



STB21N65M5, STF21N65M5 STI21N65M5, STP21N65M5, STW21N65M5

N-channel 650 V, 0.150 Ω , 17 A MDmesh™ V Power MOSFET
D²PAK, TO-220FP, TO-220, I²PAK, TO-247

Features

| Order codes | V _{DSS} @ T _{Jmax} | R _{DS(on)} max | I _D | P _W |
|-------------|---|----------------------------|---------------------|----------------|
| STB21N65M5 | 710 V | < 0.179 Ω | 17 A | 125 W |
| STF21N65M5 | | | 17 A ⁽¹⁾ | 30 W |
| STI21N65M5 | | | 17 A | 125 W |
| STP21N65M5 | | | 17 A | 125 W |
| STW21N65M5 | | | 17 A | 125 W |

1. Limited only by maximum temperature allowed

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

Application

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 codes | Marking | Package | Packaging |
|-------------|---------|--------------------|---------------|
| STB21N65M5 | 21N65M5 | D ² PAK | Tape and reel |
| STF21N65M5 | | TO-220FP | Tube |
| STI21N65M5 | | I ² PAK | Tube |
| STP21N65M5 | | TO-220 | Tube |
| STW21N65M5 | | TO-247 | Tube |

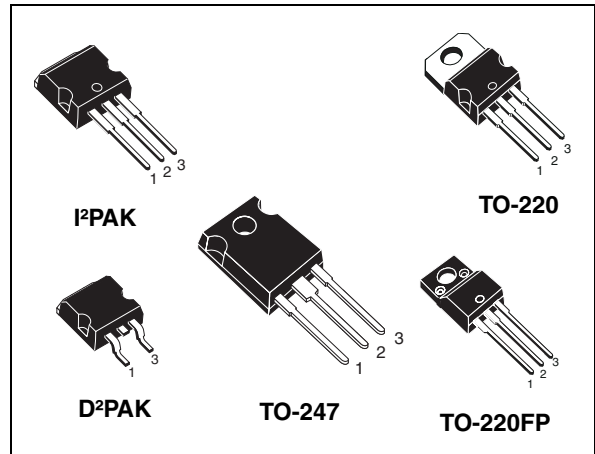
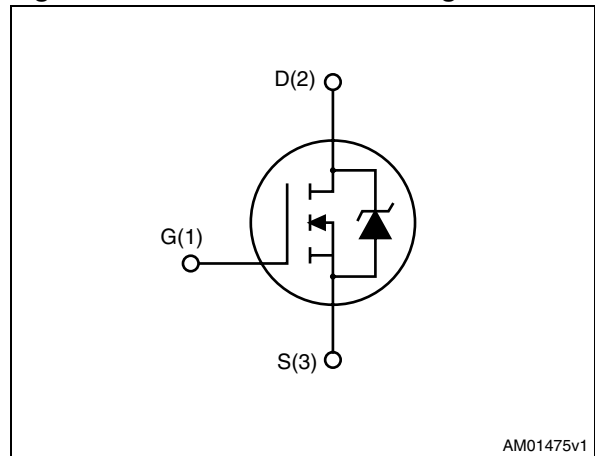


Figure 1. Internal schematic diagram



AM01475v1

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1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | | Unit |
|--------------------------------|--|--|---------------------|------|
| | | TO-220, I ² PAK, D ² PAK, TO-247 | TO-220FP | |
| V _{GS} | Gate-source voltage | ± 25 | | V |
| I _D | Drain current (continuous) at T _C = 25 °C | 17 | 17 ⁽¹⁾ | A |
| I _D | Drain current (continuous) at T _C = 100 °C | 10.7 | 10.7 ⁽¹⁾ | A |
| I _{DM} ⁽²⁾ | Drain current (pulsed) | 68 | 68 ⁽¹⁾ | A |
| P _{TOT} | Total dissipation at T _C = 25 °C | 125 | 30 | W |
| I _{AR} | Avalanche current, repetitive or not-repetitive (pulse width limited by T _j max) | 5 | | A |
| E _{AS} | Single pulse avalanche energy (starting T _j = 25 °C, I _D = I _{AR} , V _{DD} = 50 V) | 400 | | 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} ≤ 17 A, di/dt ≤ 400 A/μs; V_{Peak} < V_{(BR)DSS}; V_{DD} = 400 V.

Table 3. Thermal data

| Symbol | Parameter | Value | | | | | Unit |
|-----------------------|--|--------------------|--------------------|--------|--------|----------|------|
| | | D ² PAK | I ² PAK | TO-220 | TO-247 | TO-220FP | |
| R _{thj-case} | Thermal resistance junction-case max | 1 | | | 4.17 | °C/W | |
| R _{thj-amb} | Thermal resistance junction-ambient max | | 62.5 | 50 | 62.5 | °C/W | |
| R _{thj-pcb} | Thermal resistance junction-pcb max | 30 | | | | °C/W | |
| T _l | Maximum lead temperature for soldering purpose | 300 | | | | °C | |

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 | $V_{GS} = 10\text{ V}$, $I_D = 8.5\text{ A}$ | | 0.150 | 0.179 | Ω |

Table 5. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-------------------|---------------------------------------|--|------|------|------|----------|
| C_{iss} | Input capacitance | $V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0$ | - | 1950 | - | pF |
| C_{oss} | Output capacitance | | | 46 | | pF |
| C_{rss} | Reverse transfer capacitance | | | 3 | | pF |
| $C_{o(tr)}^{(1)}$ | Equivalent capacitance time related | $V_{DS} = 0\text{ to }520\text{ V}$, $V_{GS} = 0$ | - | 133 | - | pF |
| $C_{o(er)}^{(2)}$ | Equivalent capacitance energy related | | | 44 | | pF |
| R_G | Intrinsic gate resistance | $f = 1\text{ MHz}$ open drain | - | 2.5 | - | Ω |
| Q_g | Total gate charge | $V_{DD} = 520\text{ V}$, $I_D = 8.5\text{ A}$, $V_{GS} = 10\text{ V}$ (see Figure 20) | - | 50 | - | nC |
| Q_{gs} | Gate-source charge | | | 13 | | nC |
| Q_{gd} | Gate-drain charge | | | 23 | | nC |

1. $C_{oss\text{ eq.}}$ 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. $C_{oss\text{ eq.}}$ 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 | $V_{DD} = 400\text{ V}$, $I_D = 11\text{ A}$, | | 37 | | ns |
| t_r (v) | Voltage rise time | $R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$ | | 10 | | ns |
| t_f (i) | Current fall time | (see Figure 21) | - | 12 | - | ns |
| t_c (off) | Crossing time | (see Figure 24) | | 24 | | ns |

Table 7. Source drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|---|------|------|------|---------------|
| I_{SD} | Source-drain current | | | | 17 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | - | | 68 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD} = 17\text{ A}$, $V_{GS} = 0$ | - | | 1.5 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 17\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ | | 294 | | ns |
| Q_{rr} | Reverse recovery charge | $V_{DD} = 100\text{ V}$ (see Figure 21) | - | 4 | | μC |
| I_{RRM} | Reverse recovery current | | | 28 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 17\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ | | 340 | | ns |
| Q_{rr} | Reverse recovery charge | $V_{DD} = 100\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$ | - | 5 | | μC |
| I_{RRM} | Reverse recovery current | (see Figure 21) | | 29 | | 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 TO-220, D²PAK, I²PAK

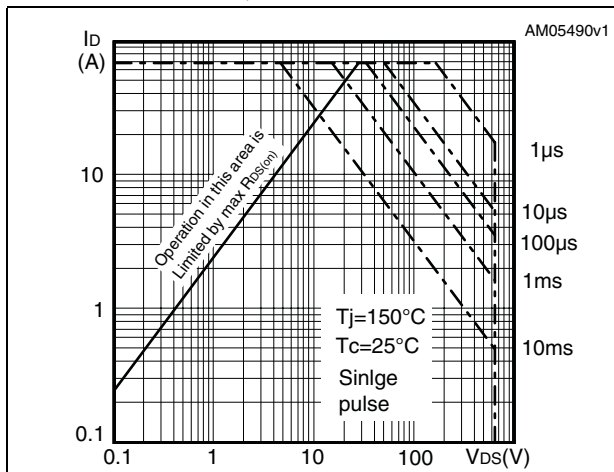


Figure 3. Thermal impedance for TO-220, D²PAK, I²PAK

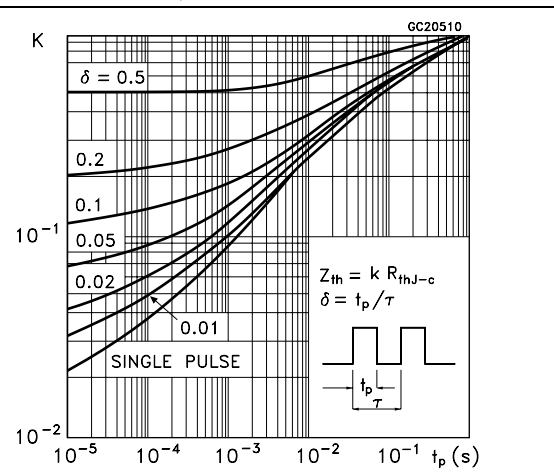


Figure 4. Safe operating area for TO-220FP

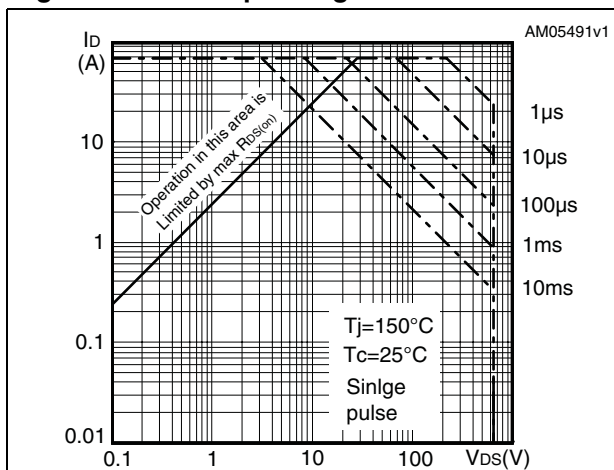


Figure 5. Thermal impedance for TO-220FP

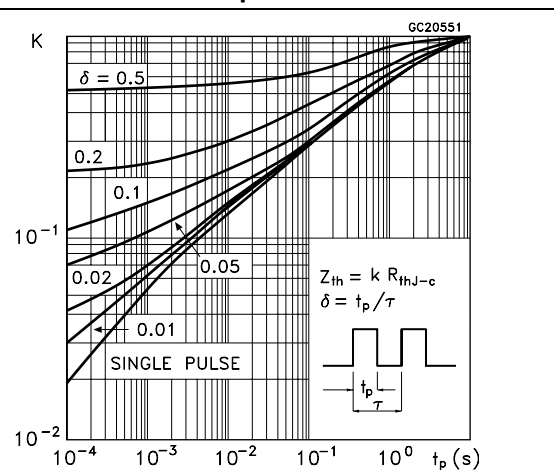


Figure 6. Safe operating area for TO-247

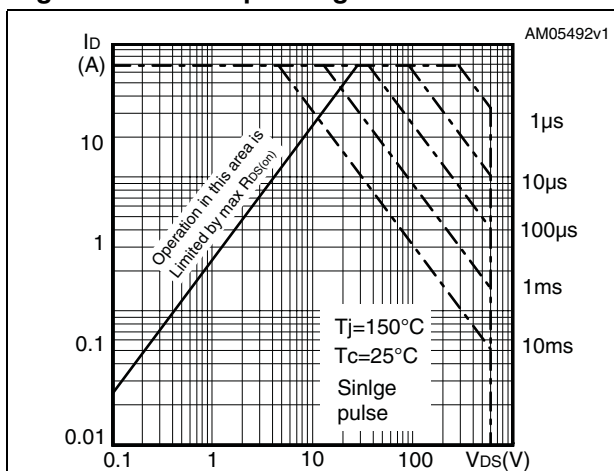


Figure 7. Thermal impedance for TO-247

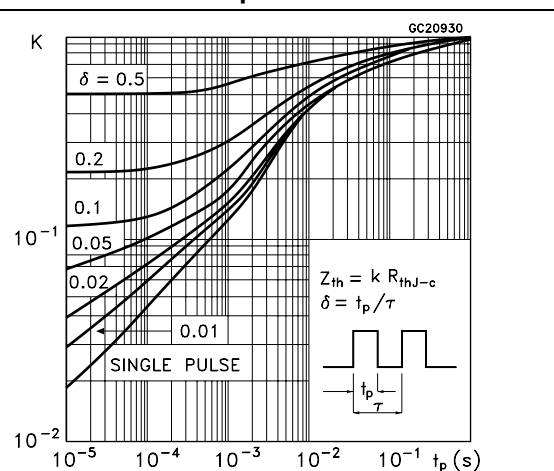


Figure 8. Output characteristics

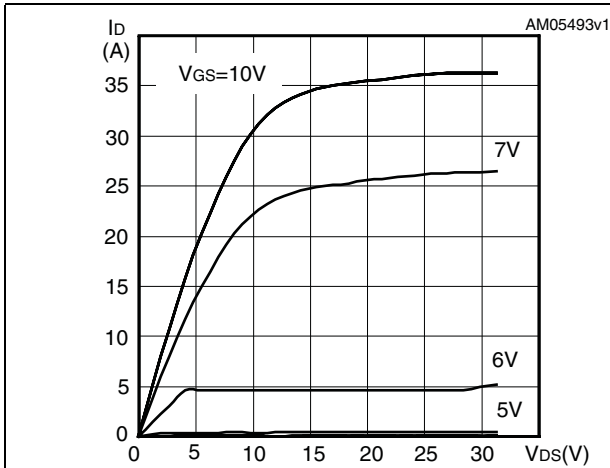


Figure 9. Transfer characteristics

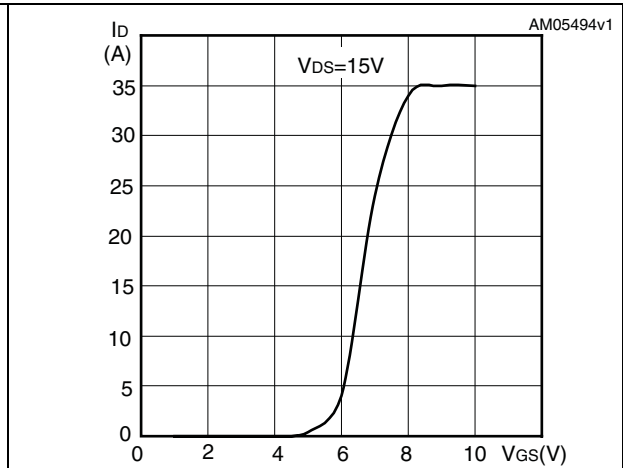


Figure 10. Gate charge vs gate-source voltage

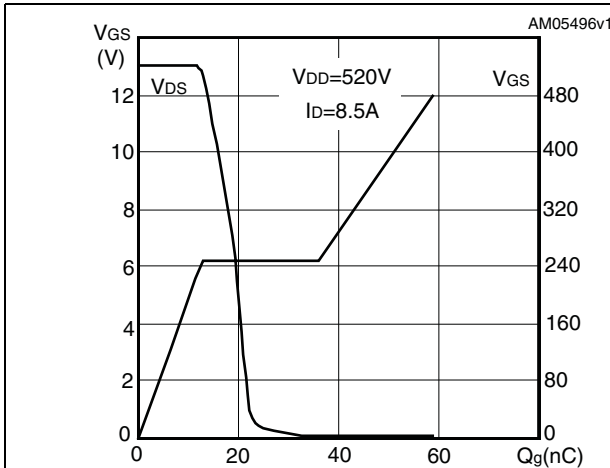


Figure 11. Static drain-source on resistance

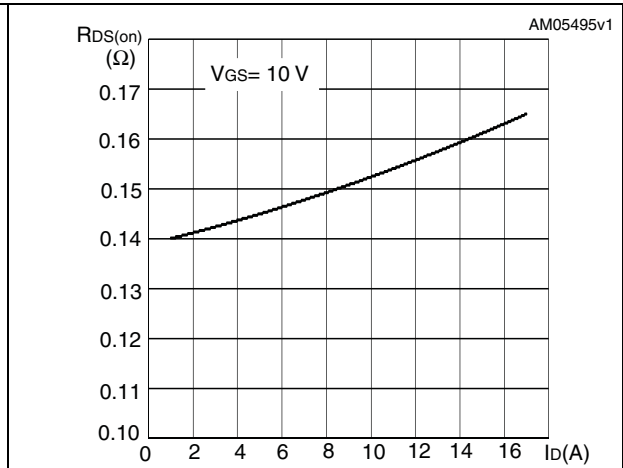


Figure 12. Capacitance variations

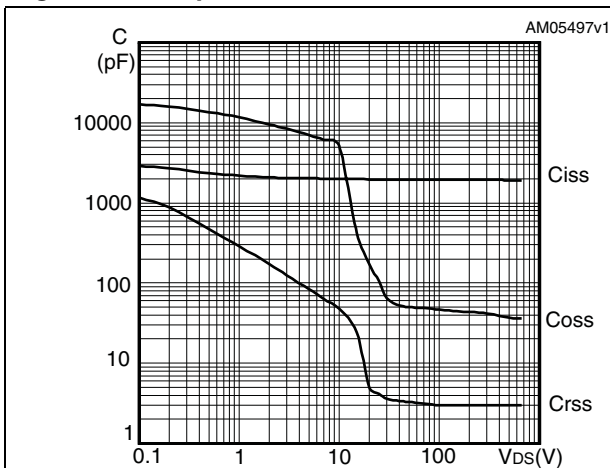


Figure 13. Output capacitance stored energy

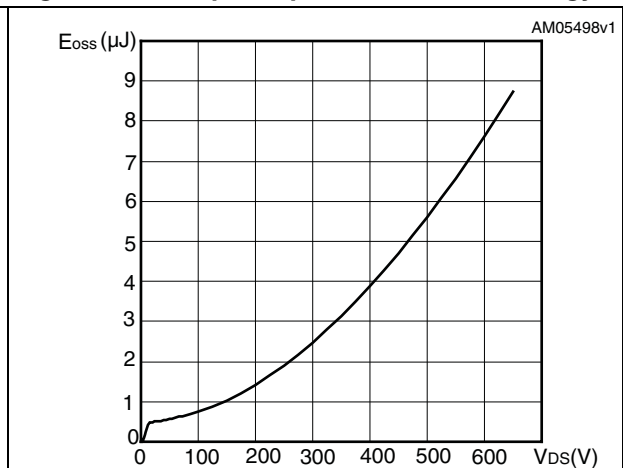


Figure 14. Normalized gate threshold voltage vs temperature

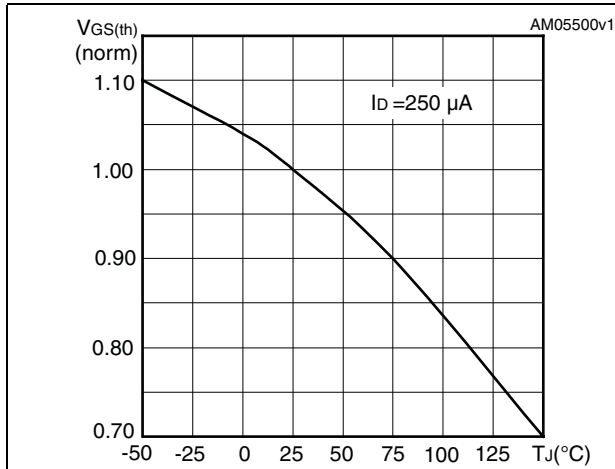


Figure 15. Normalized on resistance vs temperature

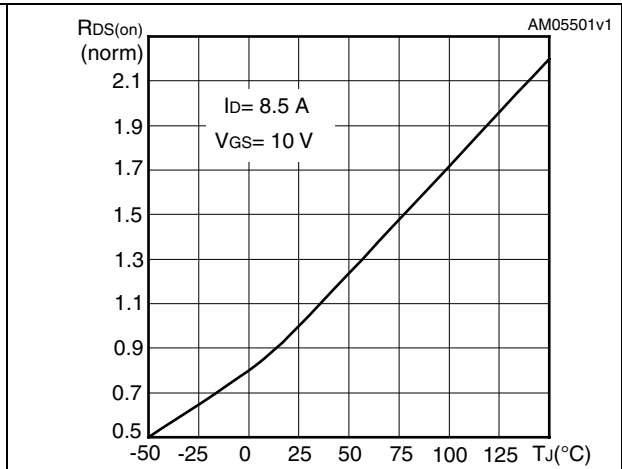


Figure 16. Source-drain diode forward characteristics

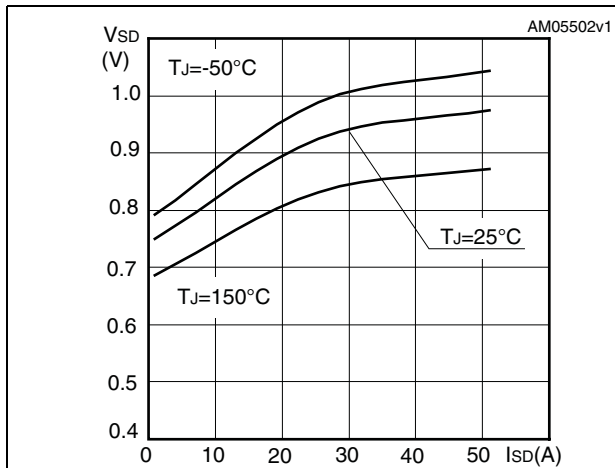


Figure 17. Normalized BV_{DSS} vs temperature

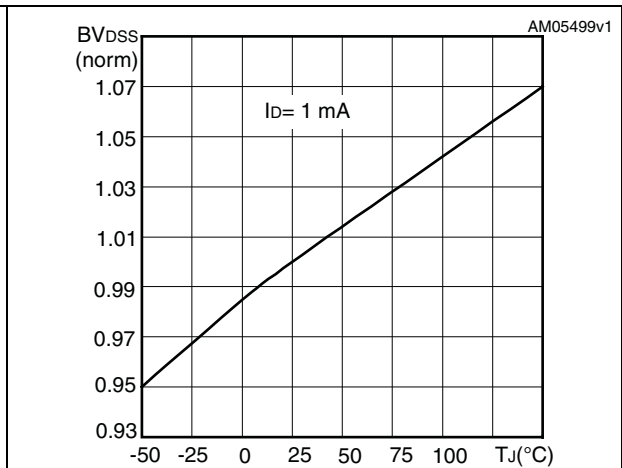
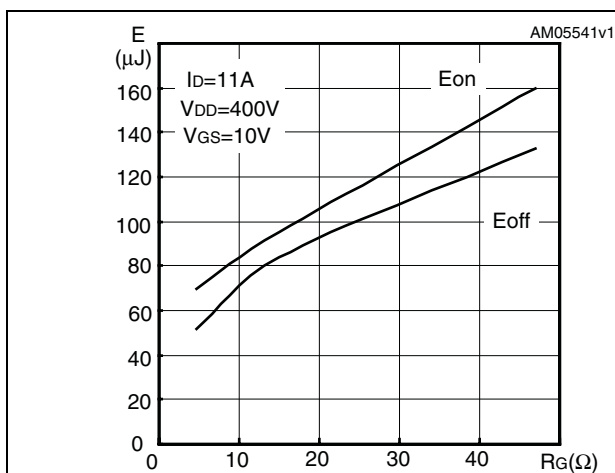


Figure 18. Switching losses vs gate resistance (1)



1. Eon including reverse recovery of a SiC diode.

3 Test circuits

Figure 19. Switching times test circuit for resistive load

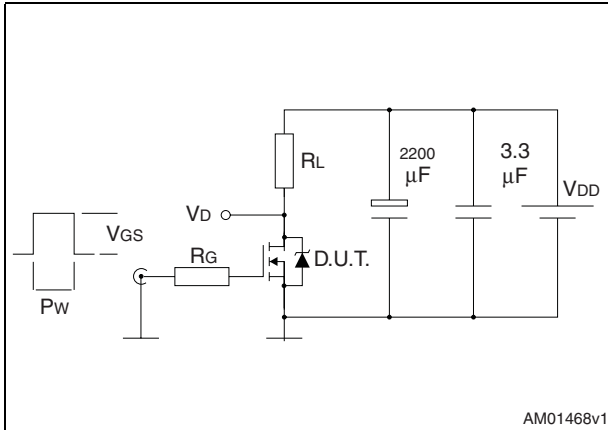


Figure 20. Gate charge test circuit

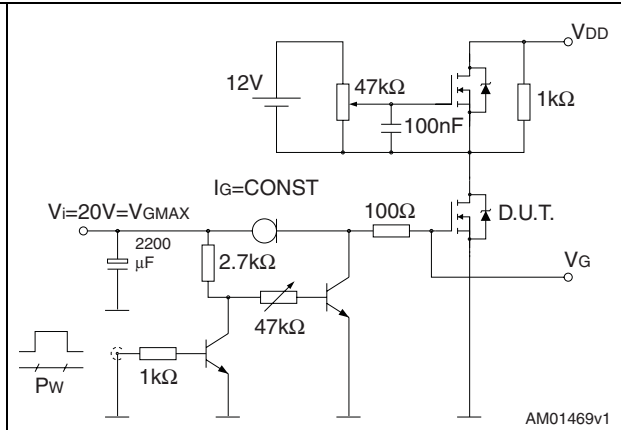


Figure 21. Test circuit for inductive load switching and diode recovery times

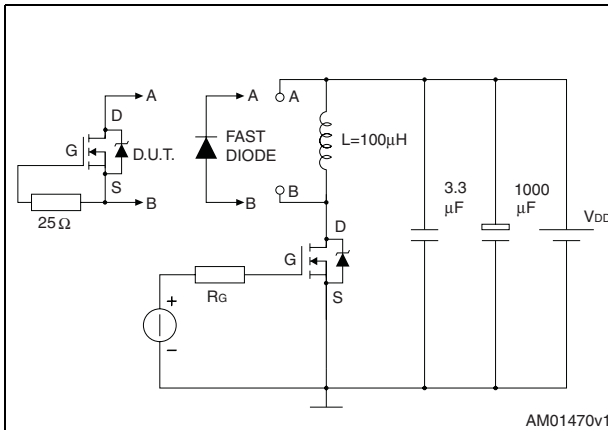


Figure 22. Unclamped inductive load test circuit

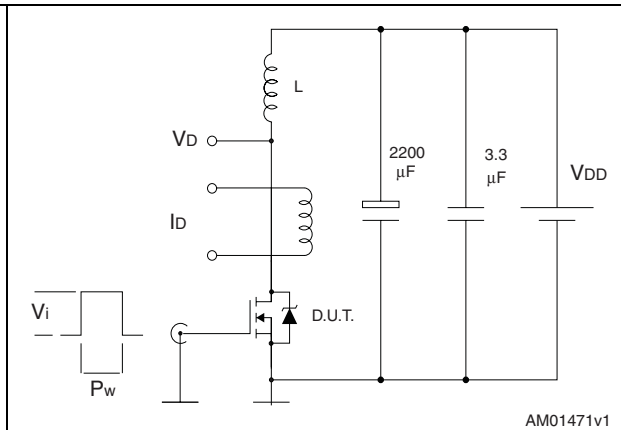


Figure 23. Unclamped inductive waveform

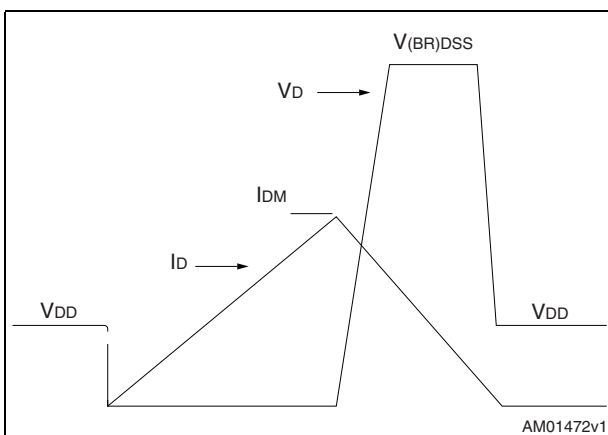
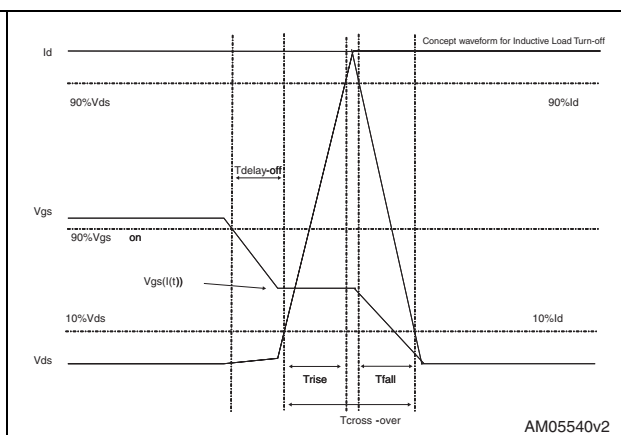


Figure 24. Switching time waveform



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 8. 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 25. TO-220FP drawing mechanical data

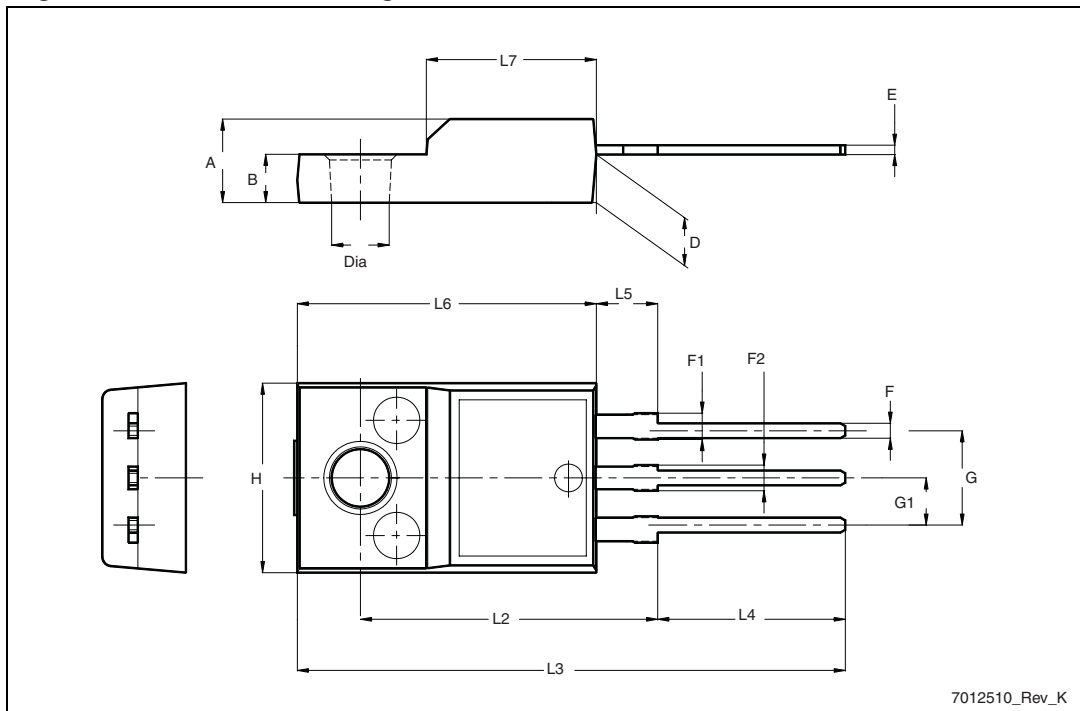


Table 9. I²PAK (TO-262) mechanical data

| 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 26. I²PAK (TO-262) drawing

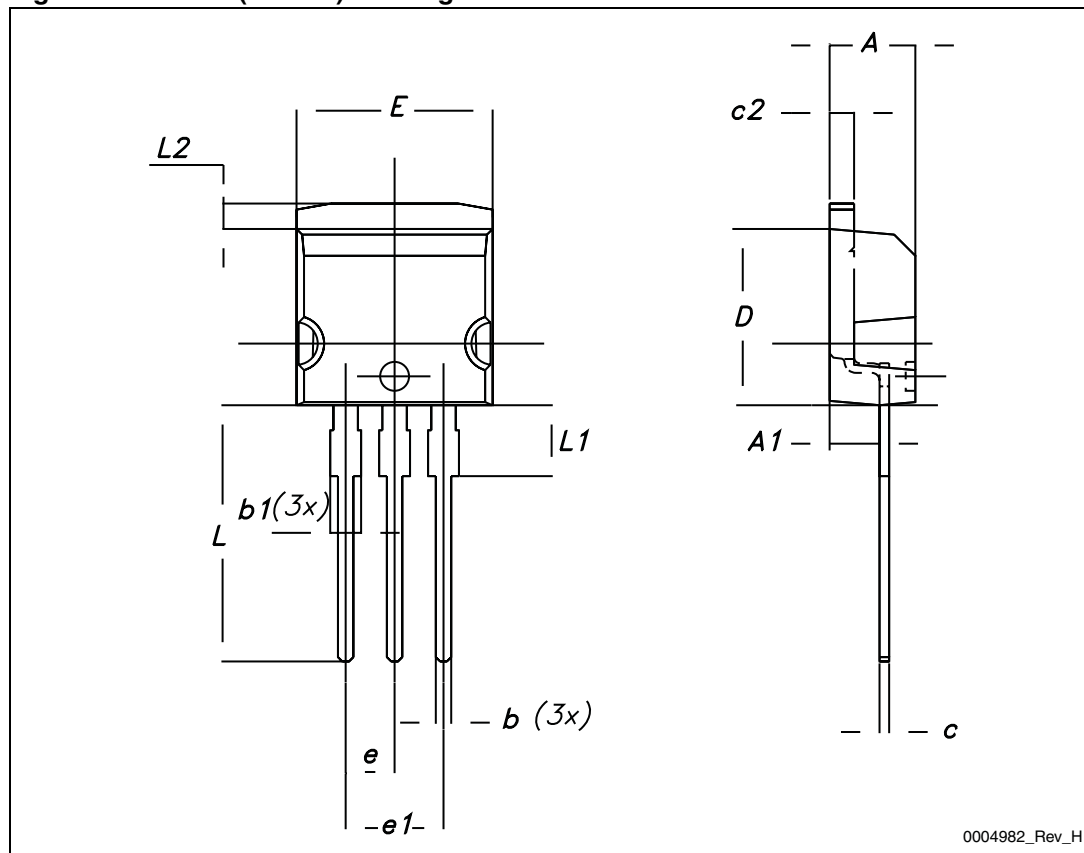


Table 10. TO-220 type A mechanical data

| 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 27. TO-220 type A drawing

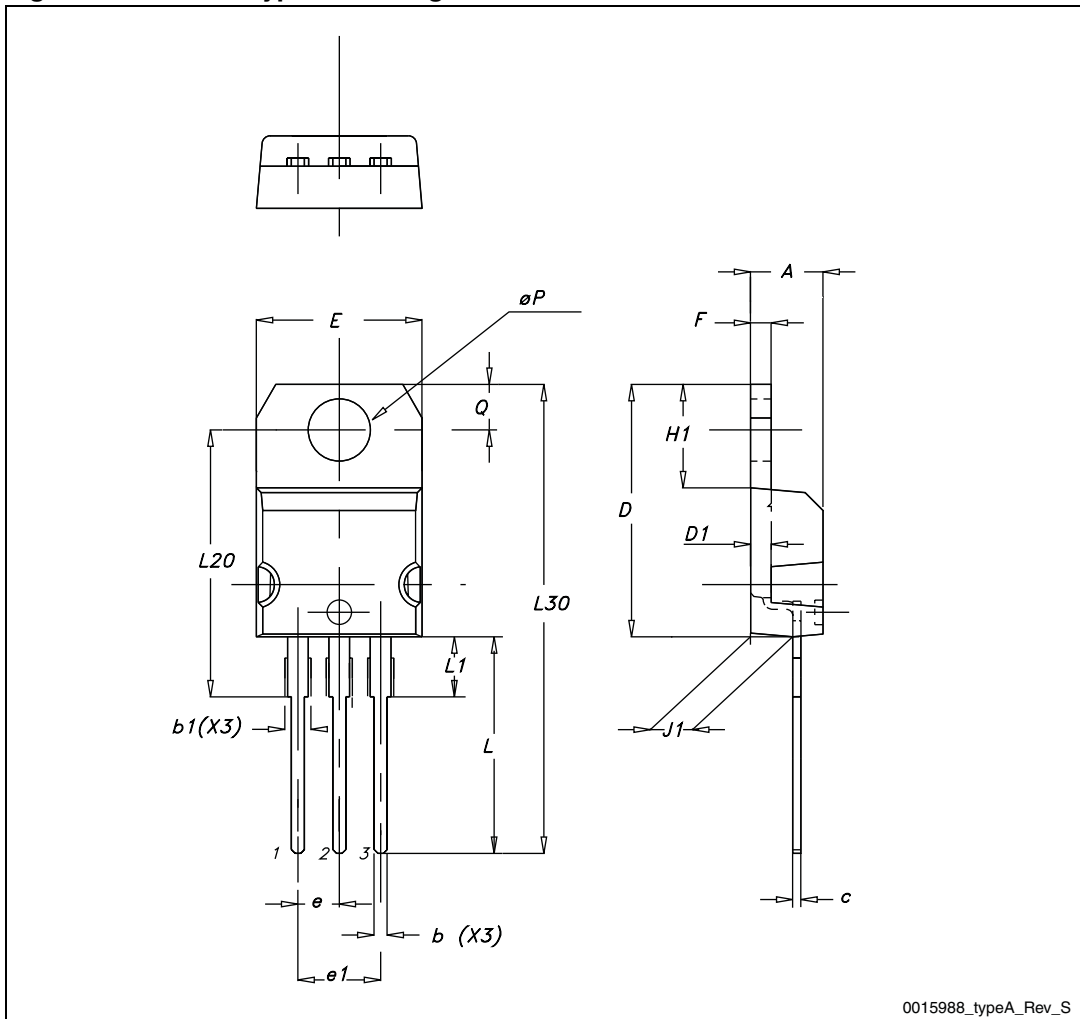
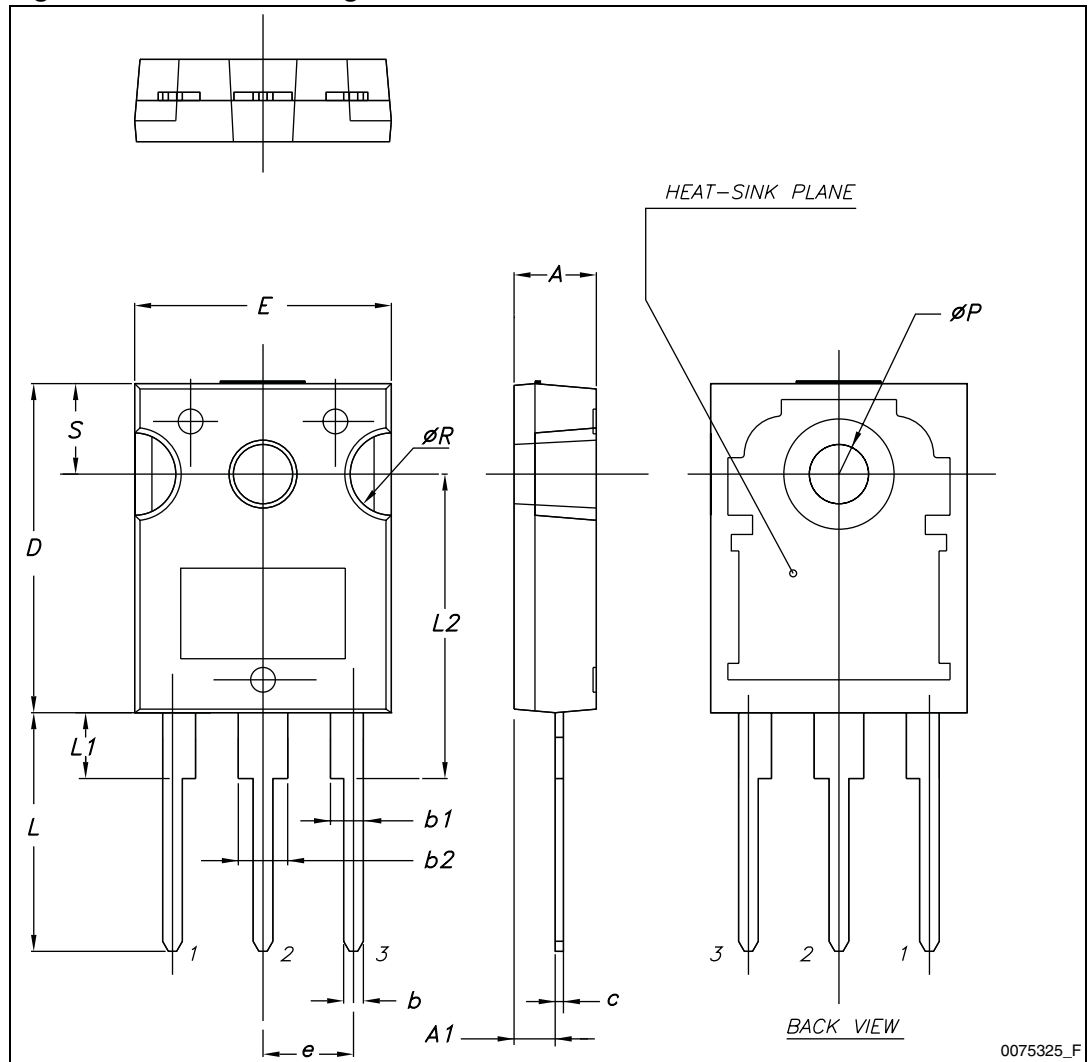


Table 11. TO-247 mechanical data

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

Figure 28. TO-247 drawing

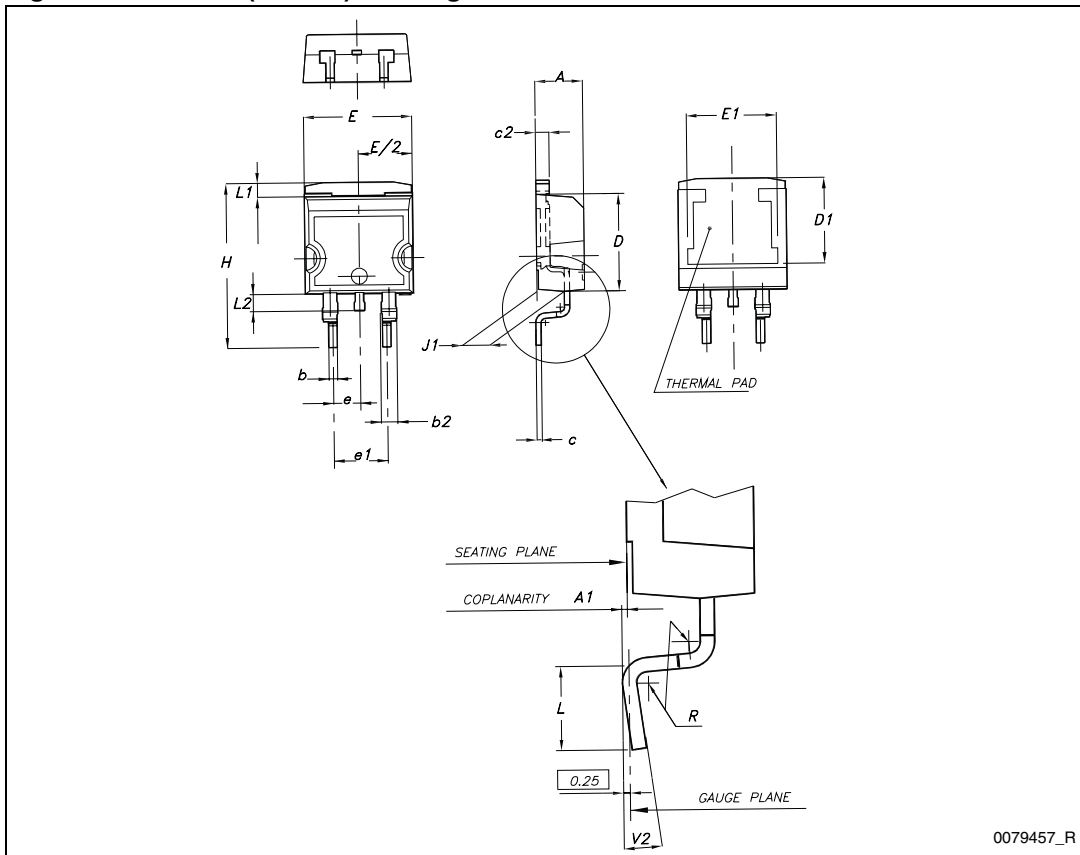


0075325_F

Table 12. 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 29. D²PAK (TO-263) drawing

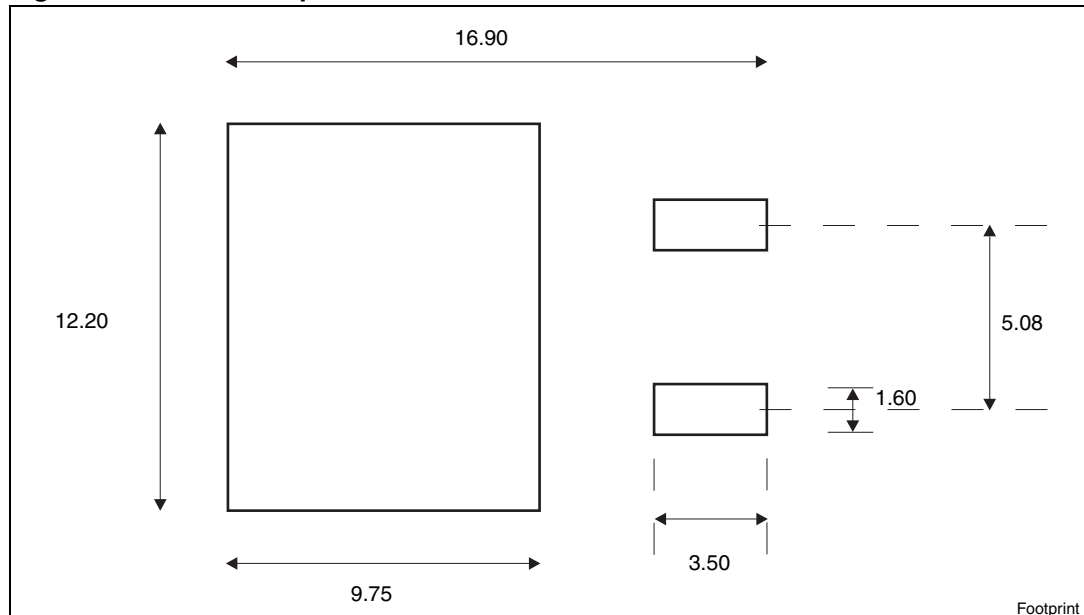


5 Packaging mechanical data

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. D²PAK footprint^(a)



a. All dimension are in millimeters

Figure 31. Tape

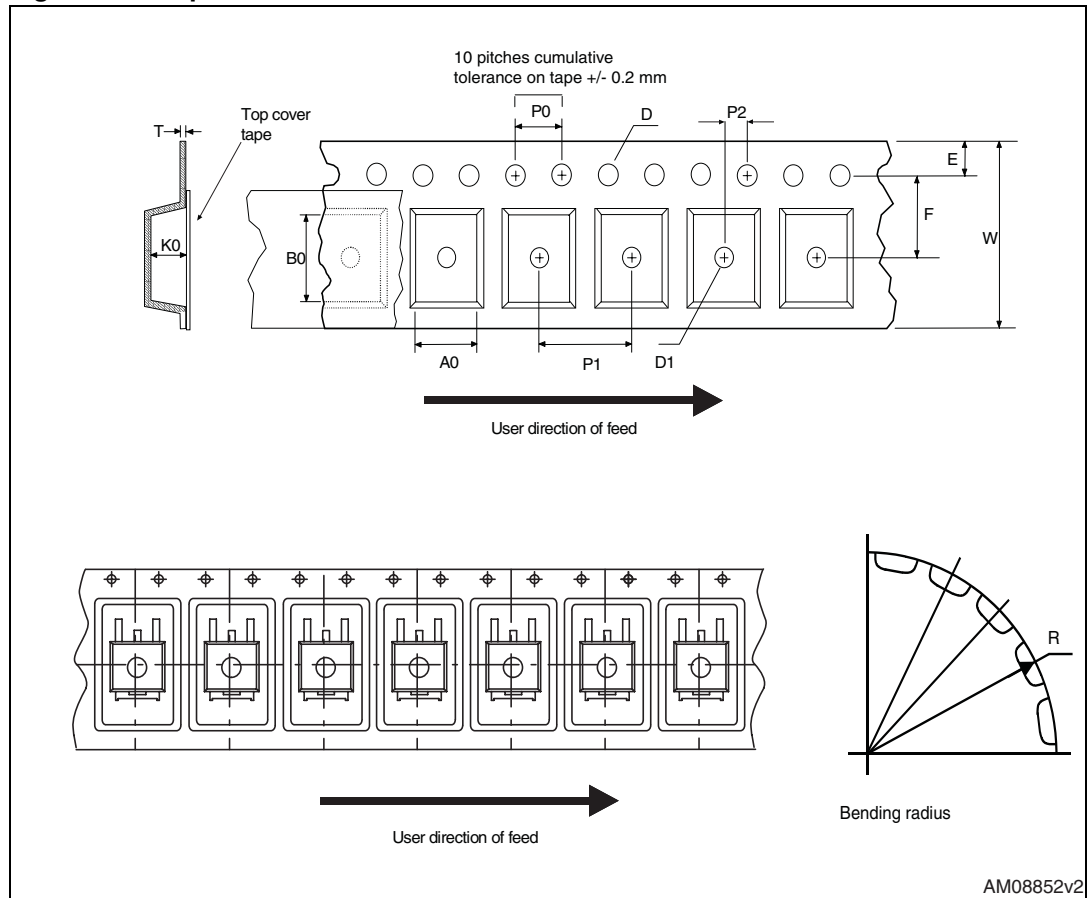
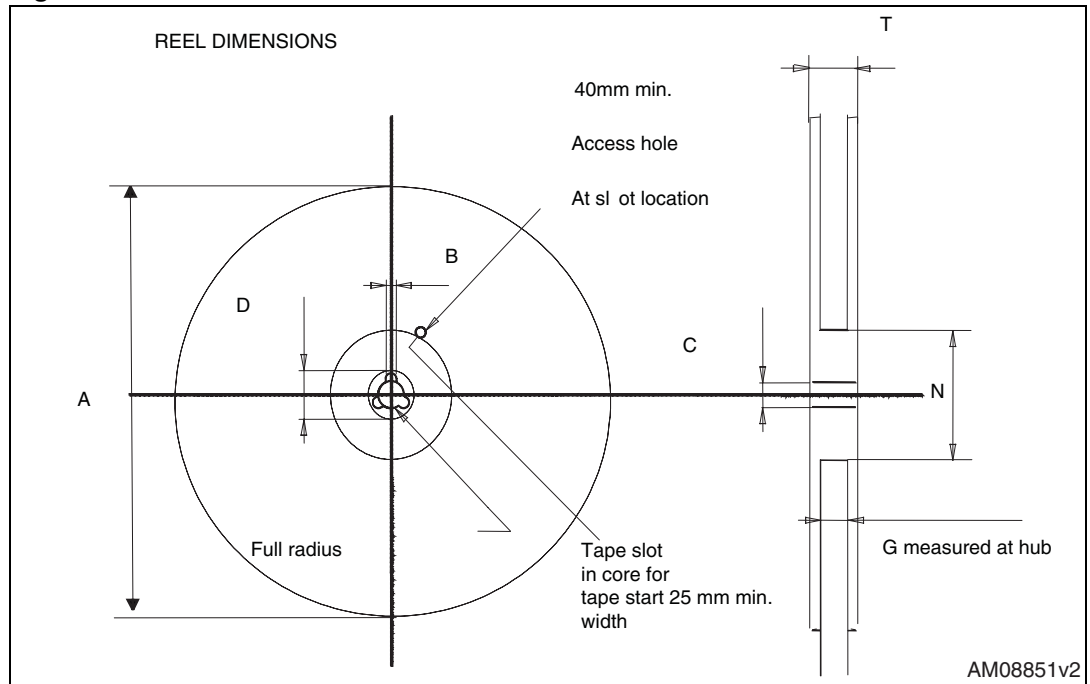


Figure 32. Reel



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. |
| 11-Nov-2009 | 3 | Document status promoted from preliminary data to datasheet. |
| 11-May-2011 | 4 | $R_{DS(on)}$ values have been updated (see Table 4: On /off states and Figure 11: Static drain-source on resistance). |

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Как с нами связаться

Телефон: 8 (812) 309 58 32 (многоканальный)

Факс: 8 (812) 320-02-42

Электронная почта: org@eplast1.ru

Адрес: 198099, г. Санкт-Петербург, ул. Калинина, дом 2, корпус 4, литера А.