



STD12N65M5, STF12N65M5, STI12N65M5 STP12N65M5, STU12N65M5

N-channel 650 V, 0.39 Ω , 8.5 A MDmesh™ V Power MOSFET
DPAK, I²PAK, TO-220FP, TO-220, IPAK

Features

| Type | V _{DSS} @ T _{Jmax} | R _{DS(on)} max | I _D | P _{TOT} |
|------------|---|----------------------------|----------------------|------------------|
| STD12N65M5 | 710 V | < 0.43 Ω | 8.5 A | 70 W |
| STF12N65M5 | | | 8.5 A ⁽¹⁾ | 25 W |
| STI12N65M5 | | | 8.5 A | 70 W |
| STP12N65M5 | | | 8.5 A | 70 W |
| STU12N65M5 | | | 8.5 A | 70 W |

1. Limited only by maximum temperature allowed.

- Worldwide best R_{DS(on)} * area
- Higher V_{DSS} rating and high dv/dt capability
- Excellent switching performance
- Easy to drive
- 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.

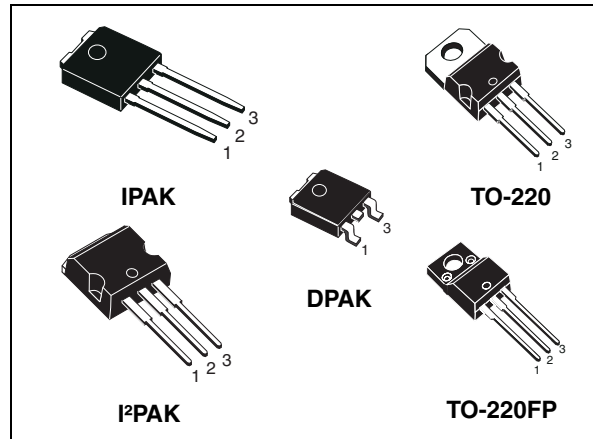


Figure 1. Internal schematic diagram

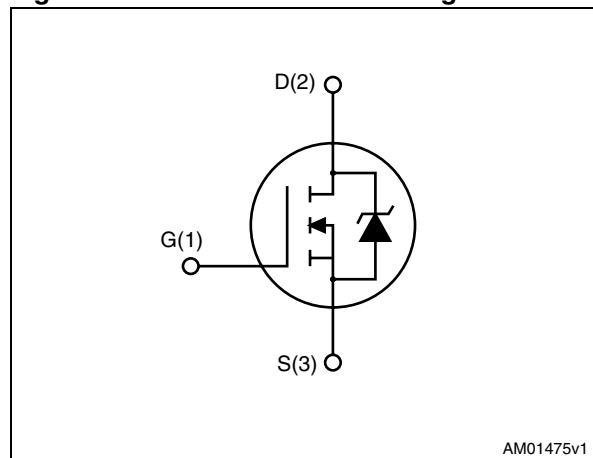


Table 1. Device summary

| Order codes | Marking | Packages | Packaging |
|-------------|---------|--------------------|---------------|
| STD12N65M5 | 12N65M5 | DPAK | Tape and reel |
| STF12N65M5 | | TO-220FP | Tube |
| STI12N65M5 | | I ² PAK | Tube |
| STP12N65M5 | | TO-220 | Tube |
| STU12N65M5 | | IPAK | Tube |

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1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | | Unit |
|--------------------------------|--|--|--------------------|------|
| | | TO-220, IPAK, DPAK, I ² PAK | TO-220FP | |
| V _{DS} | Drain-source voltage (V _{GS} = 0) | 650 | | V |
| V _{GS} | Gate-source voltage | 25 | | V |
| I _D | Drain current (continuous) at T _C = 25 °C | 8.5 | 8.5 ⁽¹⁾ | A |
| I _D | Drain current (continuous) at T _C = 100 °C | 5.4 | 5.4 ⁽¹⁾ | A |
| I _{DM} ⁽²⁾ | Drain current (pulsed) | 34 | 34 ⁽¹⁾ | A |
| P _{TOT} | Total dissipation at T _C = 25 °C | 70 | 25 | W |
| I _{AR} | Avalanche current, repetitive or not-repetitive (pulse width limited by T _j max) | 2.5 | | A |
| E _{AS} | Single pulse avalanche energy (starting T _j = 25 °C, I _D = I _{AR} , V _{DD} = 50 V) | 150 | | mJ |
| dv/dt ⁽³⁾ | Peak diode recovery voltage slope | 15 | | 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 |

1. Limited only by maximum temperature allowed.
2. Pulse width limited by safe operating area.
3. I_{SD} ≤ 8.5 A, di/dt ≤ 400 A/μs; V_{Peak} < V_{(BR)DSS}, V_{DD} = 400 V

Table 3. Thermal data

| Symbol | Parameter | Value | | | | | Unit |
|-------------------------------------|--|-------|------|--------------------|--------|----------|------|
| | | DPAK | IPAK | I ² PAK | TO-220 | TO-220FP | |
| R _{thj-case} | Thermal resistance junction-case max | 1.79 | | | 5 | °C/W | |
| R _{thj-amb} | Thermal resistance junction-ambient max | | 100 | 62.5 | | °C/W | |
| R _{thj-pcb} ⁽¹⁾ | Thermal resistance junction-pcb max | 50 | | | | °C/W | |
| T _l | Maximum lead temperature for soldering purpose | 300 | | | | °C | |

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

2 Electrical characteristics

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

Table 4. On /off states

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------|--|--|------|------|----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $I_D = 1\text{ mA}$, $V_{GS} = 0$ | 650 | | | V |
| I_{DSS} | Zero gate voltage drain current ($V_{GS} = 0$) | $V_{DS} = \text{Max rating}$ $V_{DS} = \text{Max rating}$, $T_C = 125\text{ °C}$ | | | 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 | $V_{GS} = 10\text{ V}$, $I_D = 4.3\text{ A}$ | | 0.39 | 0.43 | Ω |

Table 5. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-------------------|---------------------------------------|---|------|------|------|----------|
| C_{iss} | Input capacitance | $V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0$ | - | 900 | - | pF |
| C_{oss} | Output capacitance | | | 22 | | |
| C_{rss} | Reverse transfer capacitance | | | 2 | | |
| $C_{o(tr)}^{(1)}$ | Equivalent capacitance time related | $V_{DS} = 0\text{ to }520\text{ V}$, $V_{GS} = 0$ | - | 64 | - | pF |
| $C_{o(er)}^{(2)}$ | Equivalent capacitance energy related | | | 21 | | |
| R_G | Intrinsic gate resistance | $f = 1\text{ MHz}$ open drain | - | 2.5 | - | Ω |
| Q_g | Total gate charge | $V_{DD} = 520\text{ V}$, $I_D = 4.25\text{ A}$, $V_{GS} = 10\text{ V}$ (see Figure 20) | - | 20 | - | nC |
| Q_{gs} | Gate-source charge | | | 4.8 | | |
| Q_{gd} | Gate-drain charge | | | 8.3 | | |

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 (v) | Voltage delay time | $V_{DD} = 400$ V, $I_D = 5$ A, | | 22.6 | | ns |
| t_r (v) | Voltage rise time | $R_G = 4.7$ Ω , $V_{GS} = 10$ V | | 17.6 | | ns |
| t_f (i) | Current fall time | (see Figure 21 and | | 15.6 | | ns |
| t_c (off) | Crossing time | Figure 24) | | 23.4 | | ns |

Table 7. Source drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|---|------|------|------|---------|
| I_{SD} | Source-drain current | | | | 8.5 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | | | 34 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD} = 8.5$ A, $V_{GS} = 0$ | | | 1.5 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 8.5$ A, $di/dt = 100$ A/ μ s | | 230 | | ns |
| Q_{rr} | Reverse recovery charge | $V_{DD} = 100$ V (see Figure 24) | | 2.2 | | μ C |
| I_{RRM} | Reverse recovery current | | | 19 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 8.5$ A, $di/dt = 100$ A/ μ s | | 280 | | ns |
| Q_{rr} | Reverse recovery charge | $V_{DD} = 100$ V, $T_j = 150$ °C | | 2.7 | | μ C |
| I_{RRM} | Reverse recovery current | (see Figure 24) | | 19 | | A |

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

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-220 and I²PAK

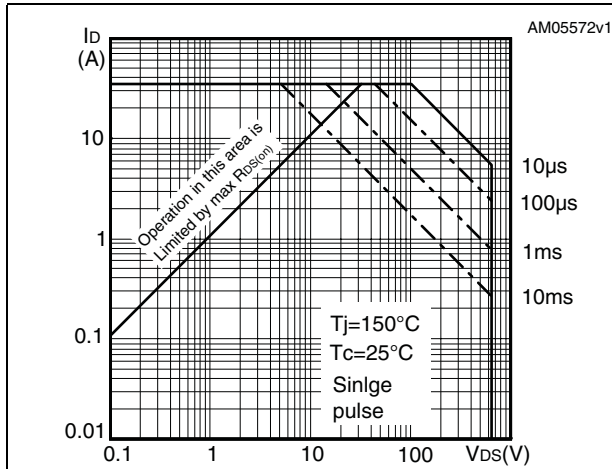


Figure 3. Thermal impedance for TO-220 and I²PAK

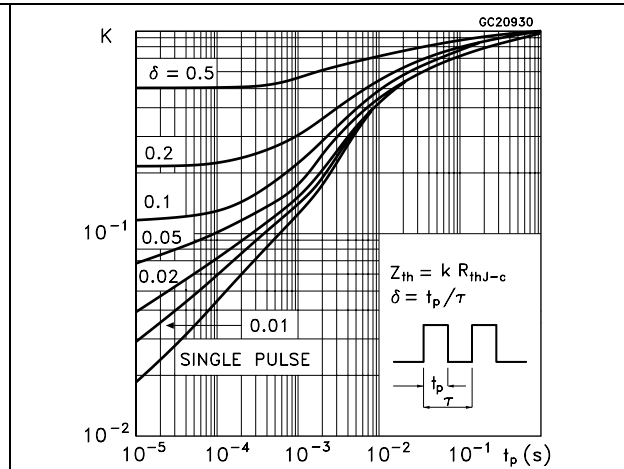


Figure 4. Safe operating area for TO-220FP

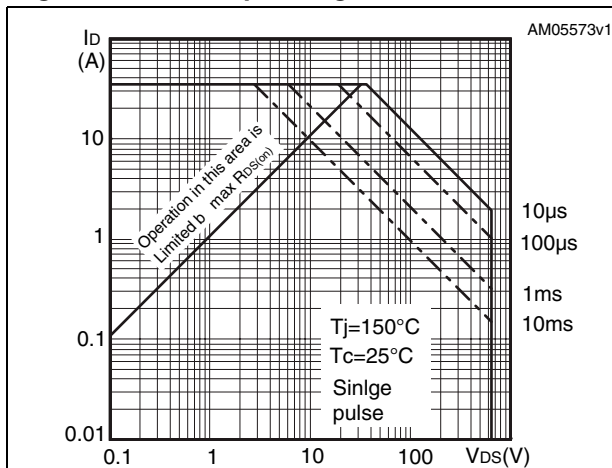


Figure 5. Thermal impedance for TO-220FP

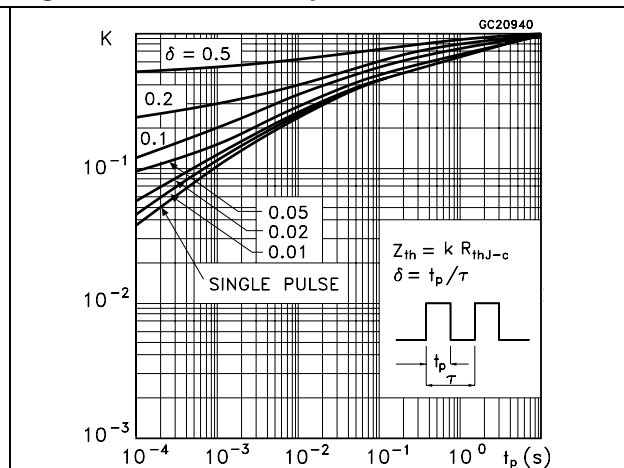


Figure 6. Safe operating area for DPAK, IPAK

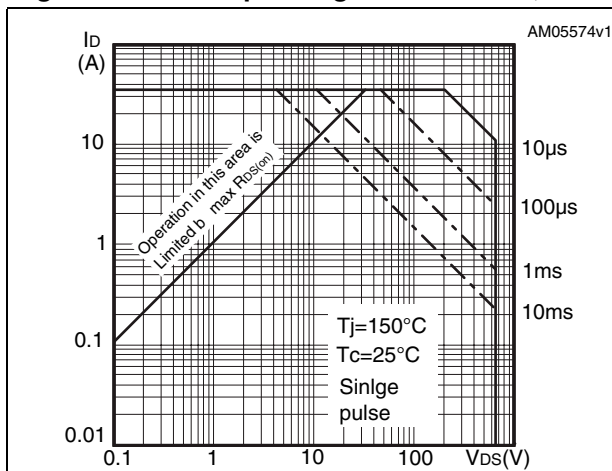


Figure 7. Thermal impedance for DPAK, IPAK

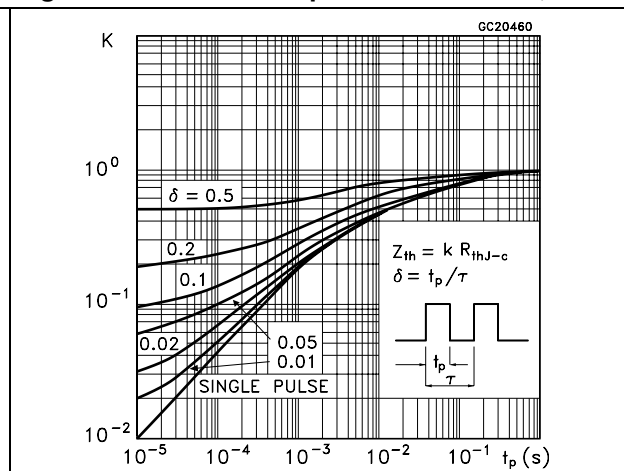


Figure 8. Output characteristics

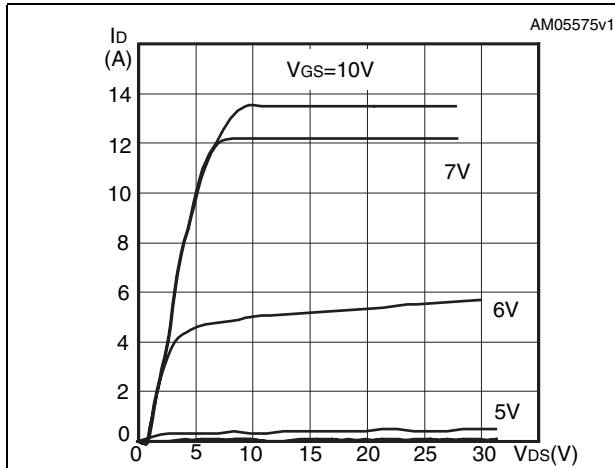


Figure 9. Transfer characteristics

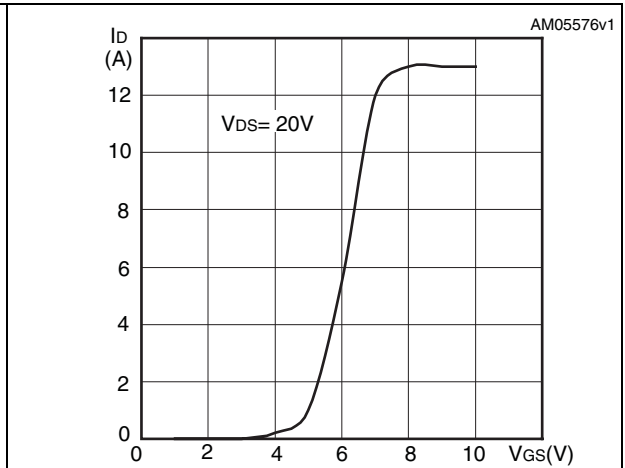


Figure 10. Gate charge vs gate-source voltage

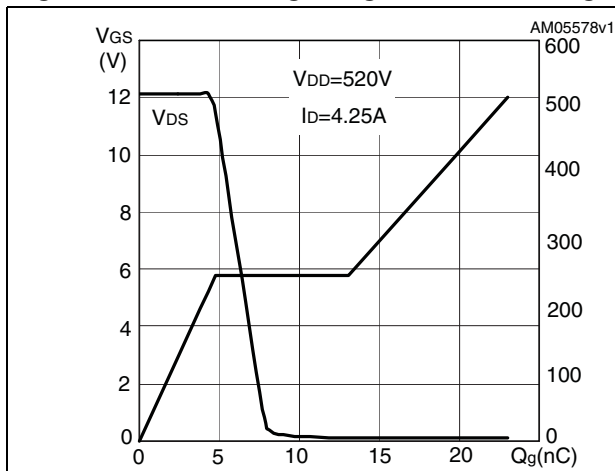


Figure 11. Static drain-source on resistance

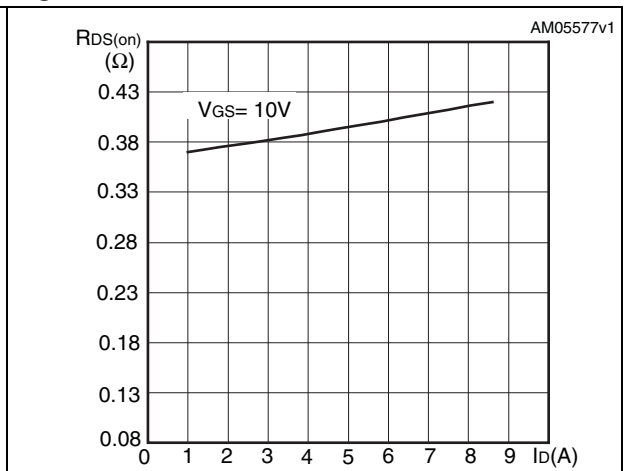


Figure 12. Capacitance variations

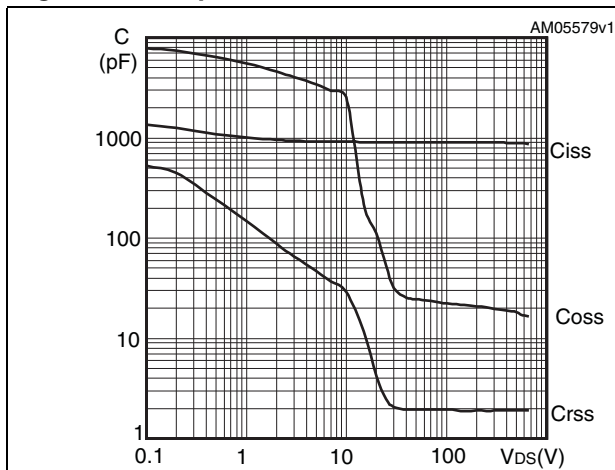


Figure 13. Output capacitance stored energy

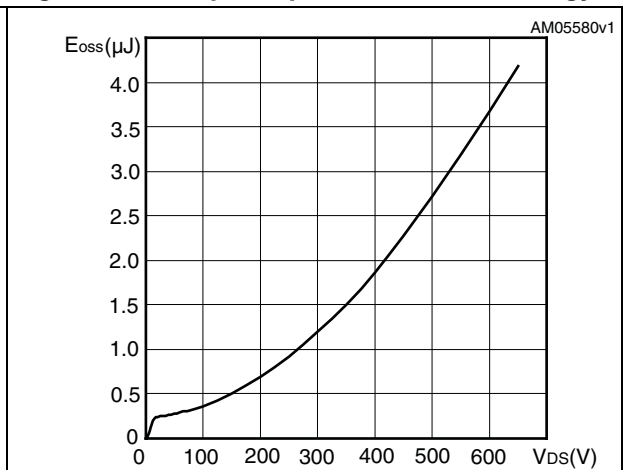


Figure 14. Normalized gate threshold voltage vs temperature

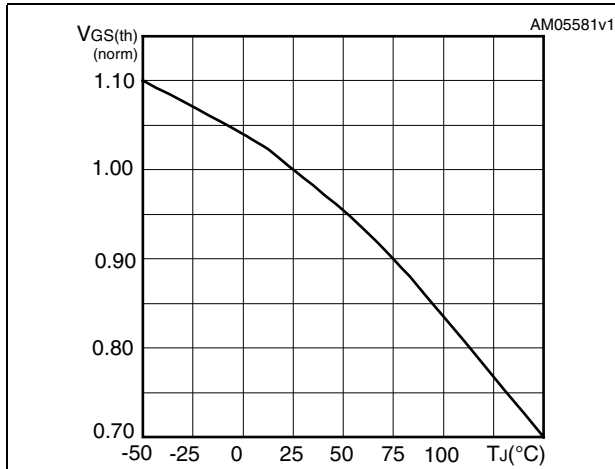


Figure 15. Normalized on resistance vs temperature

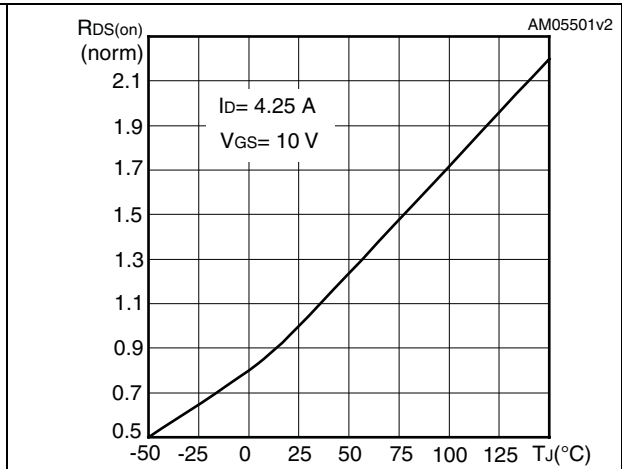


Figure 16. Source-drain diode forward characteristics

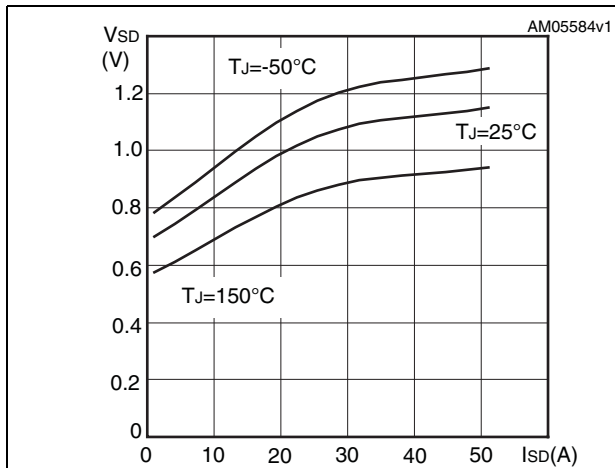


Figure 17. Normalized BV_{DSS} @ 1 mA vs temperature

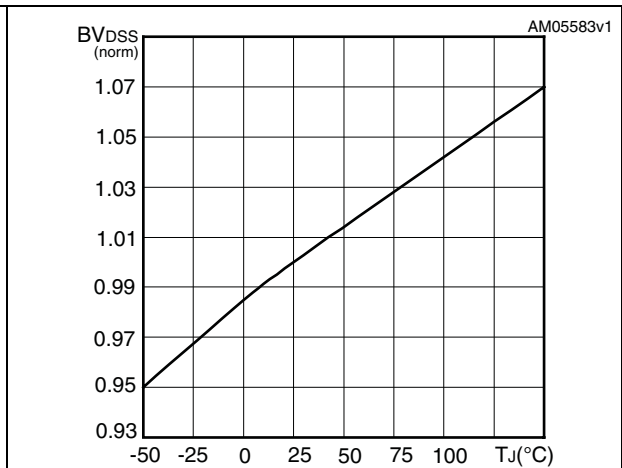
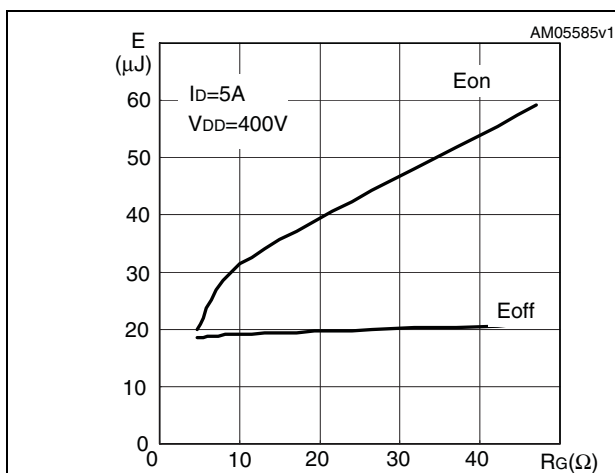


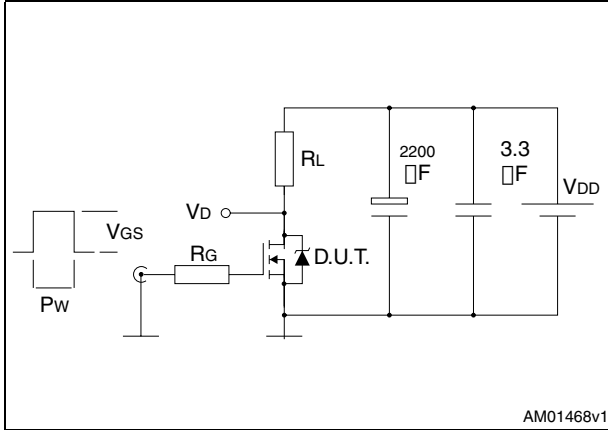
Figure 18. Switching losses vs gate resistance (1)



1. Eon including reverse recovery of a SiC diode

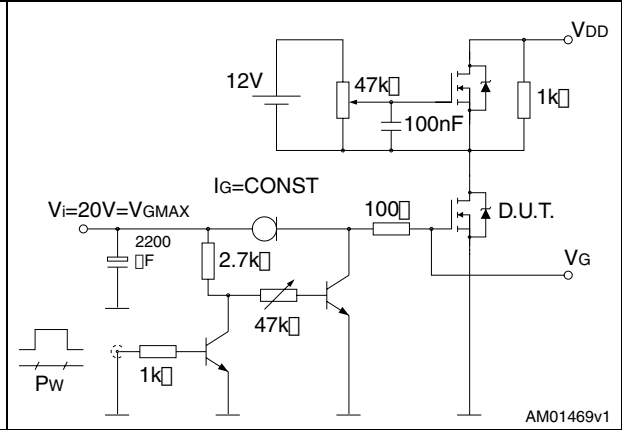
3 Test circuits

Figure 19. Switching times test circuit for resistive load



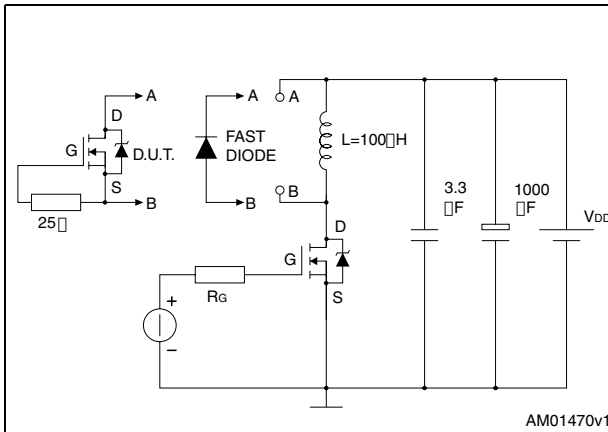
AM01468v1

Figure 20. Gate charge test circuit



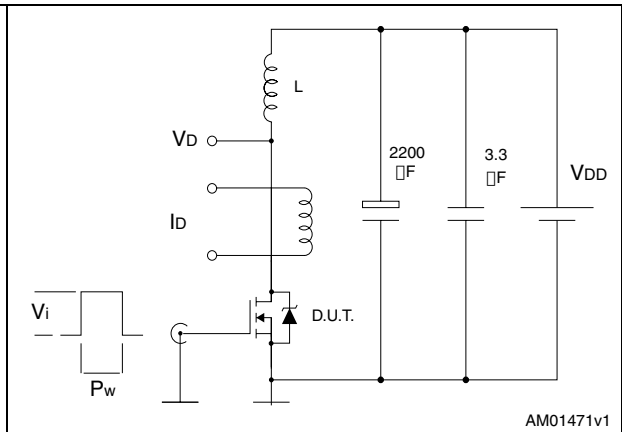
AM01469v1

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



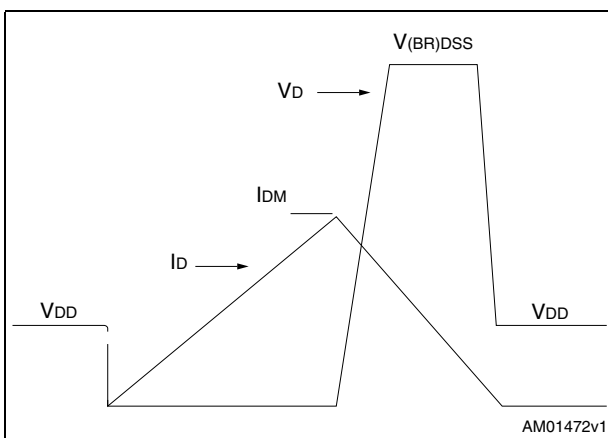
AM01470v1

Figure 22. Unclamped inductive load test circuit



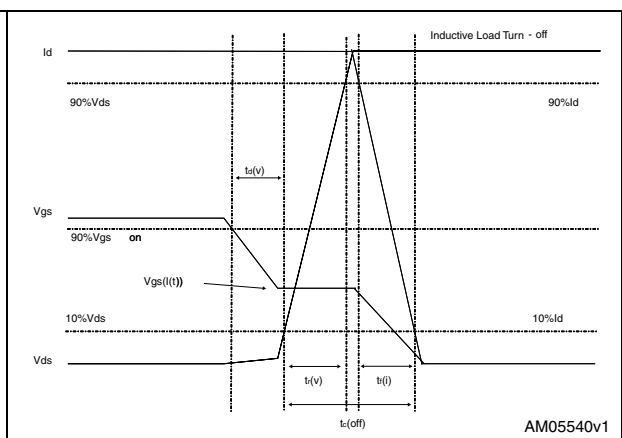
AM01471v1

Figure 23. Unclamped inductive waveform



AM01472v1

Figure 24. Switching time waveform



AM05540v1

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 8. 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 | | 1.50 |
| L1 | | 2.80 | |
| L2 | | 0.80 | |
| L4 | 0.60 | | 1 |
| R | | 0.20 | |
| V2 | 0° | | 8° |

Figure 25. DPAK (TO-252) drawing

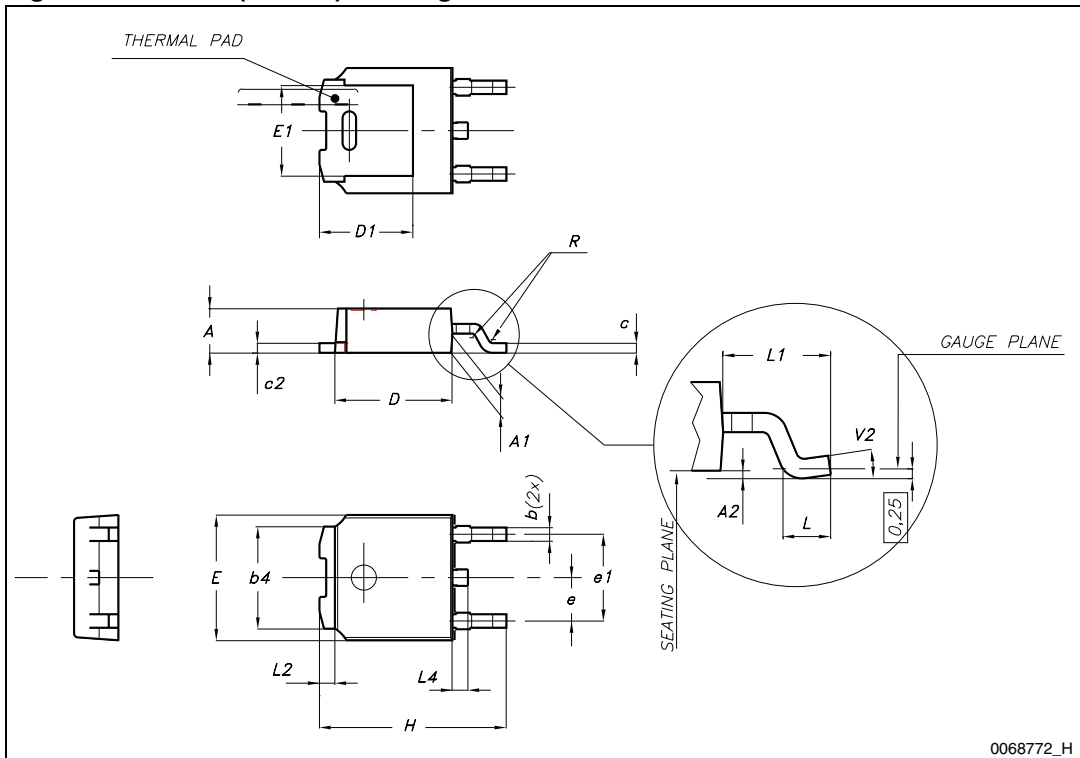
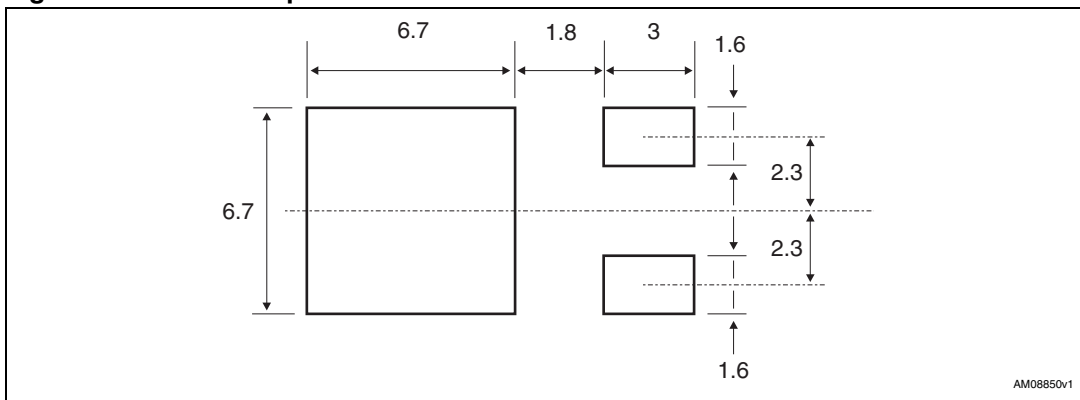


Figure 26. DPAK footprint^(a)



a. All dimension are in millimeters

Table 9. 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 | | 0.3 | |
| 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 27. IPAK (TO-251) drawing

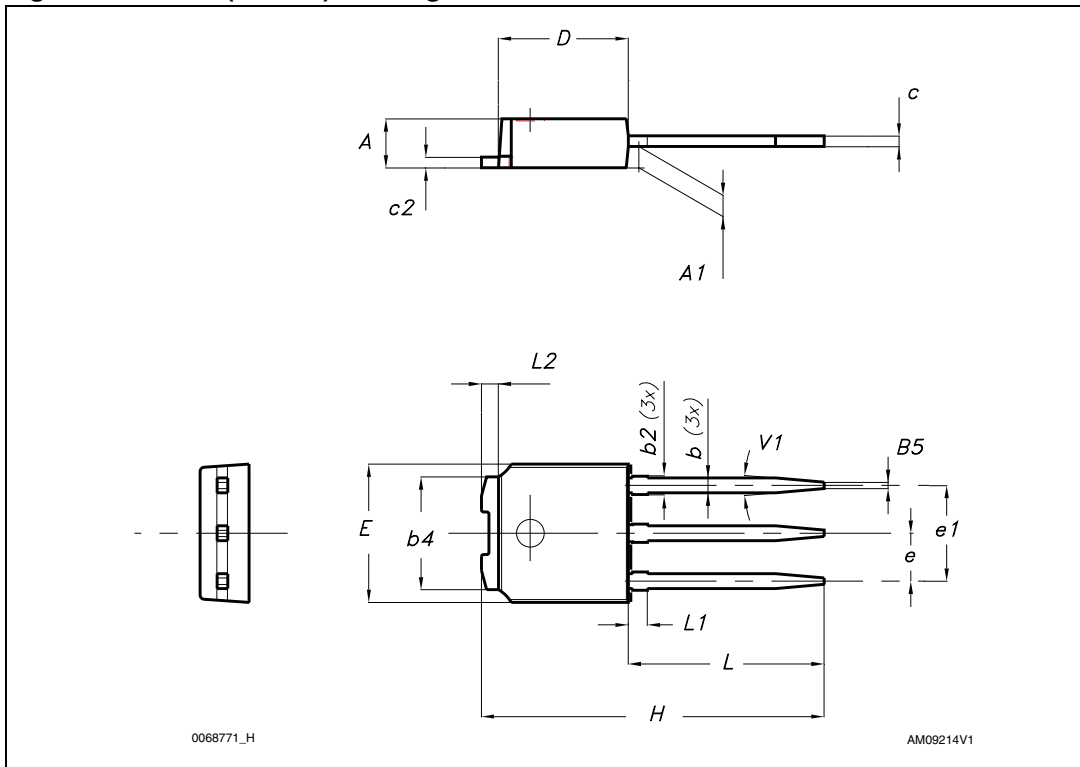
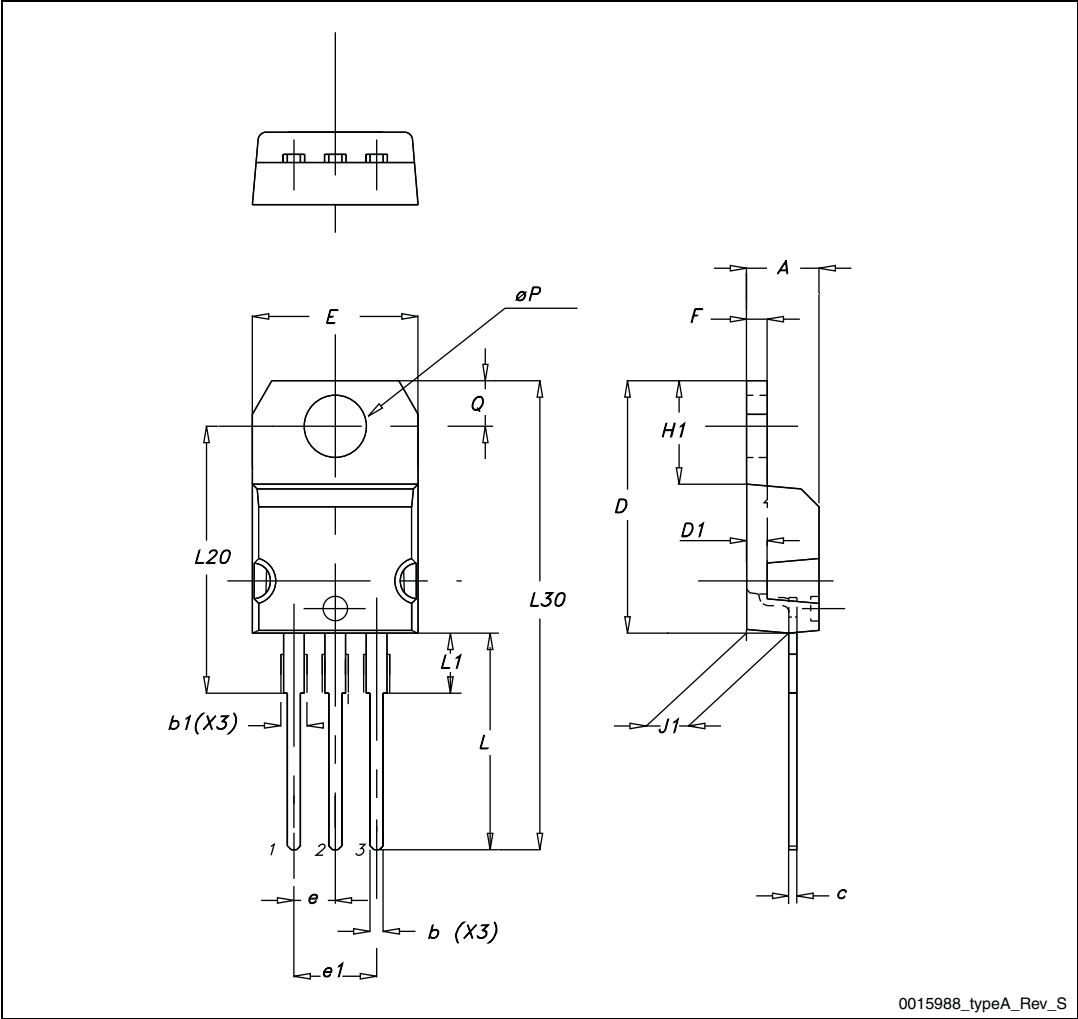


Table 10. I²PAK (TO-262) mechanical data

| DIM. | mm. | | |
|------|------|-----|-------|
| | min. | typ | max. |
| A | 4.40 | | 4.60 |
| A1 | 2.40 | | 2.72 |
| b | 0.61 | | 0.88 |
| b1 | 1.14 | | 1.70 |
| c | 0.49 | | 0.70 |
| c2 | 1.23 | | 1.32 |
| D | 8.95 | | 9.35 |
| e | 2.40 | | 2.70 |
| e1 | 4.95 | | 5.15 |
| E | 10 | | 10.40 |
| L | 13 | | 14 |
| L1 | 3.50 | | 3.93 |
| L2 | 1.27 | | 1.40 |

Figure 28. I²PAK (TO-262) drawing



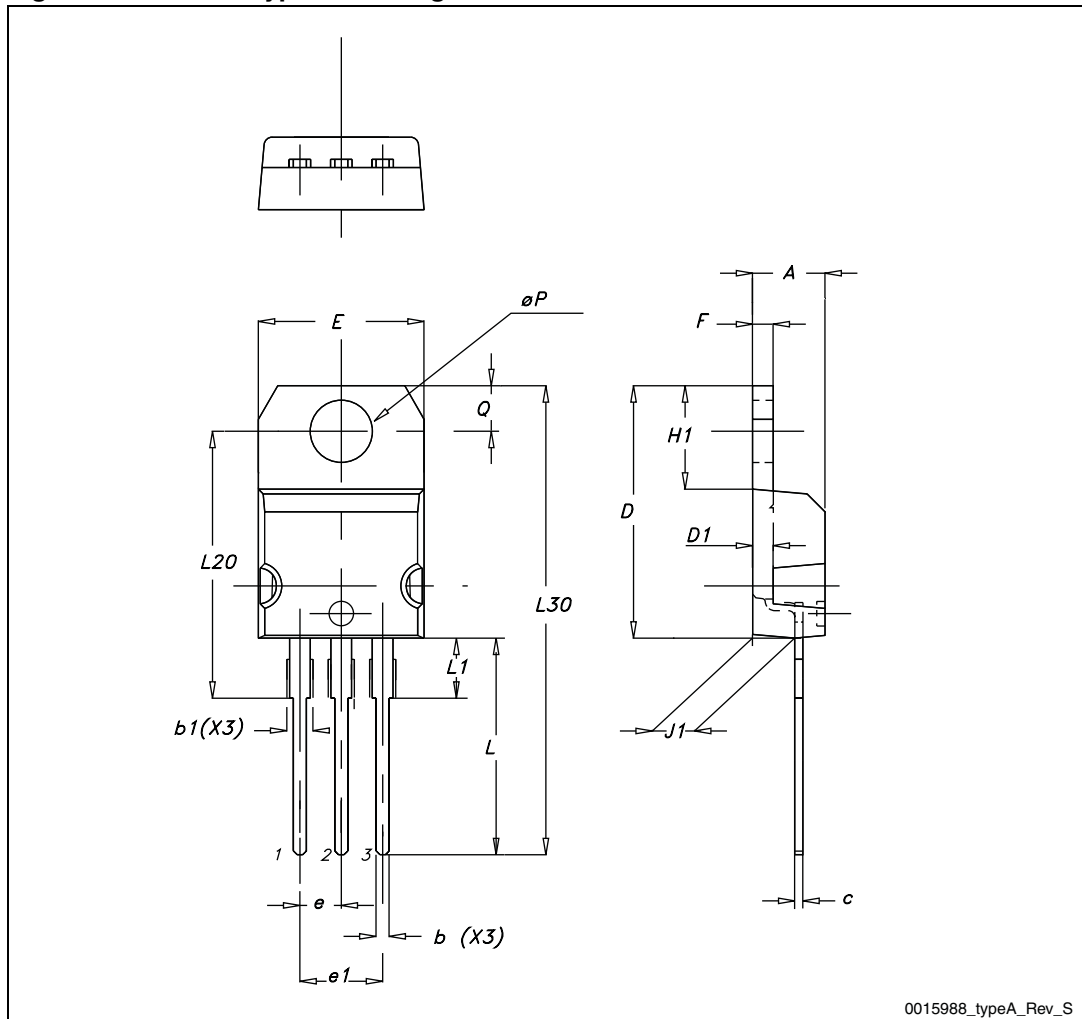
0015988_typeA_Rev_S



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 29. TO-220 type A drawing

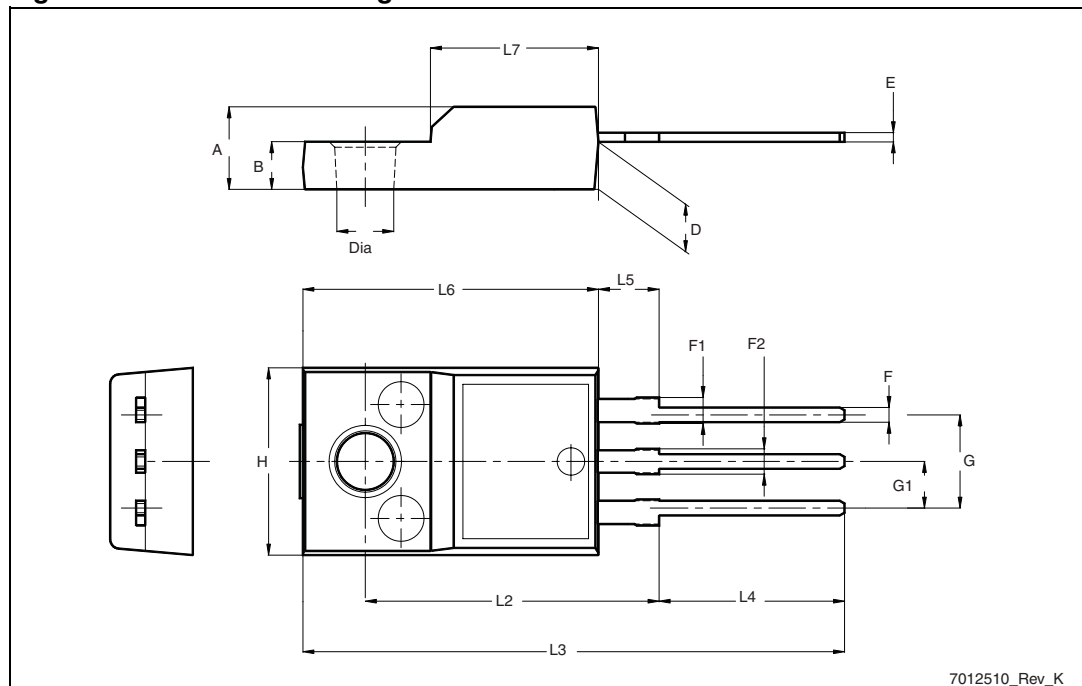


0015988_typeA_Rev_S

Table 12. 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 30. TO-220FP drawing

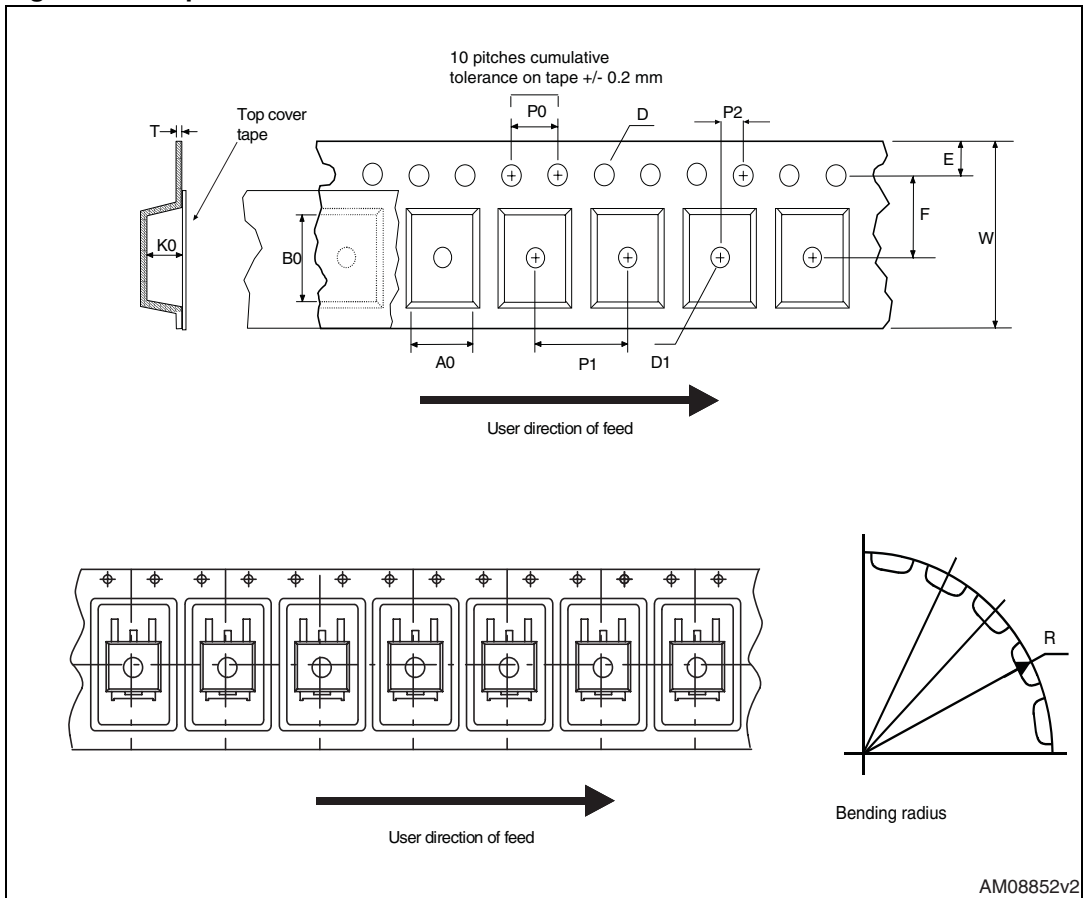


5 Packaging mechanical data

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

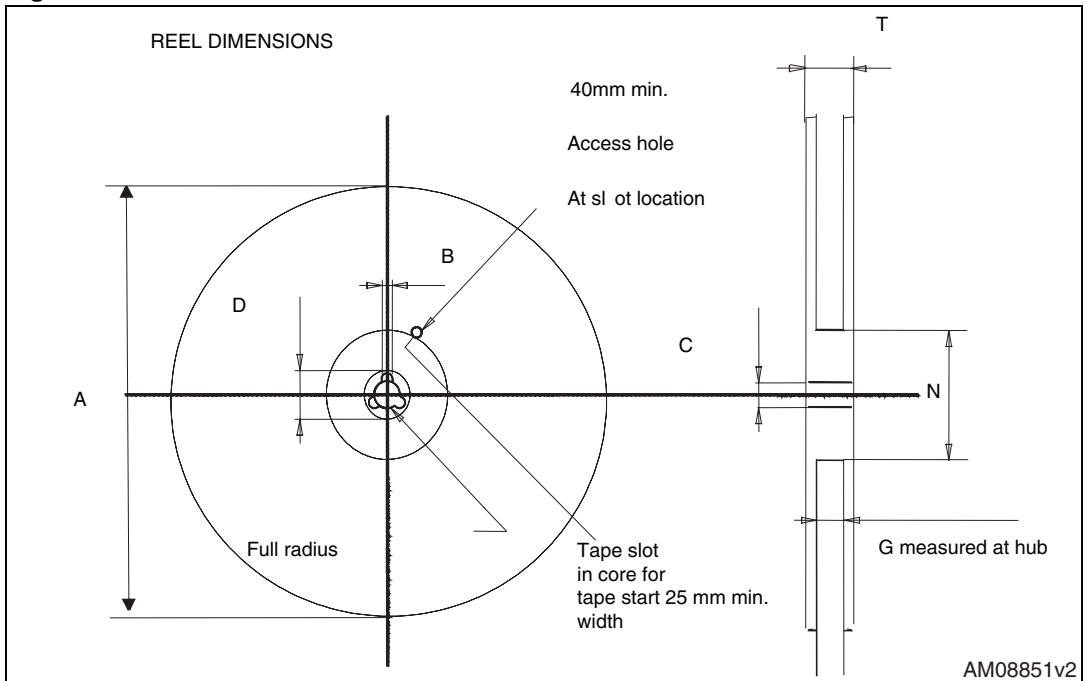
| Tape | | | Reel | | |
|------|------|------|-----------|------|------|
| Dim. | mm | | Dim. | mm | |
| | Min. | Max. | | Min. | Max. |
| A0 | 6.8 | 7 | A | | 330 |
| B0 | 10.4 | 10.6 | B | 1.5 | |
| B1 | | 12.1 | C | 12.8 | 13.2 |
| D | 1.5 | 1.6 | D | 20.2 | |
| D1 | 1.5 | | G | 16.4 | 18.4 |
| E | 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 31. Tape



AM08852v2

Figure 32. Reel



AM08851v2

6 Revision history

Table 14. Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 24-Feb-2009 | 1 | First release |
| 27-Feb-2009 | 2 | Corrected package information on first page |
| 21-Jan-2010 | 3 | Document status promoted from preliminary data to datasheet |
| 29-Jun-2010 | 4 | – Figure 15: Normalized on resistance vs temperature has been updated – V_{GS} vale in Table 4 has been corrected |
| 22-Jun-2011 | 5 | Updated Figure 18 and Figure 20 . Updated gate charge in Table 5 and switching time in Table 6 . |

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