



Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from,Europe,America and south Asia,supplying obsolete and hard-to-find components to meet their specific needs.

With the principle of “Quality Parts,Customers Priority,Honest Operation,and Considerate Service”,our business mainly focus on the distribution of electronic components. Line cards we deal with include Microchip,ALPS,ROHM,Xilinx,Pulse,ON,Everlight and Freescale. Main products comprise IC,Modules,Potentiometer,IC Socket,Relay,Connector.Our parts cover such applications as commercial,industrial, and automotives areas.

We are looking forward to setting up business relationship with you and hope to provide you with the best service and solution. Let us make a better world for our industry!



Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832

Email & Skype: info@chipsmall.com Web: www.chipsmall.com

Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China



N-channel 650 V, 0.79 Ω typ., 5 A MDmesh M2 Power MOSFETs
in DPAK, TO-220FP, TO-220 and IPAK packages

Datasheet - production data

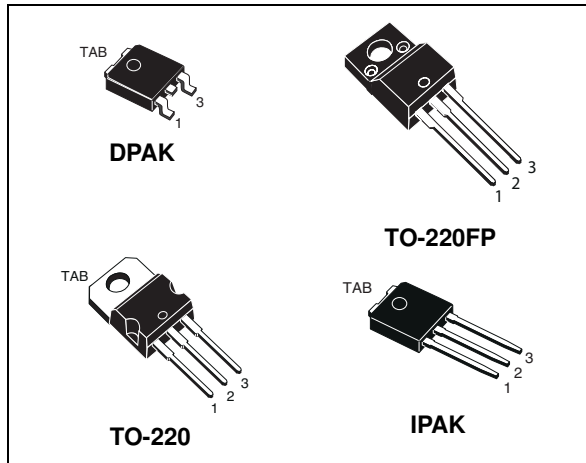
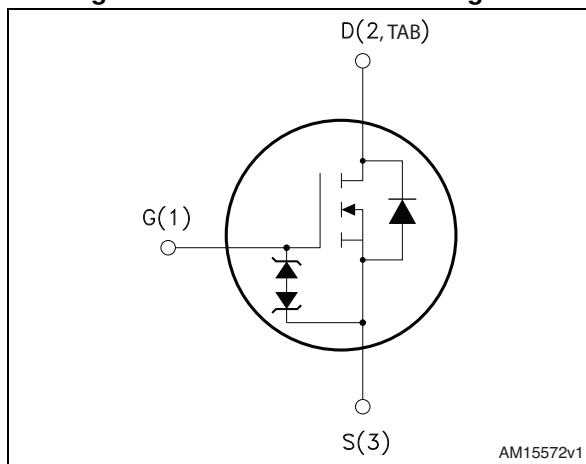


Figure 1. Internal schematic diagram



Features

| Order codes | V_{DS} | $R_{DS(on)max}$ | I_D |
|-------------|----------|-----------------|-------|
| STD9N65M2 | 650 V | 0.9 Ω | 5 A |
| STF9N65M2 | | | |
| STP9N65M2 | | | |
| STU9N65M2 | | | |

- Extremely low gate charge
- Excellent output capacitance (C_{OSS}) profile
- 100% avalanche tested
- Zener-protected

Applications

- Switching applications

Description

These devices are N-channel Power MOSFETs developed using the MDmesh™ M2 technology. Thanks to the strip layout associated to an improved vertical structure, the devices exhibit both low on-resistance and optimized switching characteristics. They are therefore suitable for the most demanding high efficiency converters.

Table 1. Device summary

| Order codes | Marking | Package | Packaging |
|-------------|---------|----------|---------------|
| STD9N65M2 | 9N65M2 | DPAK | Tape and reel |
| STF9N65M2 | | TO-220FP | Tube |
| STP9N65M2 | | TO-220 | |
| STU9N65M2 | | 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**
 - 4.1 DPAK, STD9N65M211
 - 4.2 TO-220FP, STF9N65M2 14
 - 4.3 TO-220, STP9N65M2 16
 - 4.4 IPAK, STU9N65M2 18
- 5 Packaging mechanical data 20**
- 6 Revision history 22**



1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | | Unit |
|--------------------------------|--|--------------------|--------------------|------|
| | | DPAK, TO-220, IPAK | TO-220FP | |
| V _{GS} | Gate-source voltage | ± 25 | | V |
| I _D | Drain current (continuous) at T _C = 25 °C | 5 | 5 ⁽¹⁾ | A |
| I _D | Drain current (continuous) at T _C = 100 °C | 3.2 | 3.2 ⁽¹⁾ | A |
| I _{DM} ⁽²⁾ | Drain current (pulsed) | 20 | | A |
| P _{TOT} | Total dissipation at T _C = 25 °C | 60 | 20 | W |
| V _{ISO} | Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s; T _C =25 °C) | | 2500 | V |
| dv/dt ⁽³⁾ | Peak diode recovery voltage slope | 15 | | V/ns |
| dv/dt ⁽⁴⁾ | MOSFET dv/dt ruggedness | 50 | | |
| T _{stg} | Storage temperature | - 55 to 150 | | °C |
| T _j | Max. operating junction temperature | 150 | | |

1. Current limited by package.
2. Pulse width limited by safe operating area.
3. I_{SD} ≤ 5 A, di/dt ≤ 400 A/μs; V_{DS peak} < V_{(BR)DSS}, V_{DD}=400 V
4. V_{DS} ≤ 520 V

Table 3. Thermal data

| Symbol | Parameter | Value | | | | Unit |
|-------------------------------------|---|-------|----------|--------|------|------|
| | | DPAK | TO-220FP | TO-220 | IPAK | |
| R _{thj-case} | Thermal resistance junction-case max | 2.08 | 6.25 | 2.08 | | °C/W |
| R _{thj-pcb} ⁽¹⁾ | Thermal resistance junction-pcb max | 50 | | | | °C/W |
| R _{thj-amb} | Thermal resistance junction-ambient max | | 62.5 | | 100 | °C/W |

1. When mounted on 1 inch² 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 _{jmax}) | 1 | A |
| E _{AS} | Single pulse avalanche energy (starting T _j =25°C, I _D = I _{AR} ; V _{DD} =50) | 105 | 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 | $V_{GS} = 0, I_D = 1\text{ mA}$ | 650 | | | V |
| I_{DSS} | Zero gate voltage drain current | $V_{GS} = 0, V_{DS} = 650\text{ V}$ | | | 1 | μA |
| | | $V_{GS} = 0, V_{DS} = 650\text{ V}, T_C = 125\text{ °C}$ | | | 100 | μA |
| I_{GSS} | Gate-body leakage current | $V_{DS} = 0, V_{GS} = \pm 25\text{ V}$ | | | ± 10 | μA |
| $V_{GS(th)}$ | 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 | $V_{GS} = 10\text{ V}, I_D = 2.5\text{ A}$ | | 0.79 | 0.9 | Ω |

Table 6. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------------------|-------------------------------|---|------|------|------|----------|
| C_{iss} | Input capacitance | $V_{DS} = 100\text{ V}, f = 1\text{ MHz}, V_{GS} = 0$ | - | 315 | - | pF |
| C_{oss} | Output capacitance | | - | 18 | - | pF |
| C_{riss} | Reverse transfer capacitance | | - | 1 | - | pF |
| $C_{oss\text{ eq}}^{(1)}$ | Equivalent output capacitance | $V_{GS} = 0, V_{DS} = 0\text{ to }520\text{ V}$ | - | 109 | - | pF |
| R_G | Intrinsic gate resistance | $f = 1\text{ MHz open drain}$ | - | 6.6 | - | Ω |
| Q_g | Total gate charge | $V_{DD} = 520\text{ V}, I_D = 5\text{ A}, V_{GS} = 10\text{ V}$ (see Figure 19) | - | 10 | - | nC |
| Q_{gs} | Gate-source charge | | - | 2.5 | - | nC |
| Q_{gd} | Gate-drain charge | | - | 5 | - | nC |

1. $C_{oss\text{ eq}}$ 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 | $V_{DD} = 325\text{ V}, I_D = 2.5\text{ A}, R_G = 4.7\text{ }\Omega, V_{GS} = 10\text{ V}$ (see Figure 18 and Figure 23) | - | 7.5 | - | ns |
| t_r | Rise time | | - | 6.6 | - | ns |
| $t_{d(off)}$ | Turn-off delay time | | - | 22.5 | - | ns |
| t_f | Fall time | | - | 18 | - | ns |

Table 8. Source drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|--|------|------|------|---------------|
| I_{SD} | Source-drain current | | - | | 5 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | - | | 20 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $V_{GS} = 0, I_{SD} = 5 \text{ A}$ | - | | 1.6 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 5 \text{ A}, di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}$ (see Figure 20) | - | 276 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 1.7 | | μC |
| I_{RRM} | Reverse recovery current | | - | 12.5 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 5 \text{ A}, di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}, T_j = 150 \text{ }^\circ\text{C}$ (see Figure 20) | - | 312 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 1.9 | | μC |
| I_{RRM} | Reverse recovery current | | - | 12.4 | | 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 DPAK and IPAK

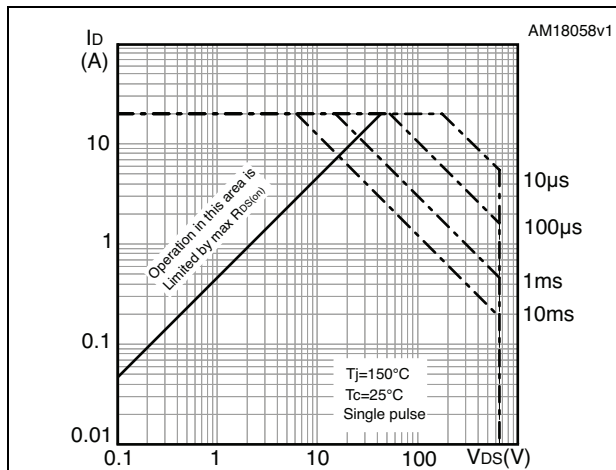


Figure 3. Thermal impedance for DPAK and IPAK

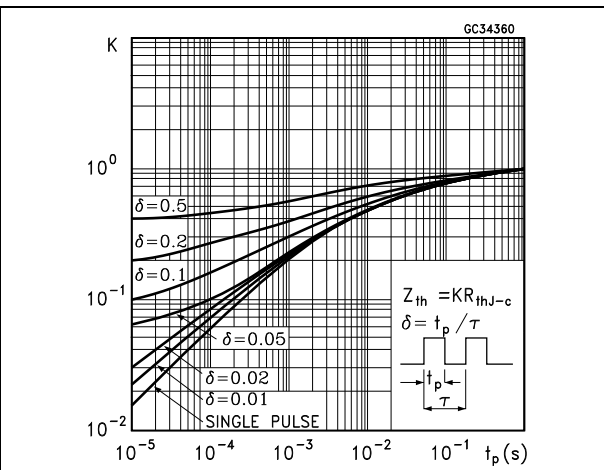


Figure 4. Safe operating area for TO-220FP

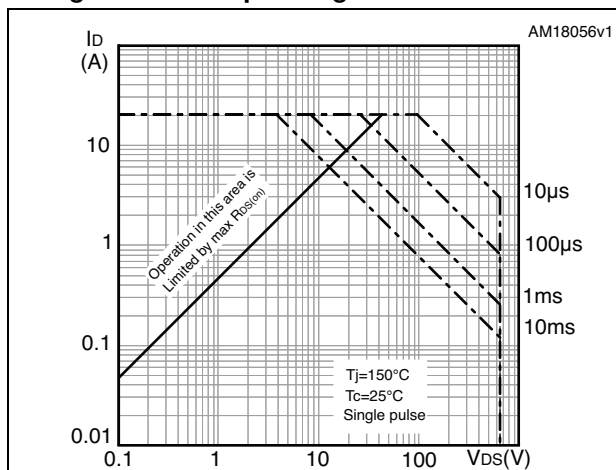


Figure 5. Thermal impedance for TO-220FP

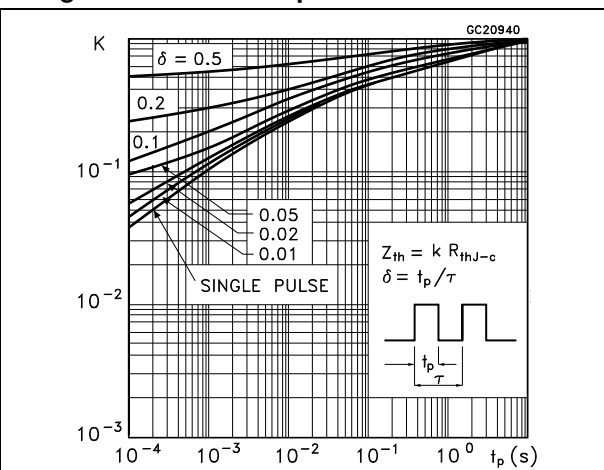


Figure 6. Safe operating area for TO-220

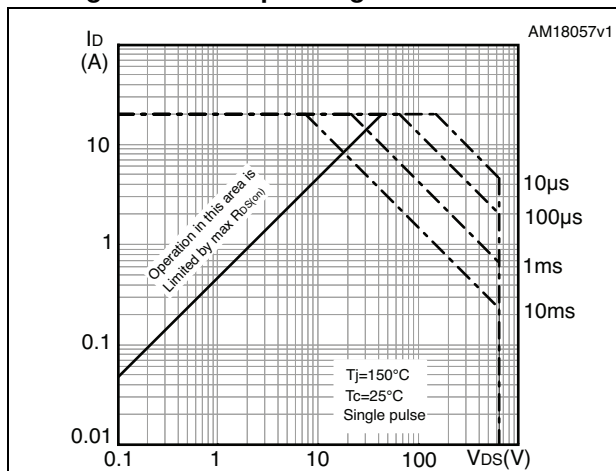


Figure 7. Thermal impedance for TO-220

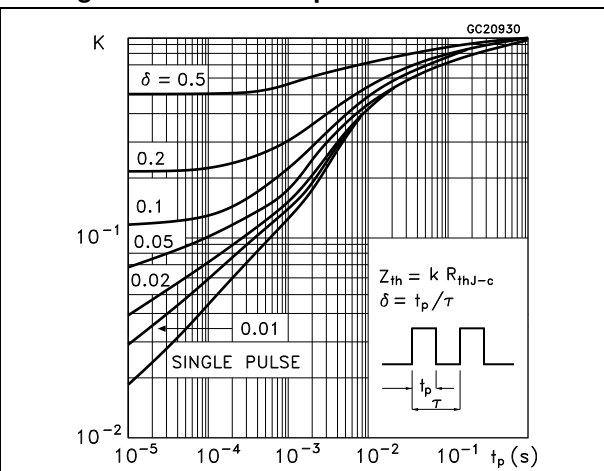


Figure 8. Output characteristics

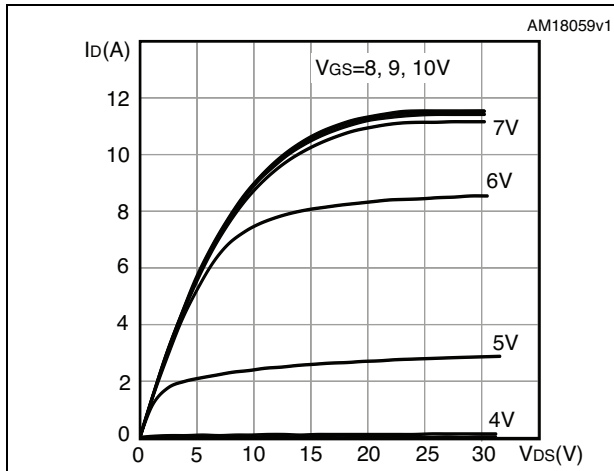


Figure 9. Transfer characteristics

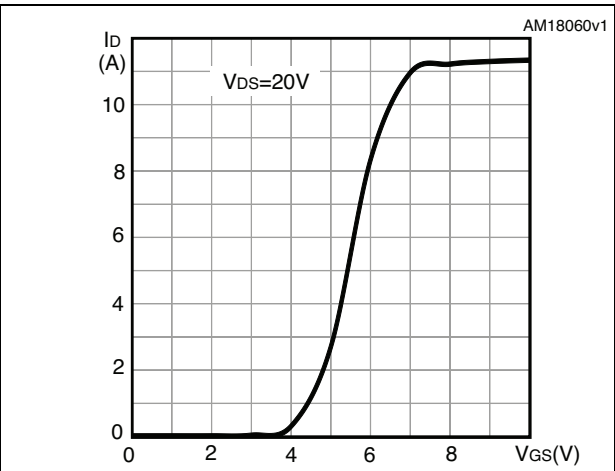


Figure 10. Gate charge vs gate-source voltage

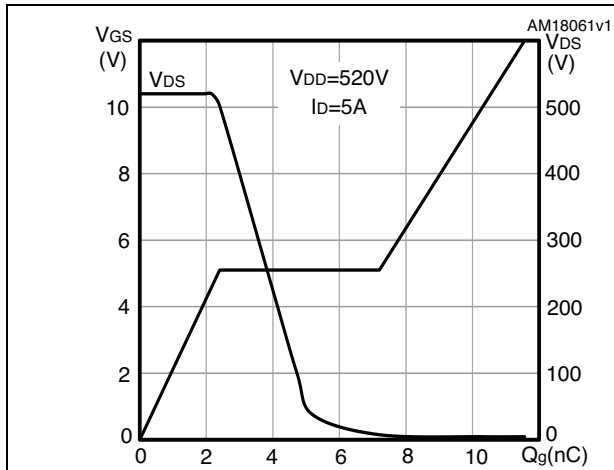


Figure 11. Static drain-source on-resistance

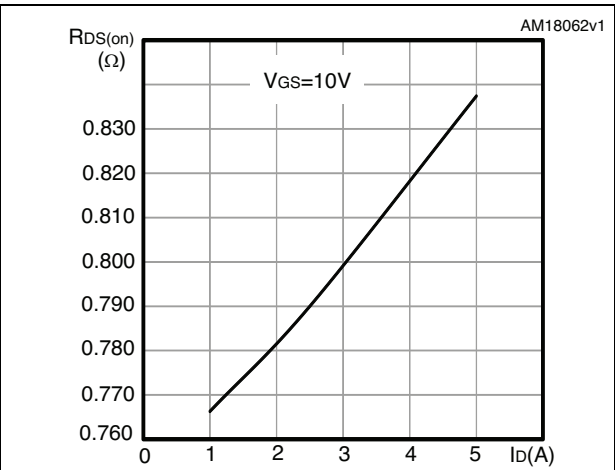


Figure 12. Capacitance variations

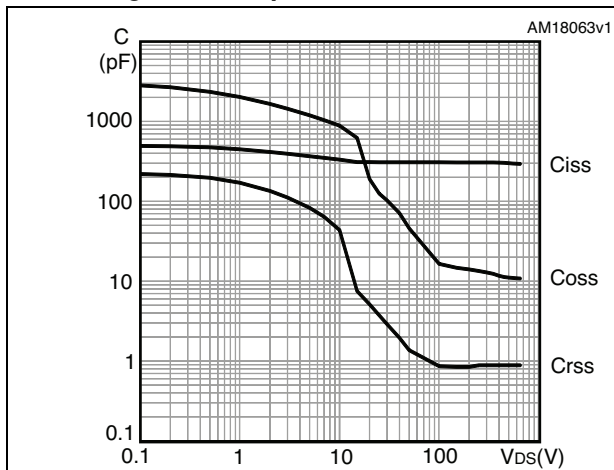


Figure 13. Output capacitance stored energy

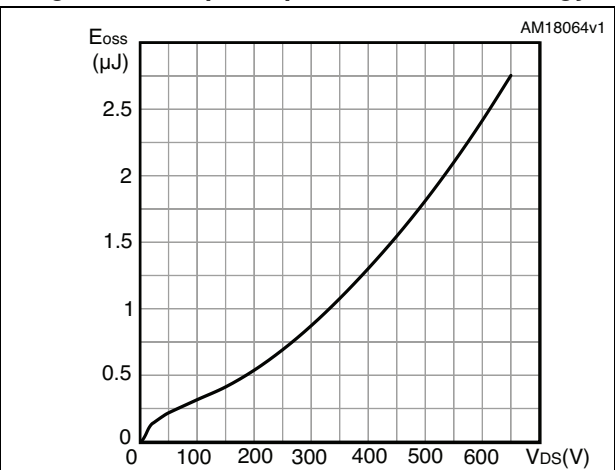


Figure 14. Normalized gate threshold voltage vs temperature

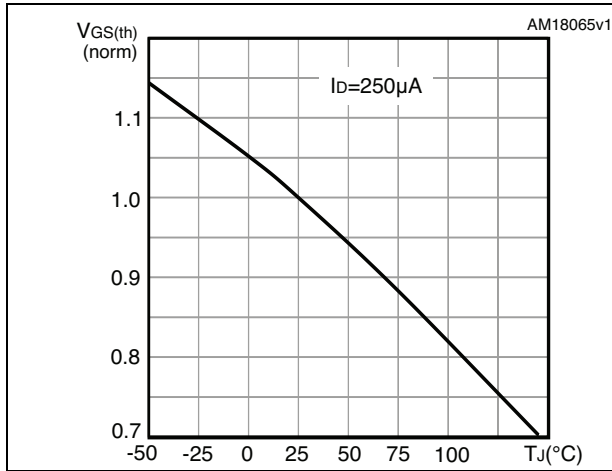


Figure 15. Normalized on-resistance vs temperature

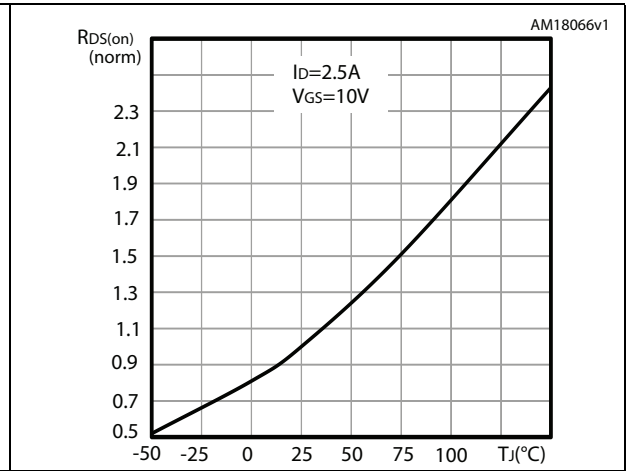


Figure 16. Source-drain diode forward characteristics

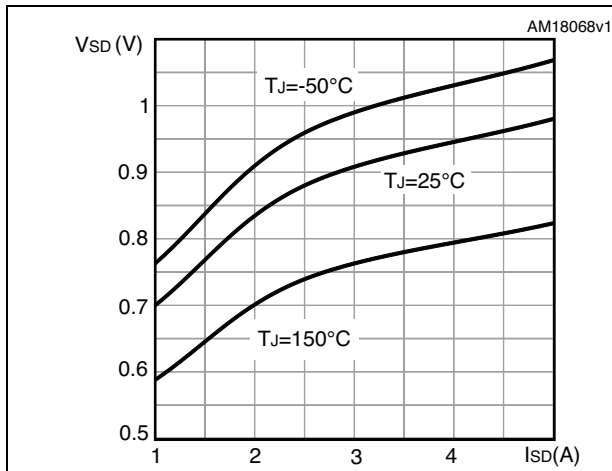
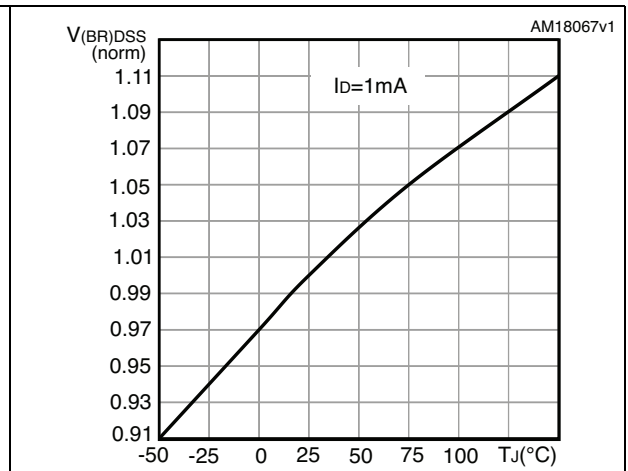
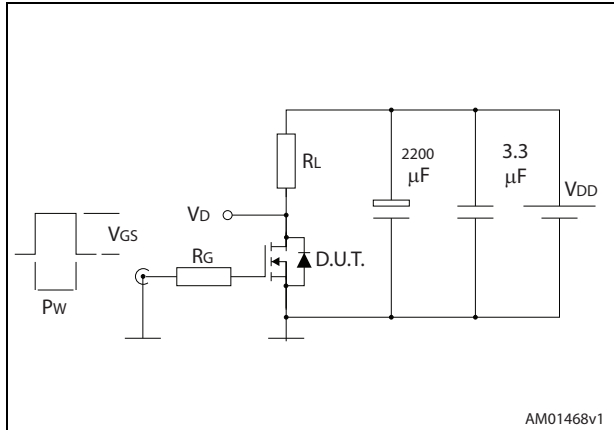


Figure 17. Normalized V_{(BR)DSS} vs temperature



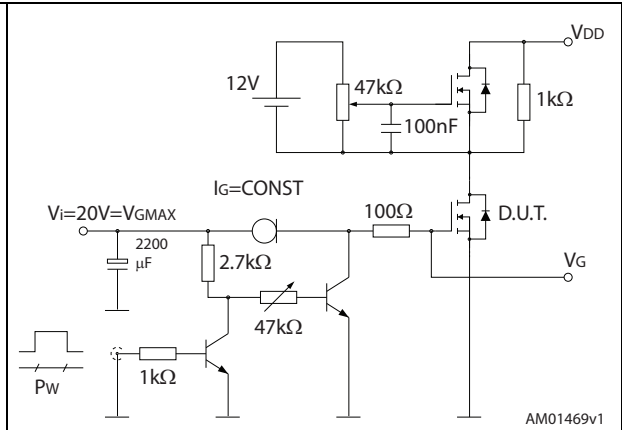
3 Test circuits

Figure 18. Switching times test circuit for resistive load



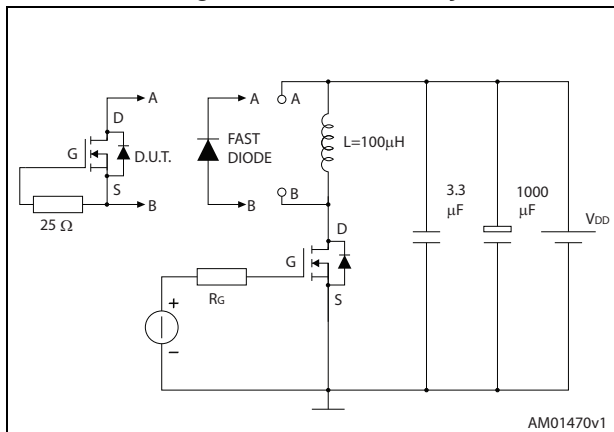
AM01468v1

Figure 19. Gate charge test circuit



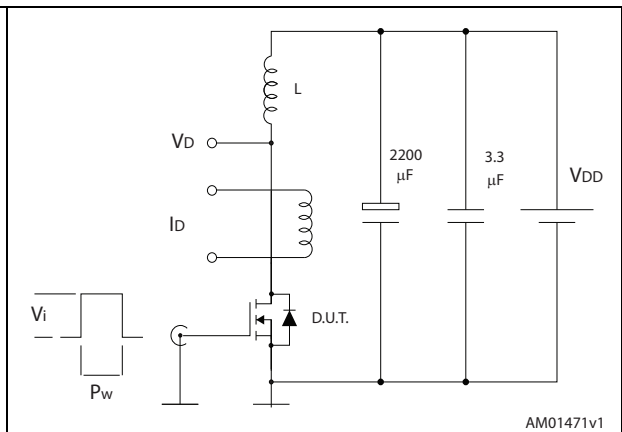
AM01469v1

Figure 20. Test circuit for inductive load switching and diode recovery times



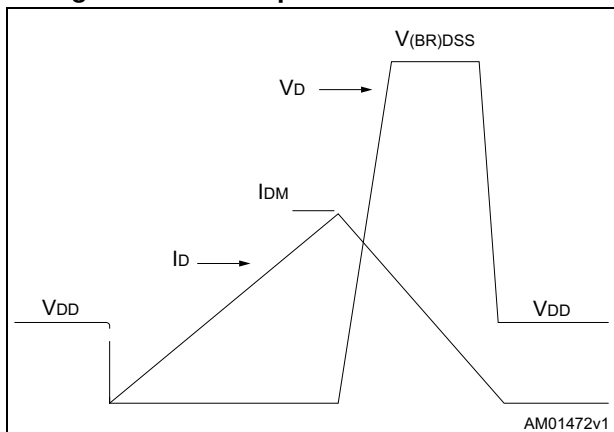
AM01470v1

Figure 21. Unclamped inductive load test circuit



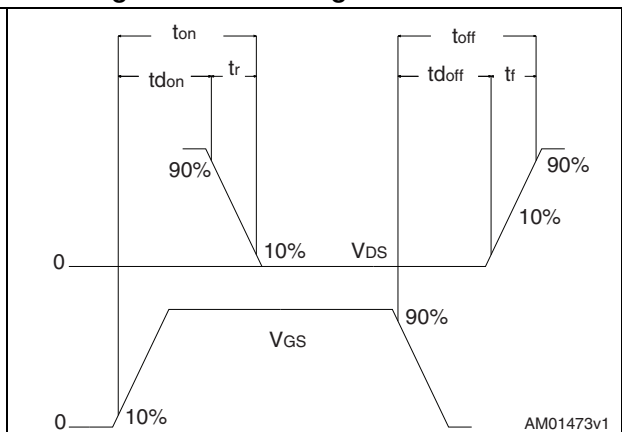
AM01471v1

Figure 22. Unclamped inductive waveform



AM01472v1

Figure 23. Switching time waveform



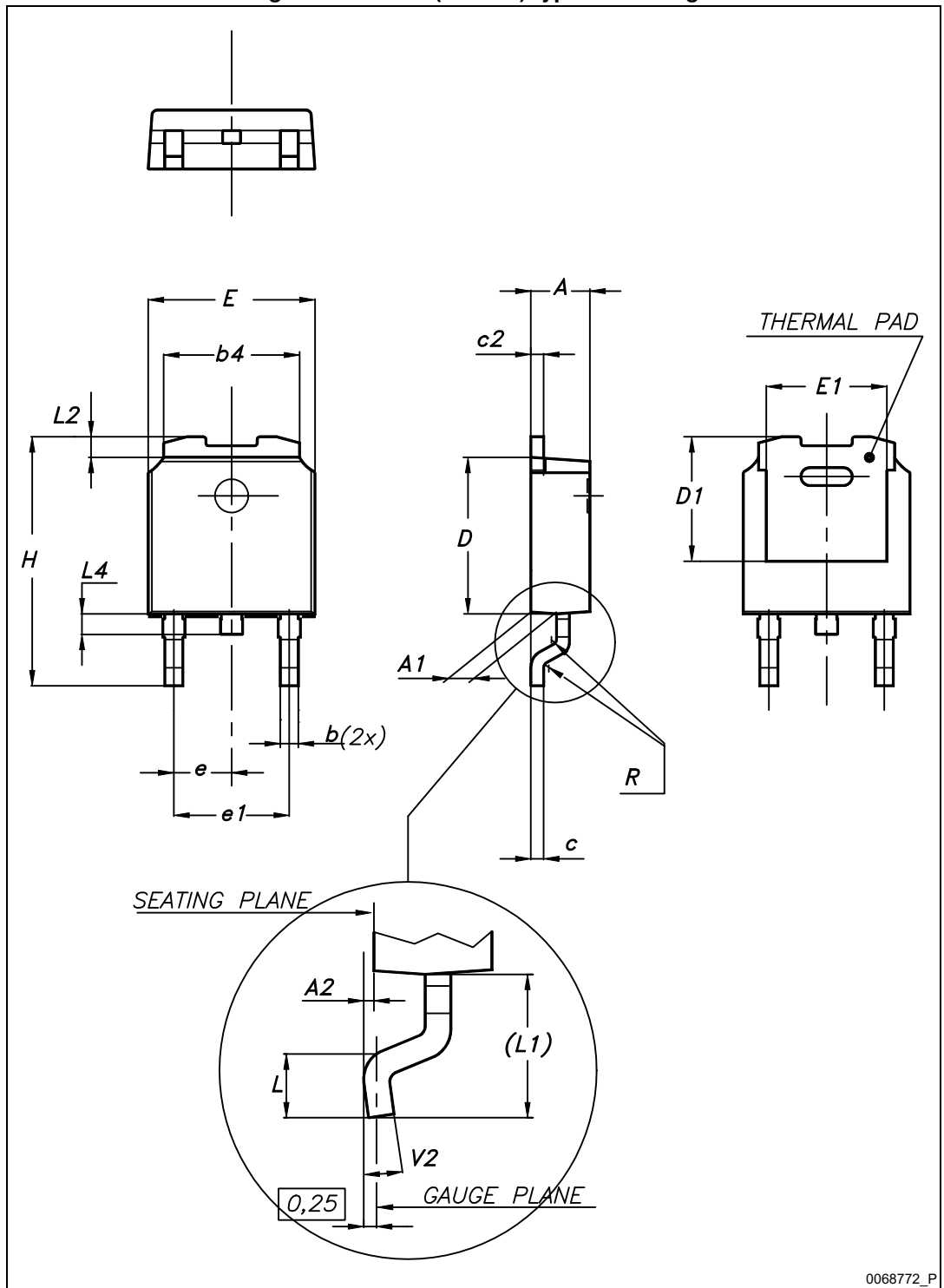
AM01473v1

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.

4.1 DPAK, STD9N65M2

Figure 24. DPAK (TO-252) type A drawing

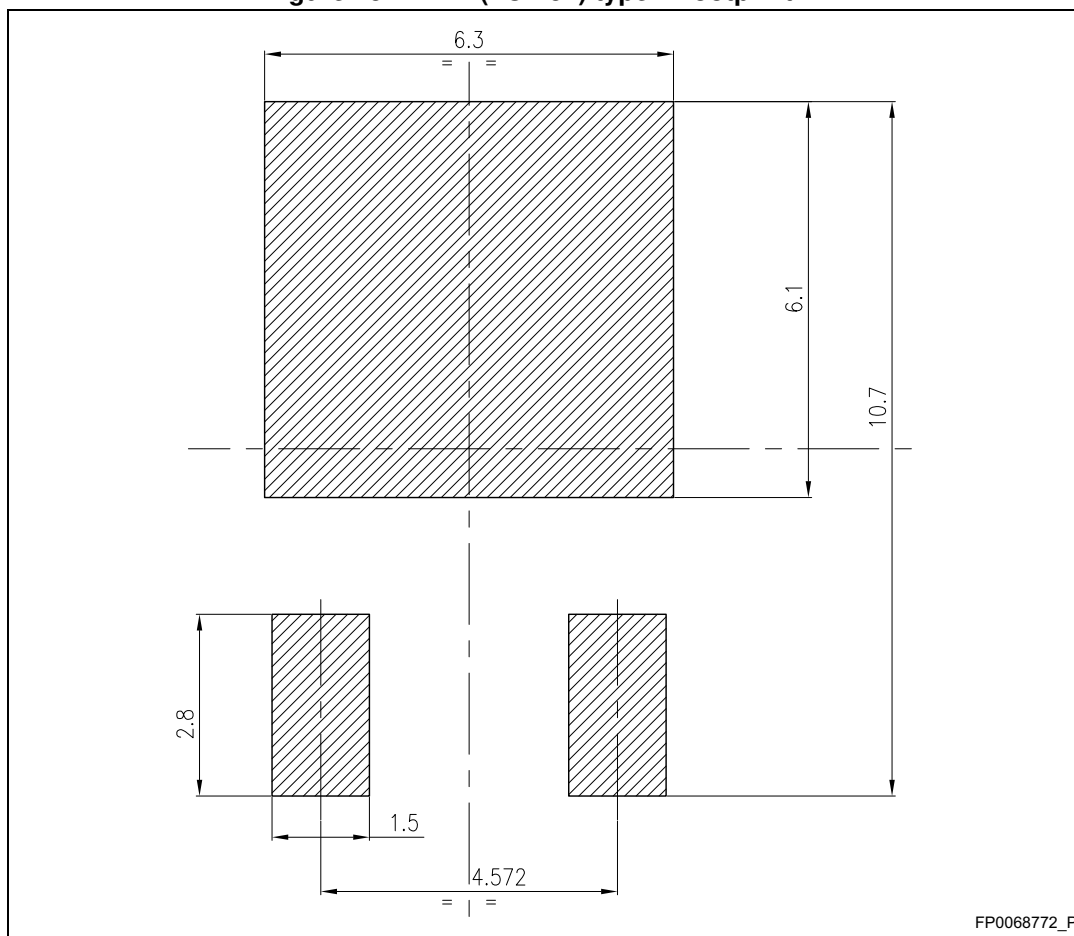


0068772_P

Table 9. DPAK (TO-252) type A 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° |

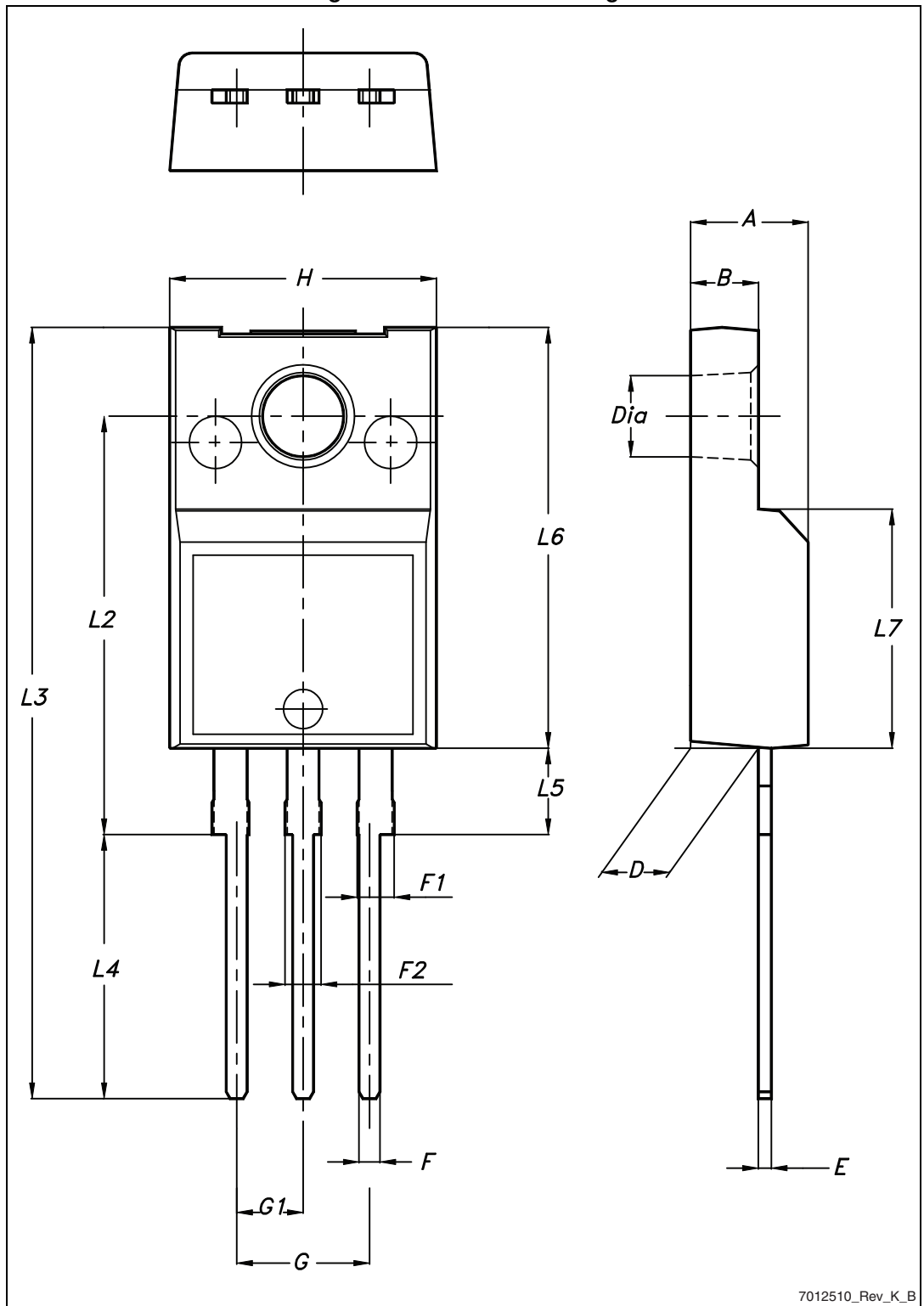
Figure 25. DPAK (TO-252) type A footprint (a)



a. All dimensions are in millimeters

4.2 TO-220FP, STF9N65M2

Figure 26. TO-220FP drawing



7012510_Rev_K_B

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 |
| Ø | 3 | | 3.2 |

4.3 TO-220, STP9N65M2

Figure 27. TO-220 type A drawing

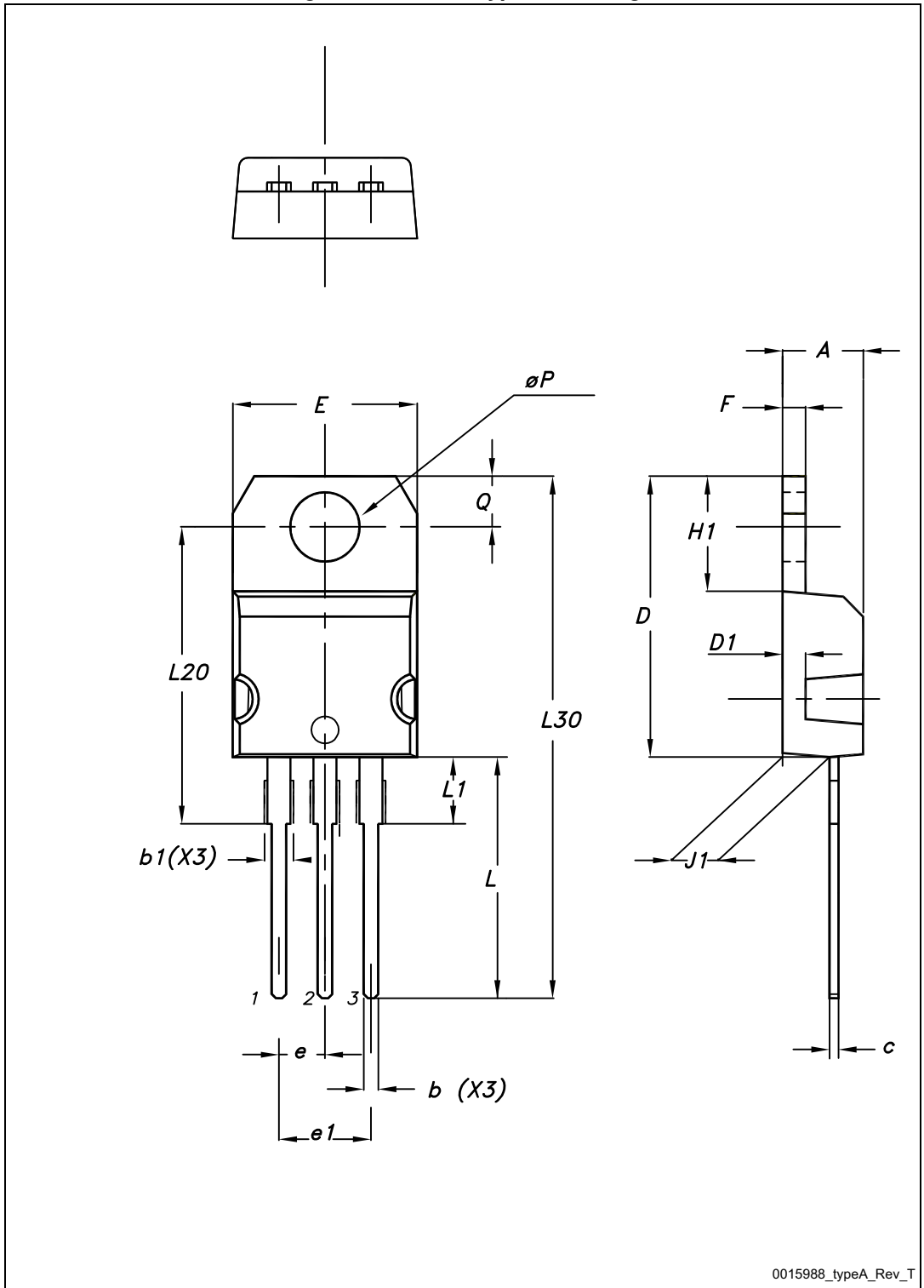


Table 11. TO-220 type A mechanical data

| 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 |

4.4 IPAK, STU9N65M2

Figure 28. IPAK (TO-251) drawing

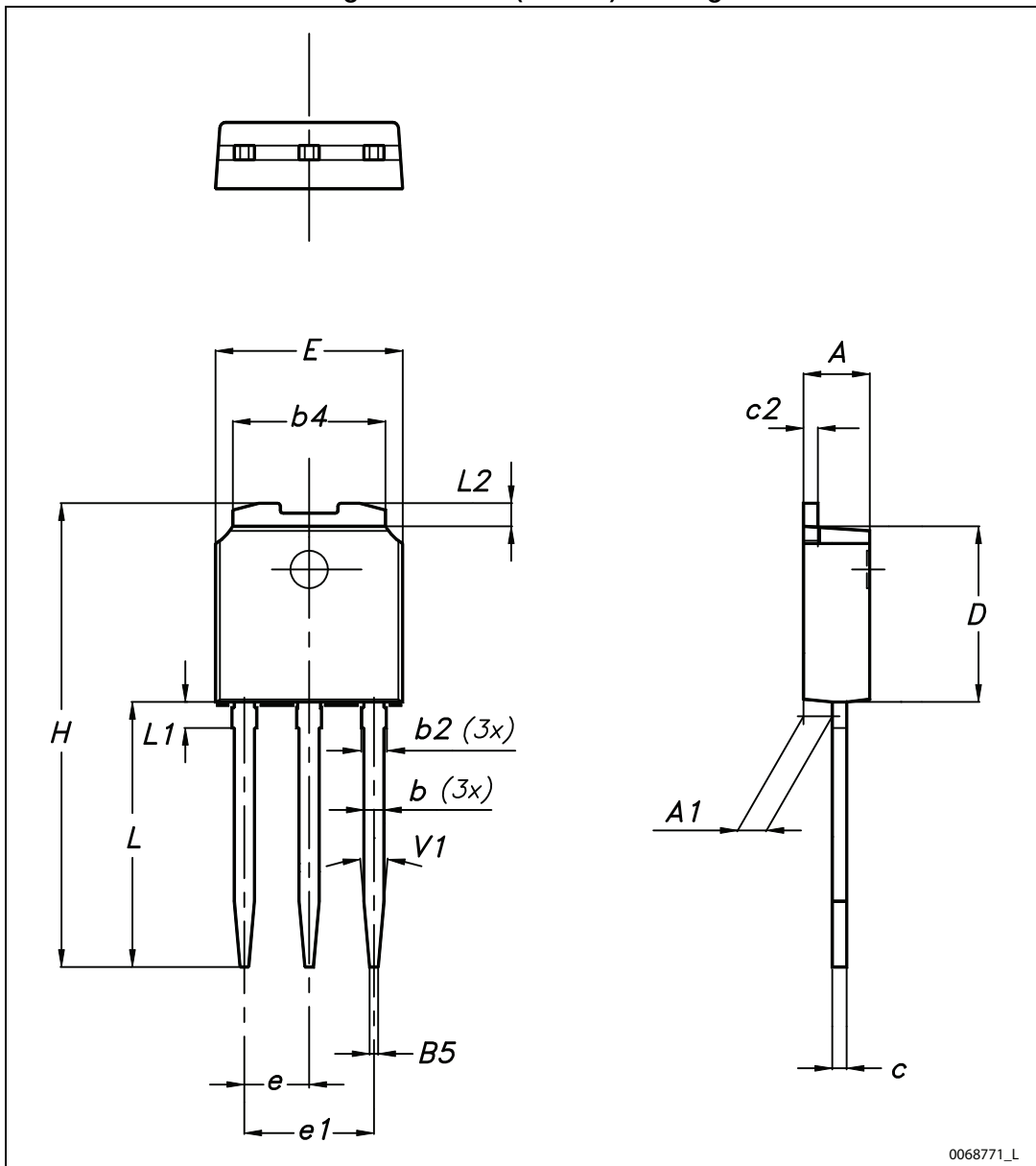


Table 12. IPAK (TO-251) mechanical data

| 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° | |

5 Packaging mechanical data

Figure 29. Tape for DPAK (TO-252)

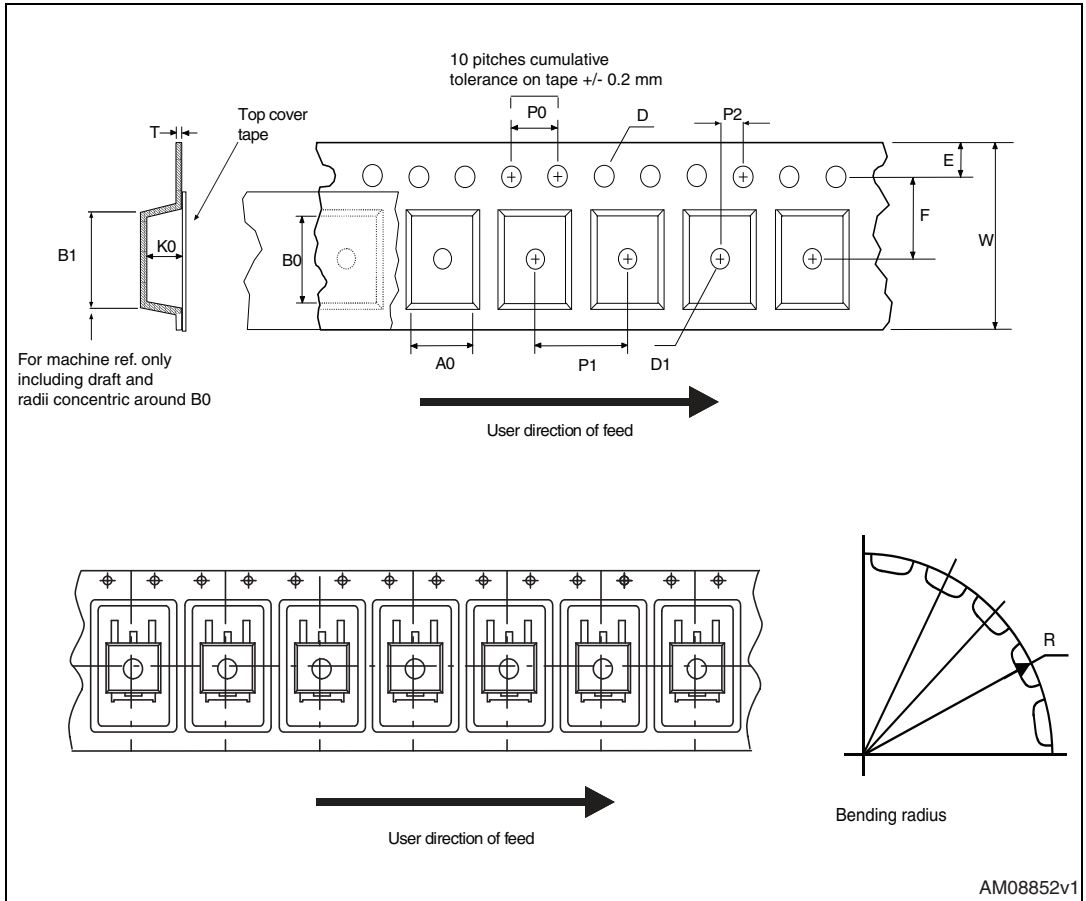


Figure 30. Reel for DPAK (TO-252)

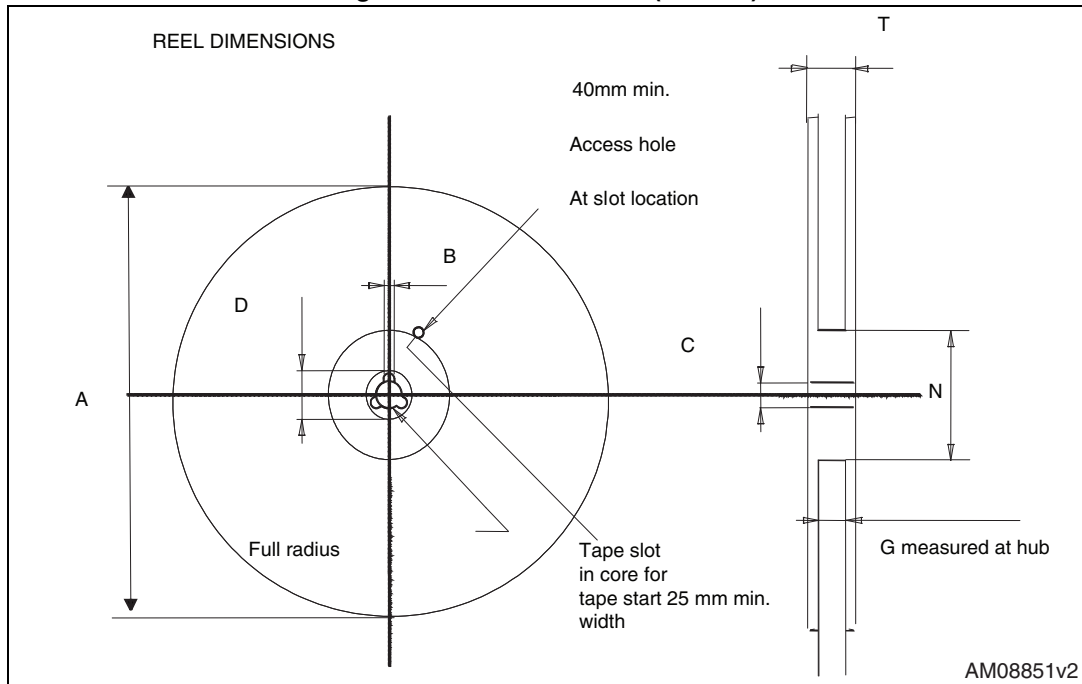


Table 13. DPAK (TO-252) tape and reel mechanical data

| 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 | | | |

6 Revision history

Table 14. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 24-Feb-2014 | 1 | First release. |
| 15-Jul-2014 | 2 | <ul style="list-style-type: none">– Modified: title, <i>Features</i> and <i>Description</i>– Modified: <i>Figure 5</i> and <i>15</i>– Updated: <i>Figure 28</i> and <i>Table 12</i>– Minor text changes |

IMPORTANT NOTICE – PLEASE READ CAREFULLY

STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST's terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers' products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

© 2014 STMicroelectronics – All rights reserved