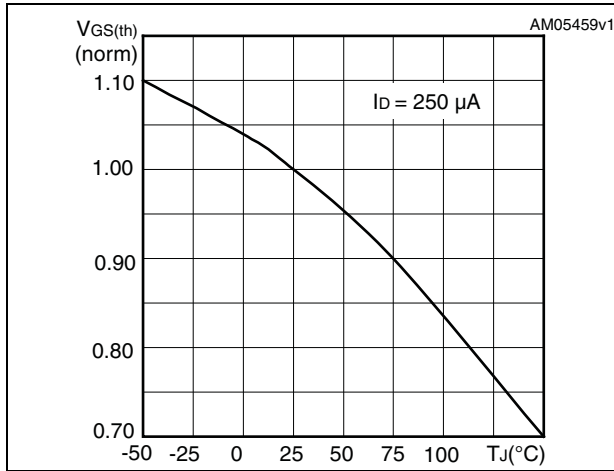


Figure 15. Normalized on-resistance vs temperature

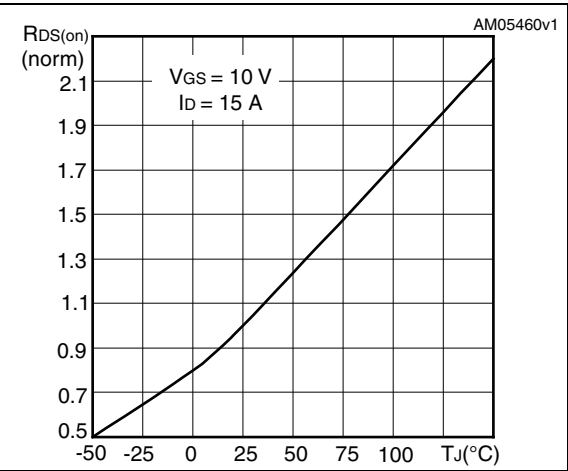


Figure 16. Source-drain diode forward characteristics

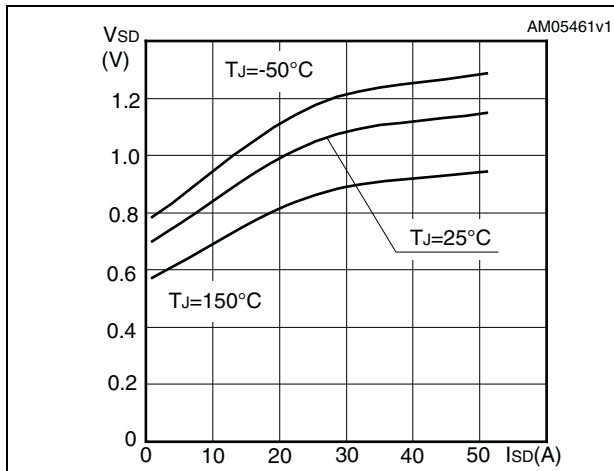


Figure 17. Normalized V_{DS} vs temperature

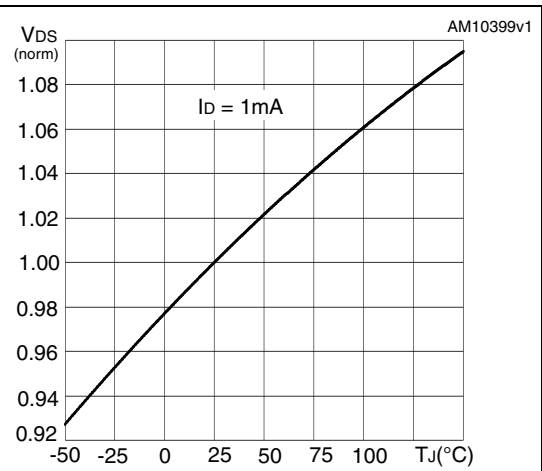
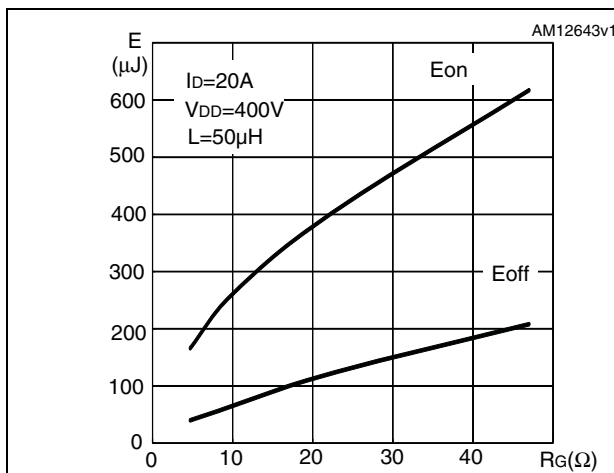


Figure 18. Switching losses vs gate resistance (1)



1. Eon including reverse recovery of a SiC diode.

3 Test circuits

Figure 19. Switching times test circuit for resistive load

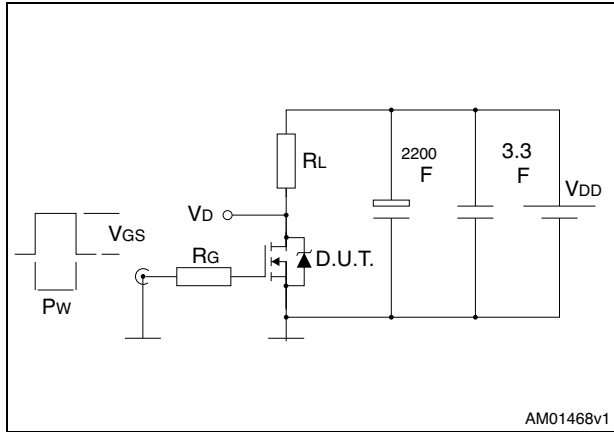


Figure 20. Gate charge test circuit

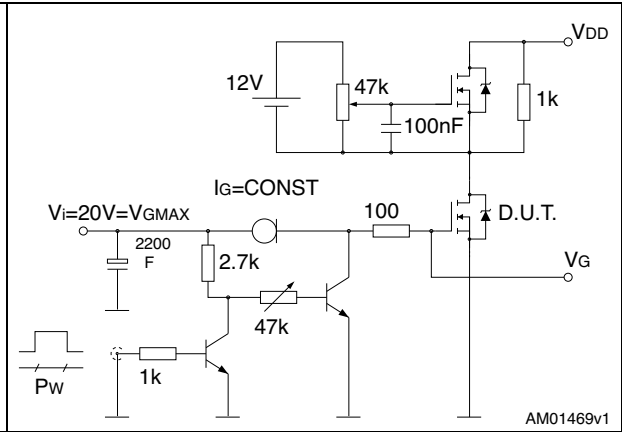


Figure 21. Test circuit for inductive load switching and diode recovery times

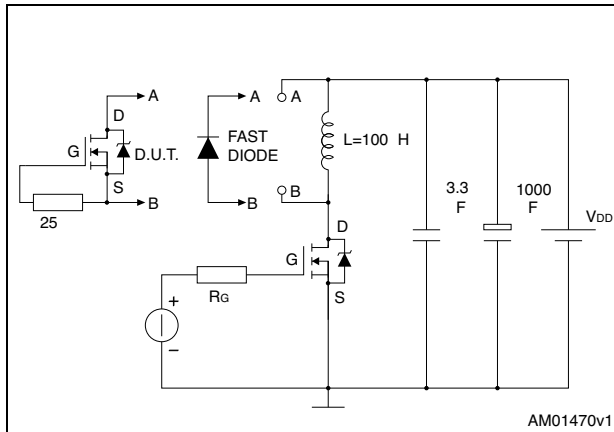


Figure 22. Unclamped inductive load test circuit

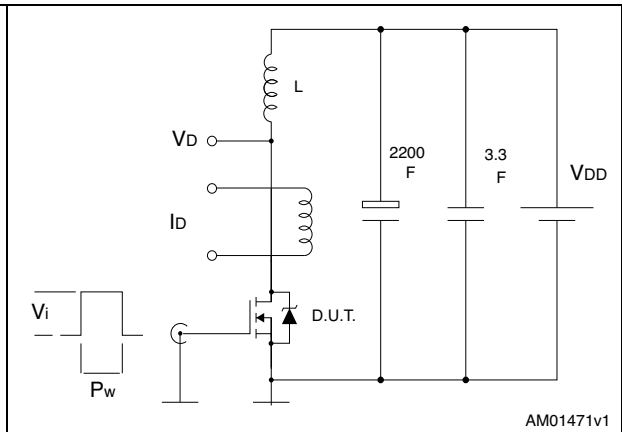


Figure 23. Unclamped inductive waveform

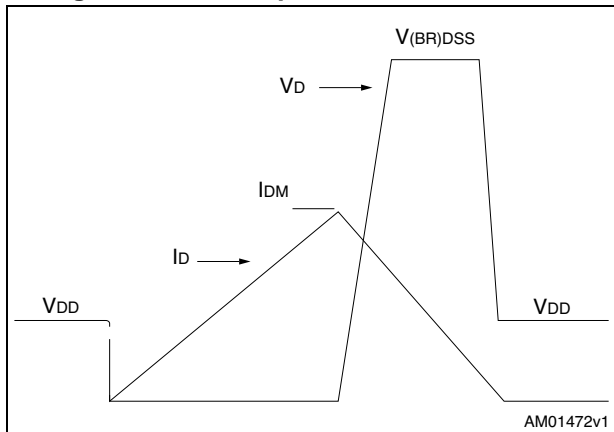
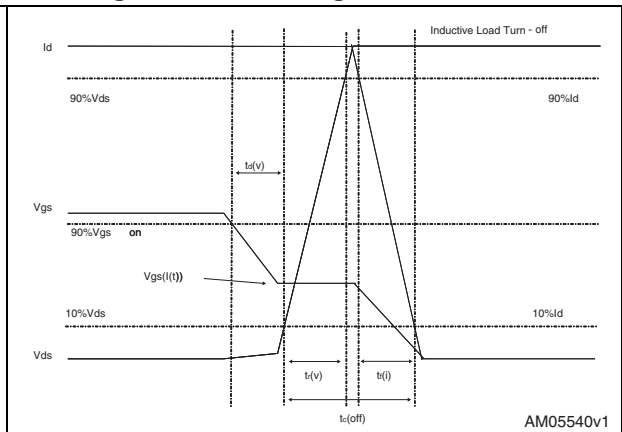


Figure 24. Switching time waveform



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. D²PAK (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 25. D²PAK (TO-263) drawing

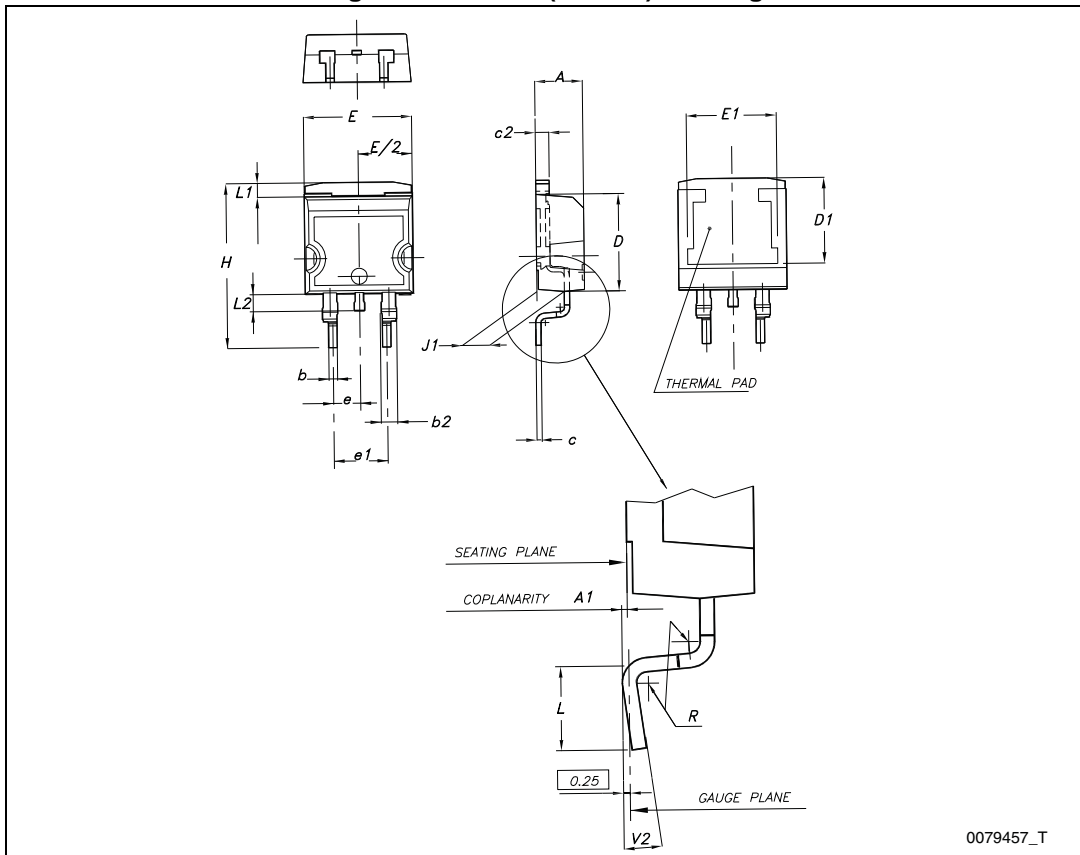
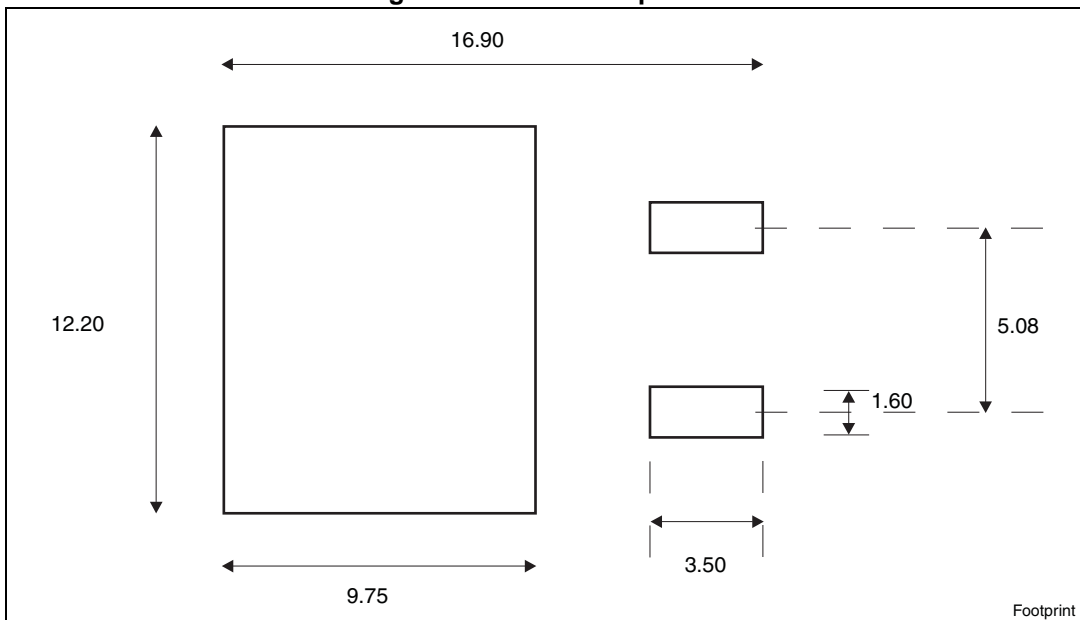


Figure 26. D²PAK footprint^(a)

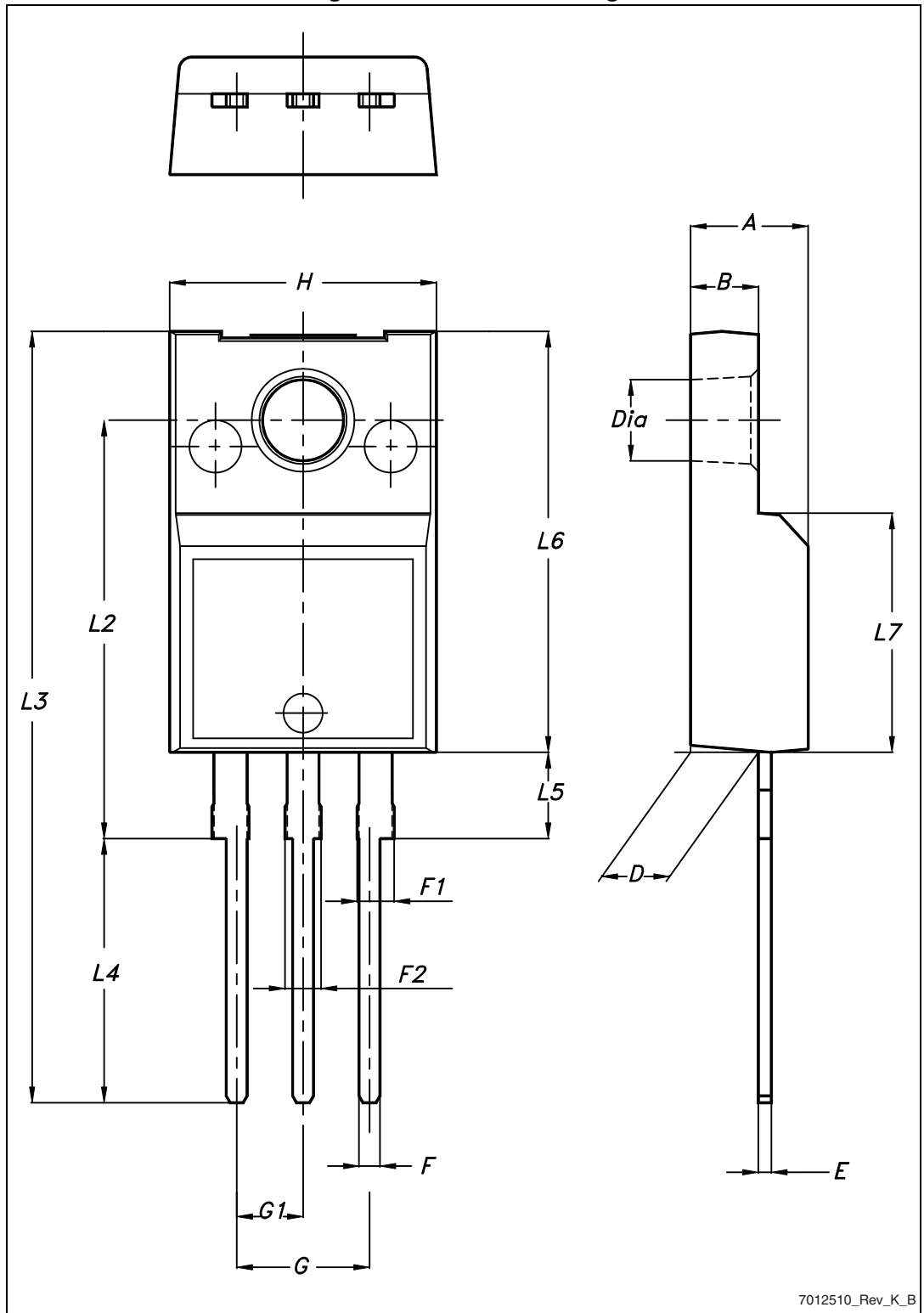


a. All dimension are in millimeters

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



7012510_Rev_K_B

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

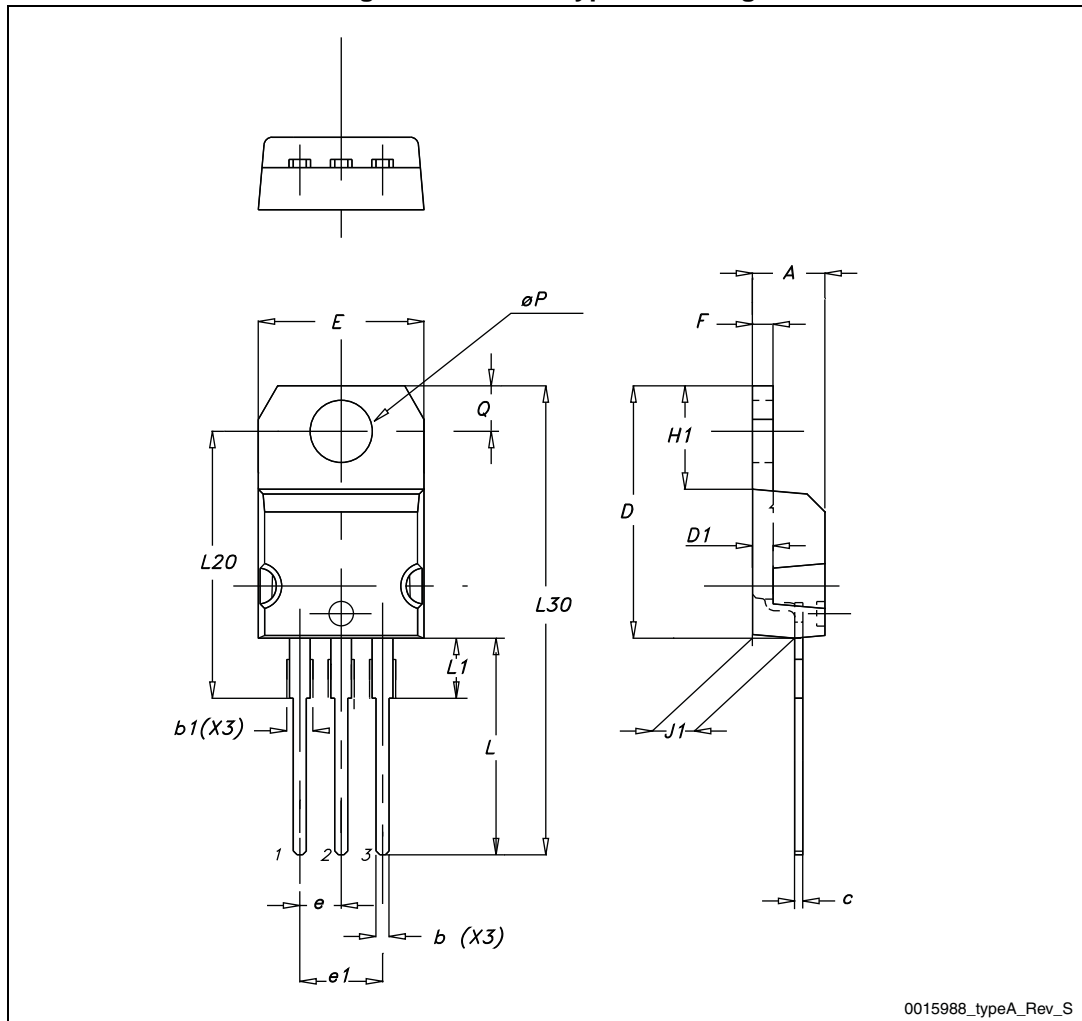
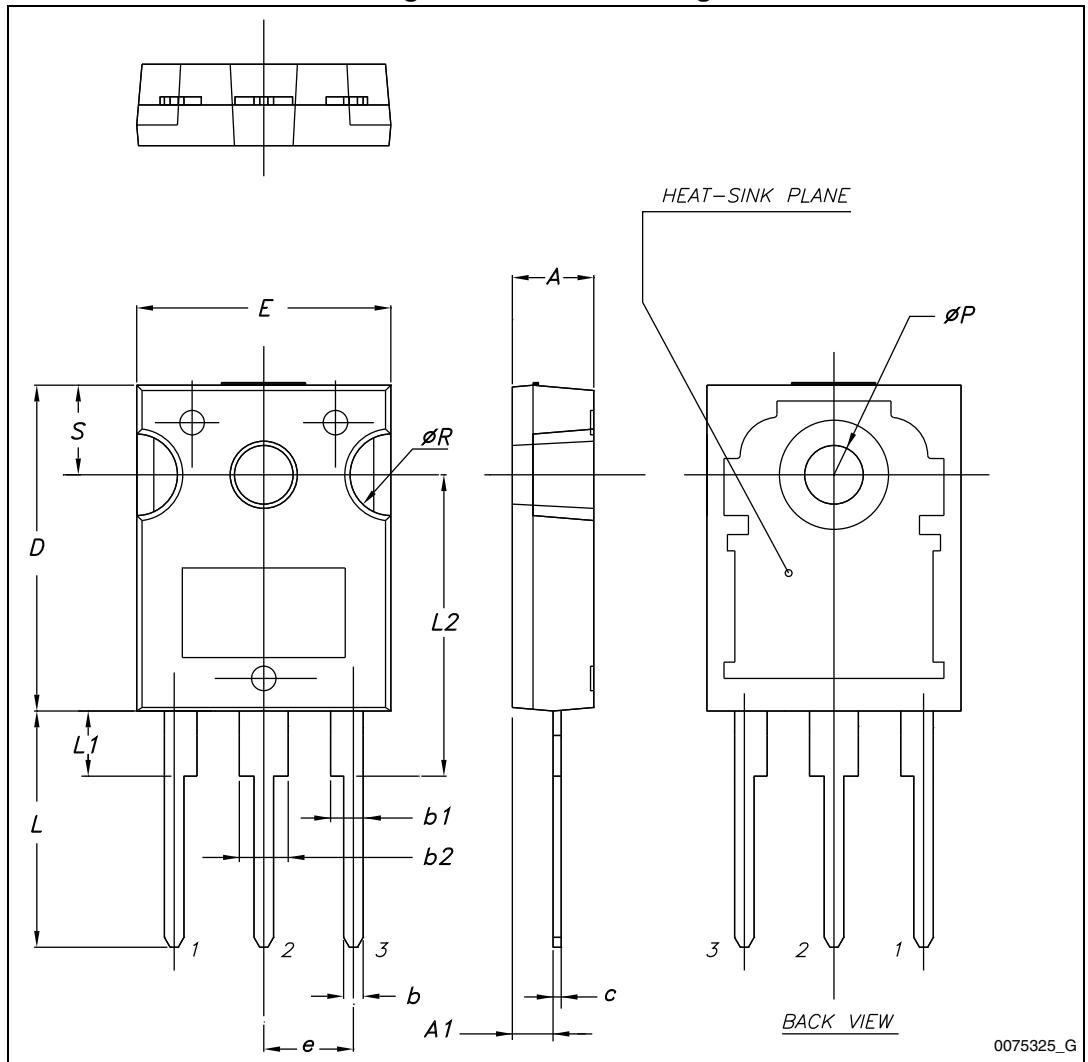


Table 12. TO-247 mechanical data

| 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 | 5.30 | 5.45 | 5.60 |
| L | 14.20 | | 14.80 |
| L1 | 3.70 | | 4.30 |
| L2 | | 18.50 | |
| ØP | 3.55 | | 3.65 |
| ØR | 4.50 | | 5.50 |
| S | 5.30 | 5.50 | 5.70 |

Figure 29. TO-247 drawing

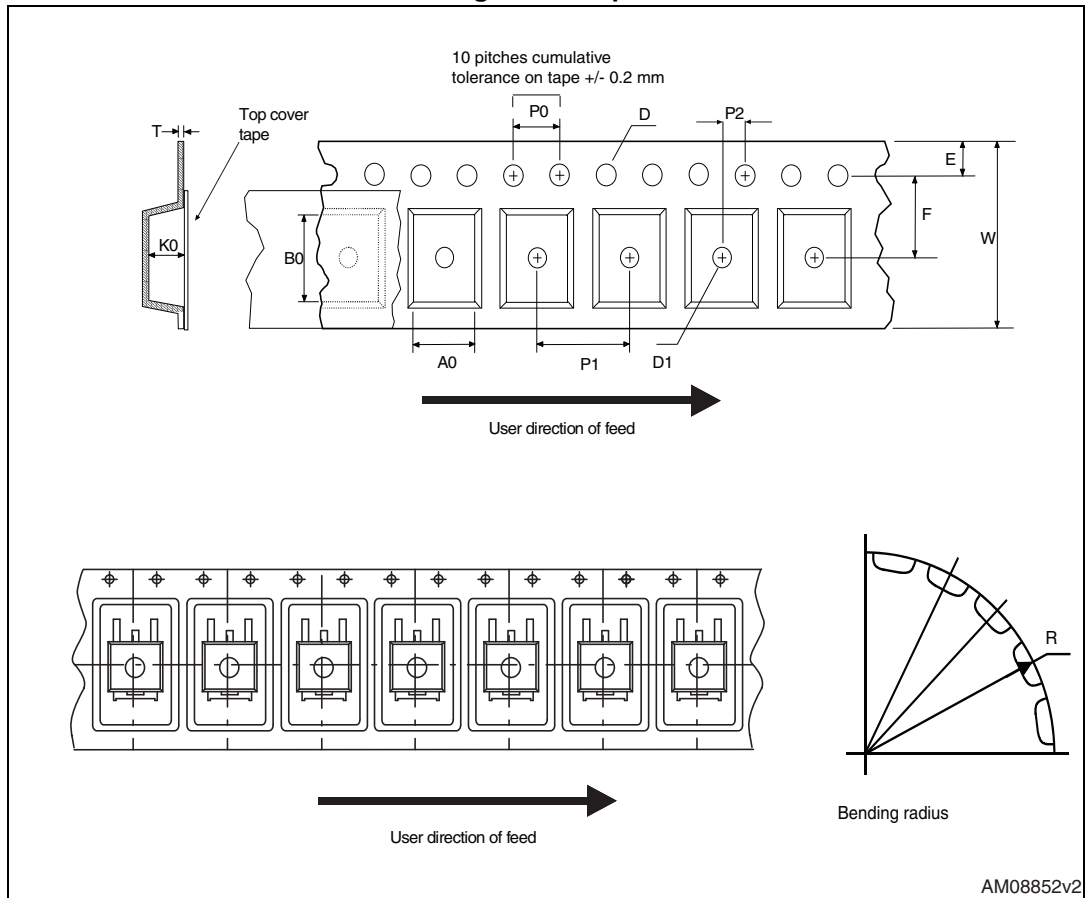


5 Packaging mechanical data

Table 13. D²PAK (TO-263) tape and reel mechanical data

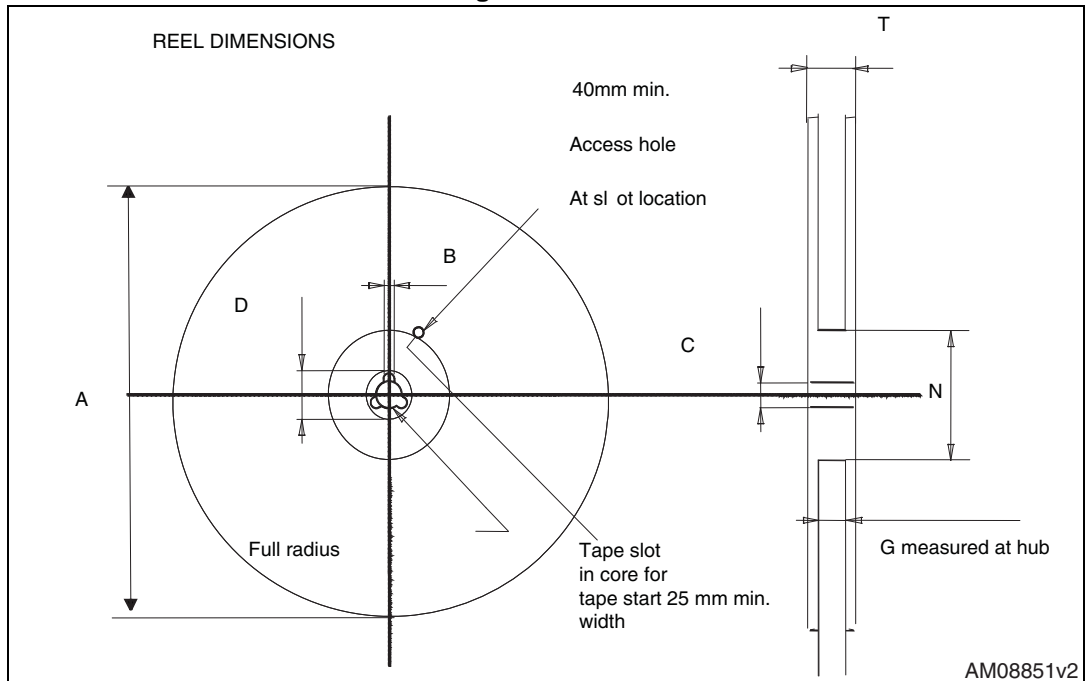
| Tape | | | Reel | | |
|------|------|------|------|----------|------|
| Dim. | mm | | Dim. | mm | |
| | Min. | Max. | | Min. | Max. |
| A0 | 10.5 | 10.7 | A | | 330 |
| B0 | 15.7 | 15.9 | B | 1.5 | |
| D | 1.5 | 1.6 | C | 12.8 | 13.2 |
| D1 | 1.59 | 1.61 | D | 20.2 | |
| E | 1.65 | 1.85 | G | 24.4 | 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 30. Tape



AM08852v2

Figure 31. Reel



AM08851v2

6 Revision history

Table 14. Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 22-Feb-2012 | 1 | First release. |
| 21-Jun-2012 | 2 | Document status changed from preliminary data to production data. Added Section 2.1: Electrical characteristics (curves) . |
| 05-Mar-2013 | 3 | Added dv/dt value on Table 2: Absolute maximum ratings . |

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