



STB14NM50N, STD14NM50N, STF14NM50N, STI14NM50N, STP14NM50N

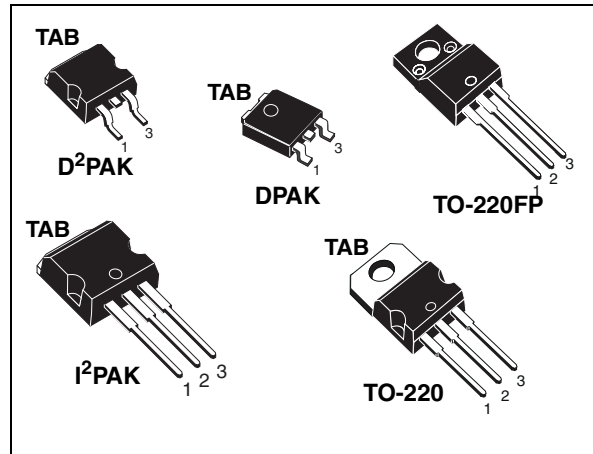
N-channel 500 V, 0.28 Ω typ., 12 A MDmesh™ II Power MOSFET
in D²PAK, DPAK, TO-220FP, I²PAK and TO-220 packages

Datasheet – production data

Features

| Type | V _{DSS} @ T _{Jmax} | R _{DS(on)} max | I _D |
|--|---|----------------------------|----------------|
| STB14NM50N STD14NM50N STF14NM50N STI14NM50N STP14NM50N | 550 V | < 0.32 Ω | 12 A |

- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance



Applications

- Switching applications

Description

These devices are N-channel Power MOSFET developed using the second generation of MDmesh™ technology. This revolutionary Power MOSFET associates a vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. It is therefore suitable for the most demanding high efficiency converters.

Figure 1. Internal schematic diagram

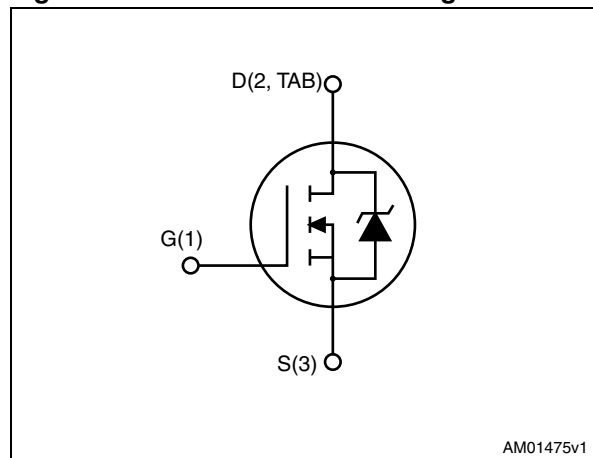


Table 1. Device summary

| Order codes | Marking | Package | Packaging |
|-------------|---------|--------------------|---------------|
| STB14NM50N | 14NM50N | D ² PAK | Tape and reel |
| STD14NM50N | | DPAK | |
| STF14NM50N | | TO-220FP | Tube |
| STI14NM50N | | I ² PAK | |
| STP14NM50N | | TO-220 | |

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1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | | Unit |
|--------------------------------|---|--|-------------------|------|
| | | D ² PAK, DPAK I ² PAK, TO-220 | TO-220FP | |
| V _{DS} | Drain-source voltage | 500 | | V |
| V _{GS} | Gate-source voltage | ± 25 | | V |
| I _D | Drain current (continuous) at T _C = 25 °C | 12 | 12 ⁽¹⁾ | A |
| I _D | Drain current (continuous) at T _C = 100 °C | 8 | 8 ⁽¹⁾ | A |
| I _{DM} ⁽²⁾ | Drain current (pulsed) | 48 | 48 ⁽¹⁾ | A |
| P _{TOT} | Total dissipation at T _C = 25 °C | 90 | 25 | W |
| 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 by maximum junction temperature
2. Pulse width limited by safe operating area
3. $I_{SD} \leq 12$ A, $di/dt \leq 400$ A/s, $V_{DS\ peak} \leq V_{(BR)DSS}$, $V_{DD} = 80\% V_{(BR)DSS}$

Table 3. Thermal data

| Symbol | Parameter | Value | | | | | Unit |
|-------------------------------------|---|--------------------|------|----------|--------------------|--------|------|
| | | D ² PAK | DPAK | TO-220FP | I ² PAK | TO-220 | |
| 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 | | | °C/W |
| R _{thj-pcb} ⁽¹⁾ | Thermal resistance junction-pcb max | 30 | 50 | | | | °C/W |

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

Table 4. Avalanche data

| Symbol | Parameter | Value | Unit |
|----------|---|-------|------|
| I_{AR} | Avalanche current, repetitive or not-repetitive (pulse width limited by T_j max) | 4 | A |
| E_{AS} | Single pulse avalanche energy (starting $T_j = 25^\circ\text{C}$, $I_D = I_{AR}$, $V_{DD} = 50\text{ V}$) | 172 | 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 | $I_D = 1\text{ mA}$, $V_{GS} = 0$ | 500 | | | V |
| I_{DSS} | Zero gate voltage drain current ($V_{GS} = 0$) | $V_{DS} = 620\text{ V}$ $V_{DS} = 620\text{ V}$, $T_C = 125\text{ °C}$ | | | 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 | $V_{DS} = V_{GS}$, $I_D = 100\text{ }\mu\text{A}$ | 2 | 3 | 4 | V |
| $R_{DS(on)}$ | Static drain-source on-resistance | $V_{GS} = 10\text{ V}$, $I_D = 6\text{ A}$ | | 0.28 | 0.32 | Ω |

Table 6. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------------------|-------------------------------|--|------|-------|------|----------|
| C_{iss} | Input capacitance | $V_{DS} = 50\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0$ | - | 816 | - | pF |
| C_{oss} | Output capacitance | | | 60 | | pF |
| C_{rss} | Reverse transfer capacitance | | | 3 | | pF |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{DS} = 0\text{ to }50\text{ V}$, $V_{GS} = 0$ | - | 307.5 | - | pF |
| R_G | Intrinsic gate resistance | $f = 1\text{ MHz}$ open drain | - | 4.5 | - | Ω |
| Q_g | Total gate charge | $V_{DD} = 400\text{ V}$, $I_D = 12\text{ A}$, $V_{GS} = 10\text{ V}$ (see Figure 17) | - | 27 | - | nC |
| Q_{gs} | Gate-source charge | | | 4.6 | | nC |
| Q_{gd} | Gate-drain charge | | | 15 | | 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_{DS}

Table 7. Switching times

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------------|---------------------|---|------|------|------|------|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD} = 400\text{ V}$, $I_D = 12\text{ A}$, $R_G = 4.7\text{ }\Omega$, $V_{GS} = 10\text{ V}$ (see Figure 18) | - | 10.2 | - | ns |
| t_r | Rise time | | | 16 | | ns |
| $t_{d(off)}$ | Turn-off-delay time | | | 42 | | ns |
| t_f | Fall time | | | 22 | | ns |

Table 8. Source drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|---|------|------|------|---------------|
| I_{SD} | Source-drain current | | - | | 12 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | - | | 48 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD} = 12\text{ A}$, $V_{GS} = 0$ | - | | 1.6 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 12\text{ A}$, $di/dt = 100\text{ V/ns}$, $V_{DD} = 400\text{ V}$ (see Figure 21) | - | 252 | | ns |
| Q_{rr} | Reverse recovery charge | | | 2.8 | | μC |
| I_{RRM} | Reverse recovery current | | | 22 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 12\text{ A}$, $di/dt = 100\text{ V/ns}$, $V_{DD} = 400\text{ V}$, $T_J = 150\text{ }^\circ\text{C}$ (see Figure 21) | - | 300 | | ns |
| Q_{rr} | Reverse recovery charge | | | 3.3 | | μC |
| I_{RRM} | Reverse recovery current | | | 22.2 | | 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, I²PAK, TO-220

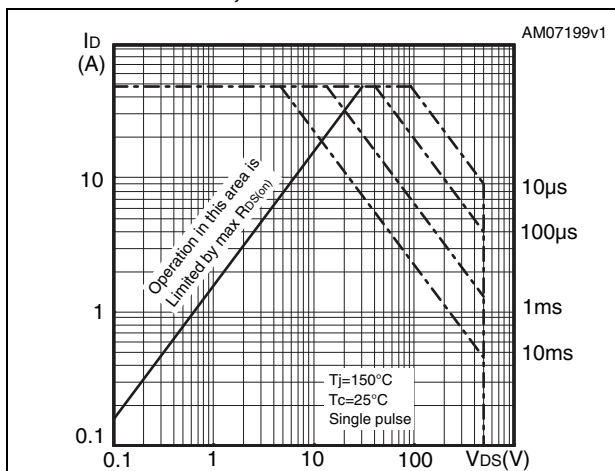


Figure 3. Thermal impedance for D²PAK, I²PAK, TO-220

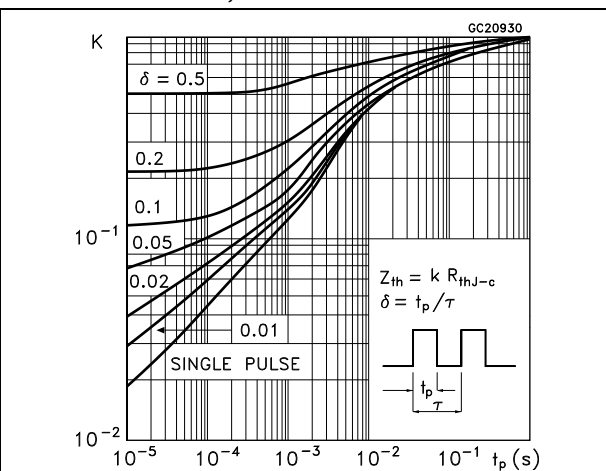


Figure 4. Safe operating area for DPAK

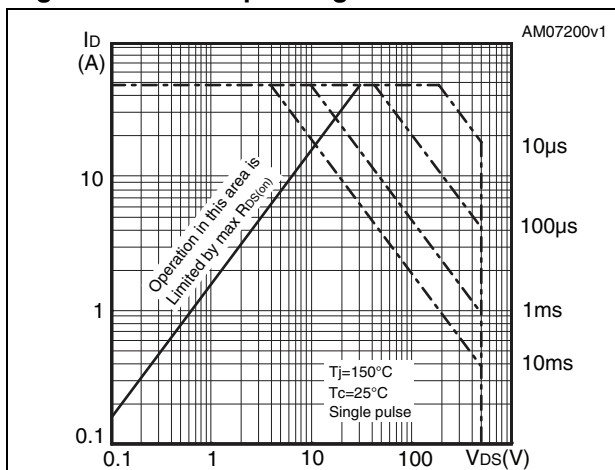


Figure 5. Thermal impedance for DPAK

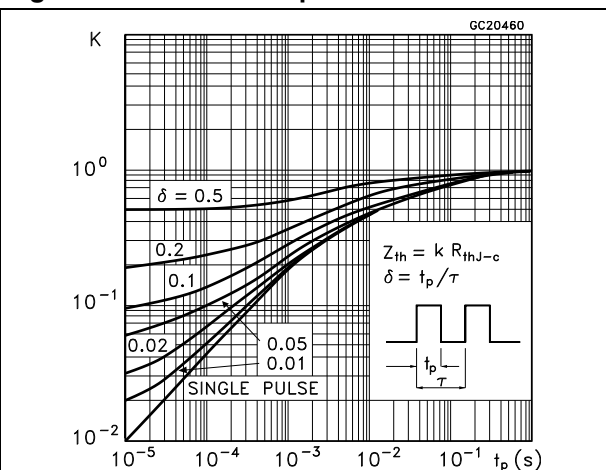


Figure 6. Safe operating area for TO-220FP

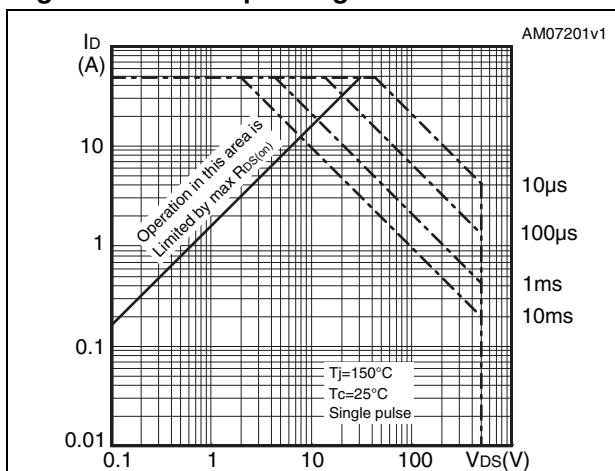


Figure 7. Thermal impedance for TO-220FP

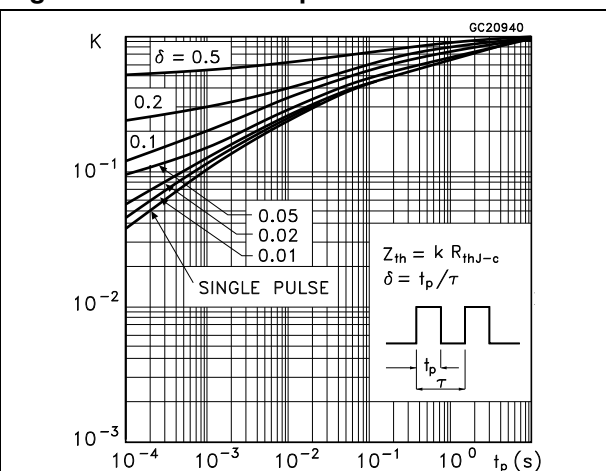


Figure 8. Output characteristics

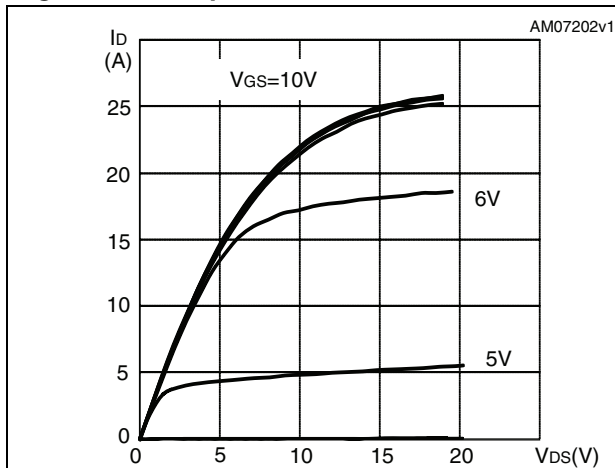


Figure 9. Transfer characteristics

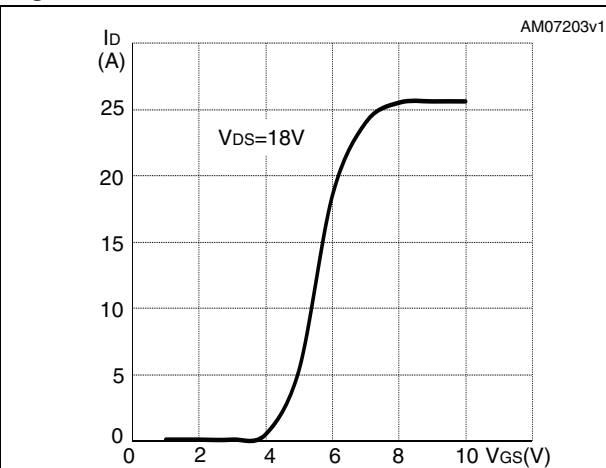


Figure 10. Normalized $B_{V_{DS}}$ vs temperature

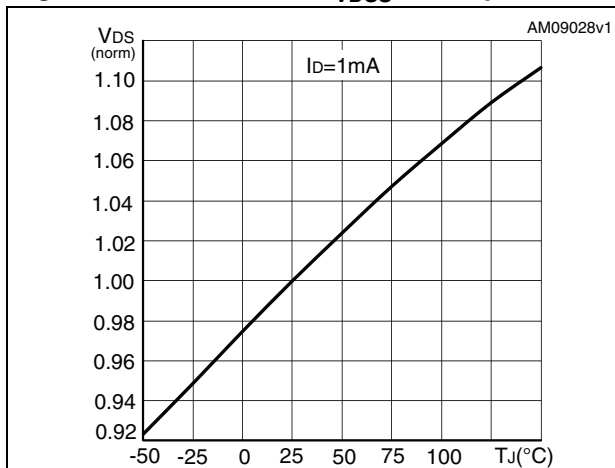


Figure 11. Static drain-source on-resistance

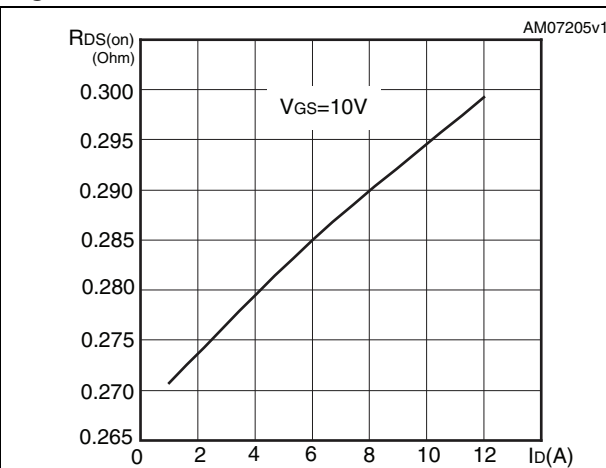


Figure 12. Capacitance variations

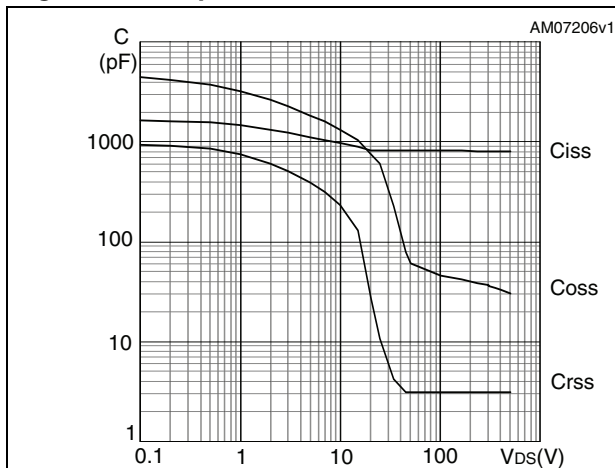


Figure 13. Gate charge vs gate-source voltage

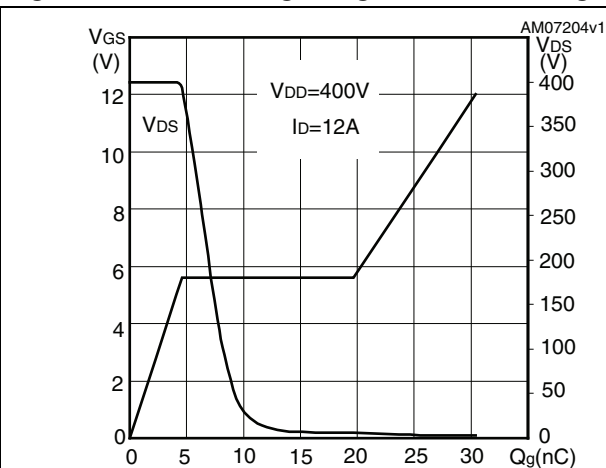


Figure 14. Normalized gate threshold voltage vs temperature

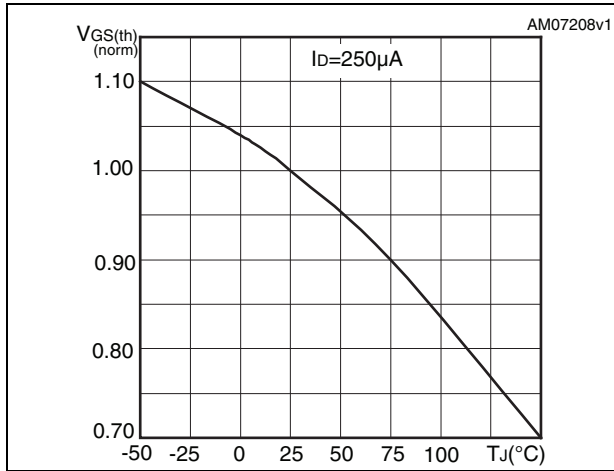
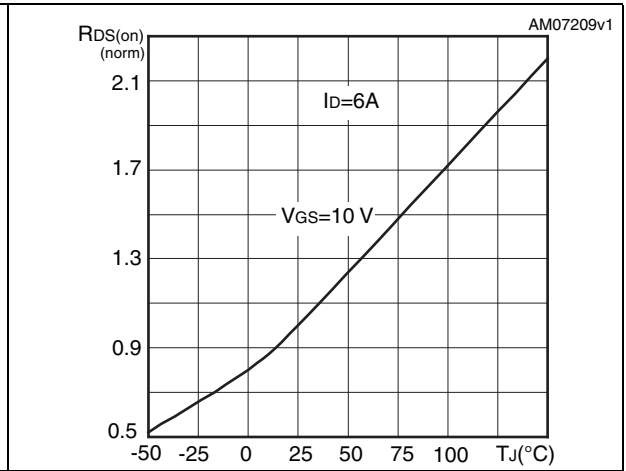
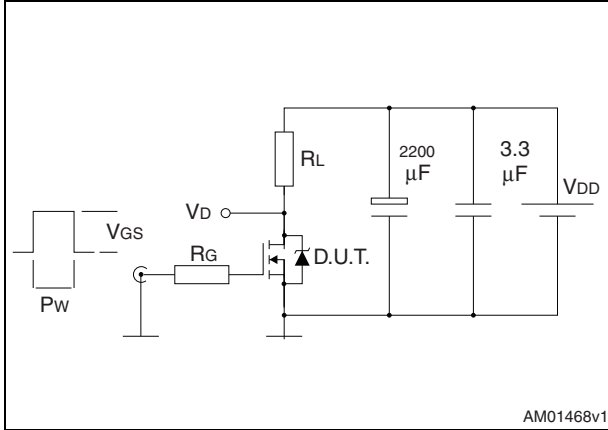


Figure 15. Normalized on-resistance vs temperature



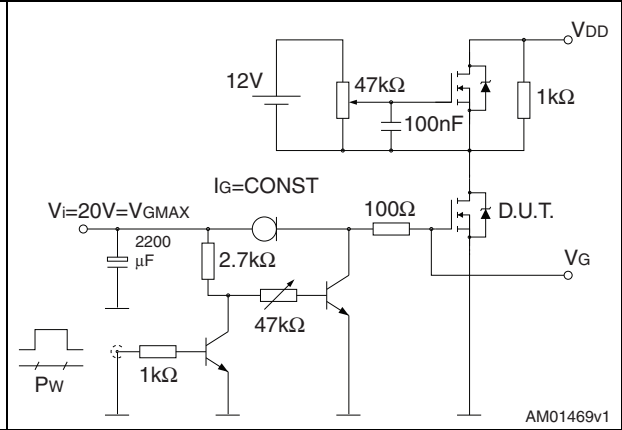
3 Test circuits

Figure 16. Switching times test circuit for resistive load



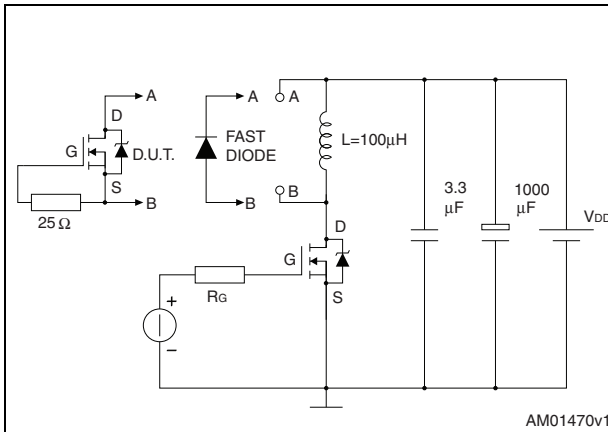
AM01468v1

Figure 17. Gate charge test circuit



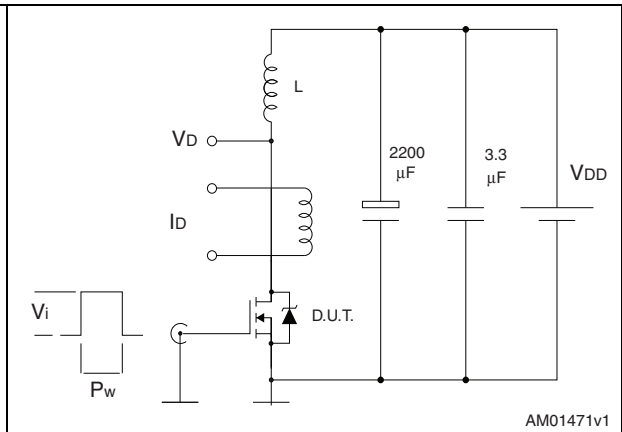
AM01469v1

Figure 18. Test circuit for inductive load switching and diode recovery times



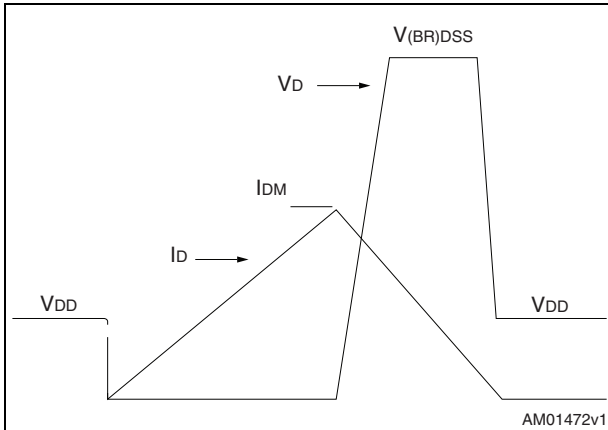
AM01470v1

Figure 19. Unclamped inductive load test circuit



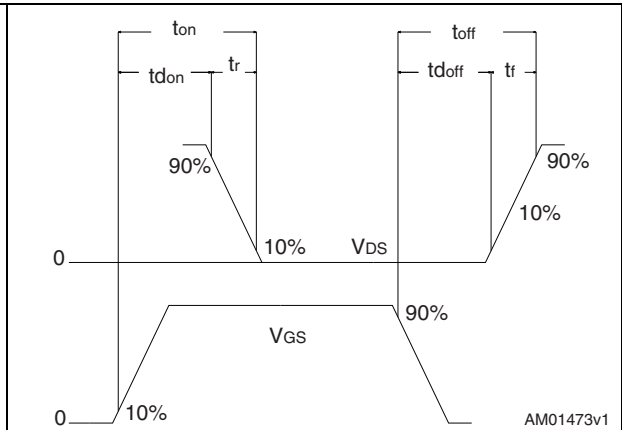
AM01471v1

Figure 20. Unclamped inductive waveform



AM01472v1

Figure 21. 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.

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 22. D²PAK (TO-263) drawing

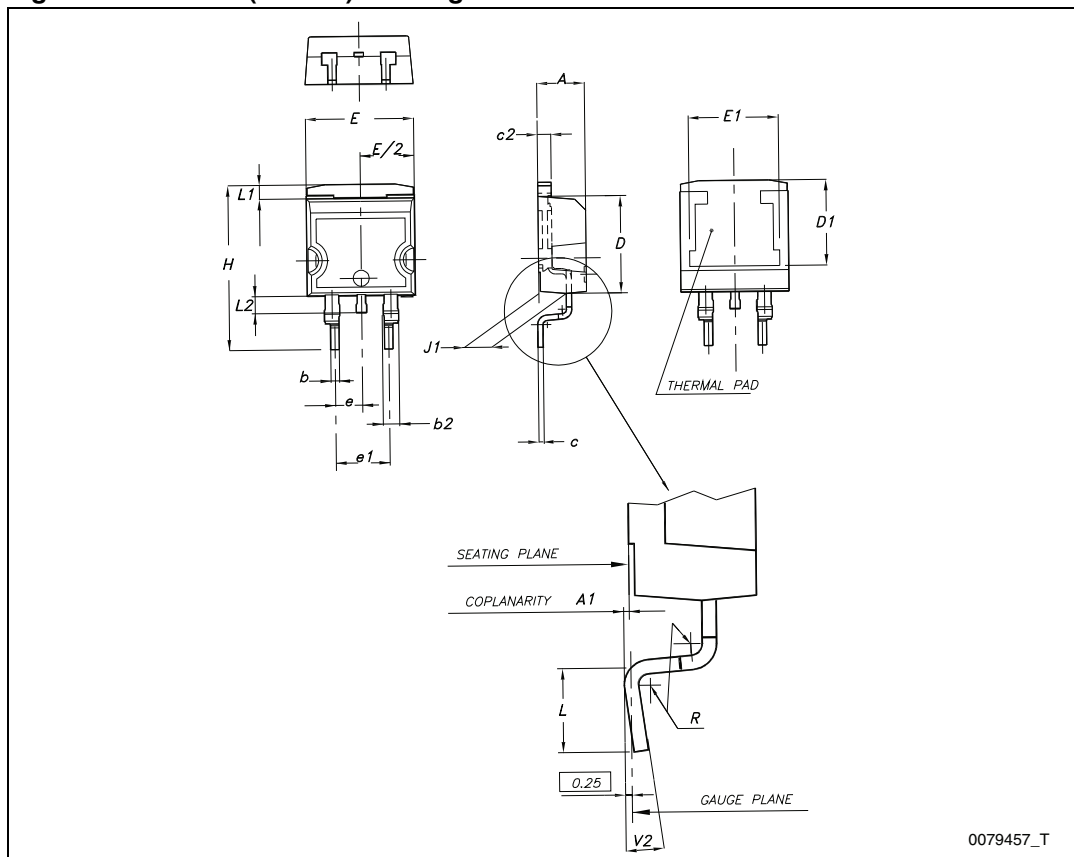
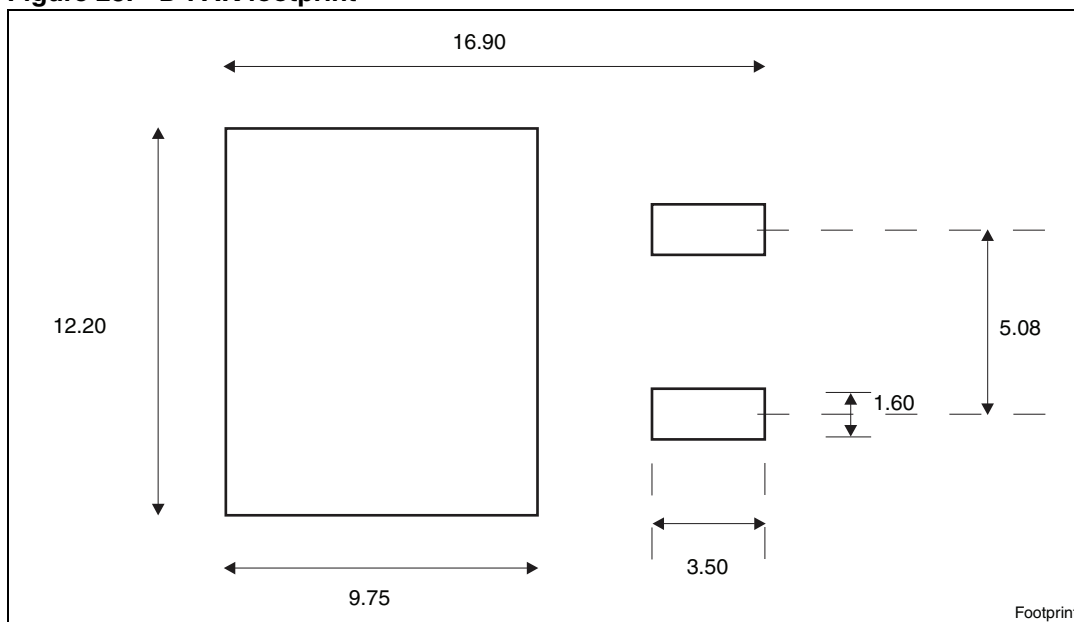


Figure 23. D²PAK footprint^(a)



a. All dimensions are in millimeters

Table 10. 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 | | |
| L1 | | 2.80 | |
| L2 | | 0.80 | |
| L4 | 0.60 | | 1 |
| R | | 0.20 | |
| V2 | 0° | | 8° |

Figure 24. DPAK (TO-252) drawing

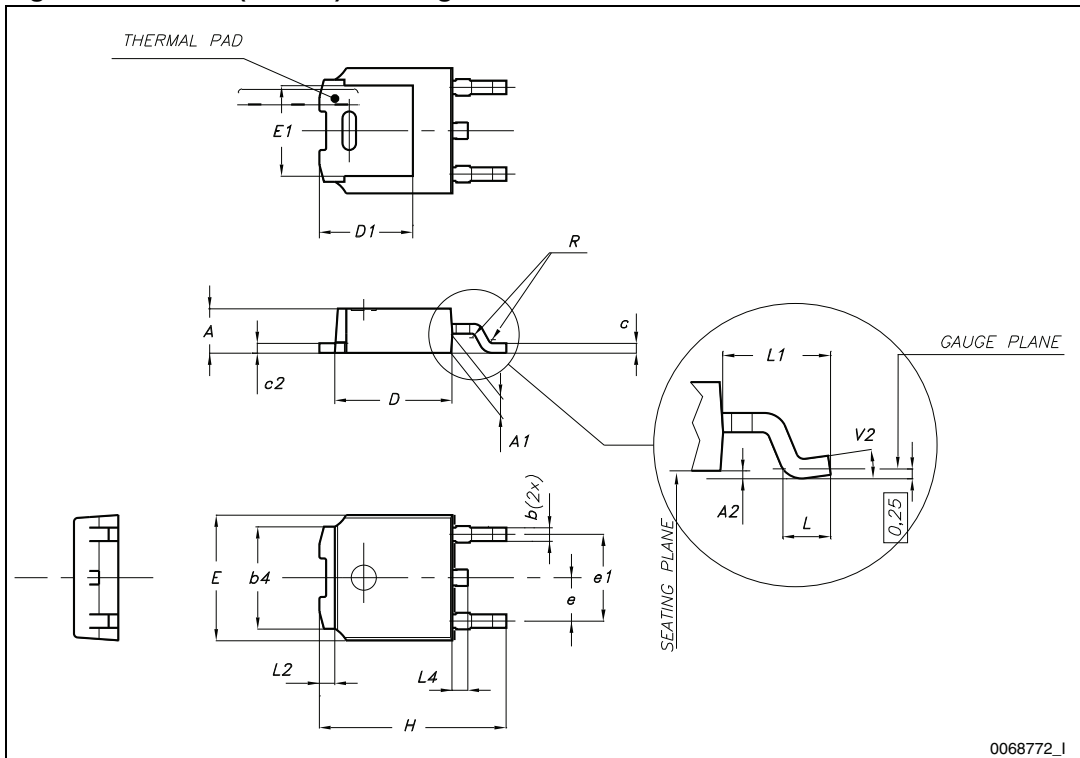
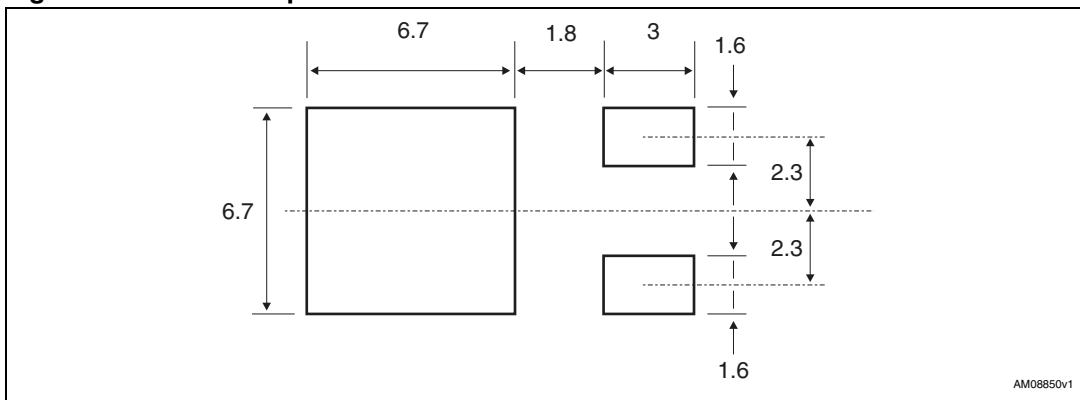


Figure 25. DPAK footprint^(b)

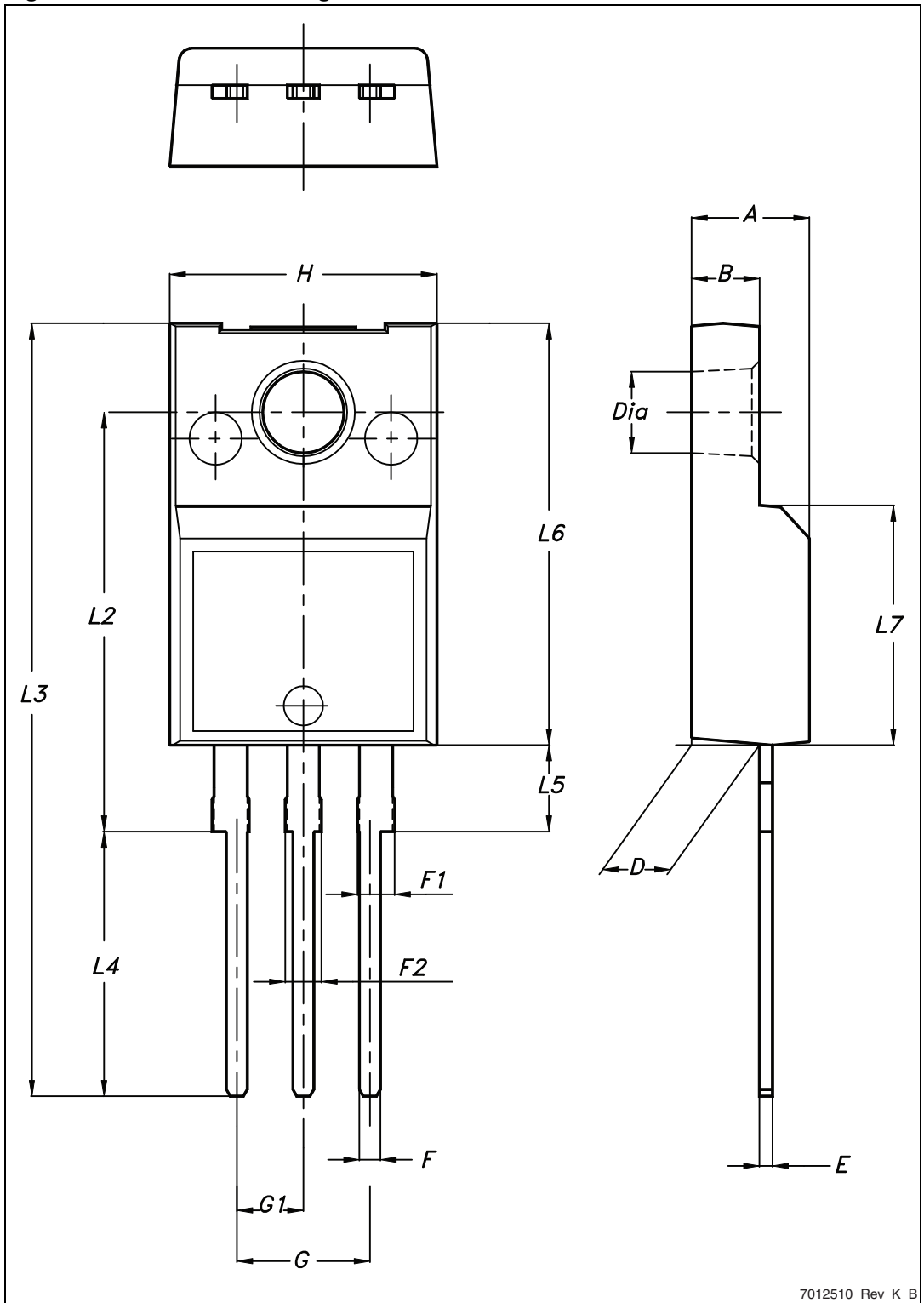


b. All dimensions are in millimeters

Table 11. 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 26. TO-220FP drawing



7012510_Rev_K_B

Table 12. 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 27. I²PAK (TO-262) drawing

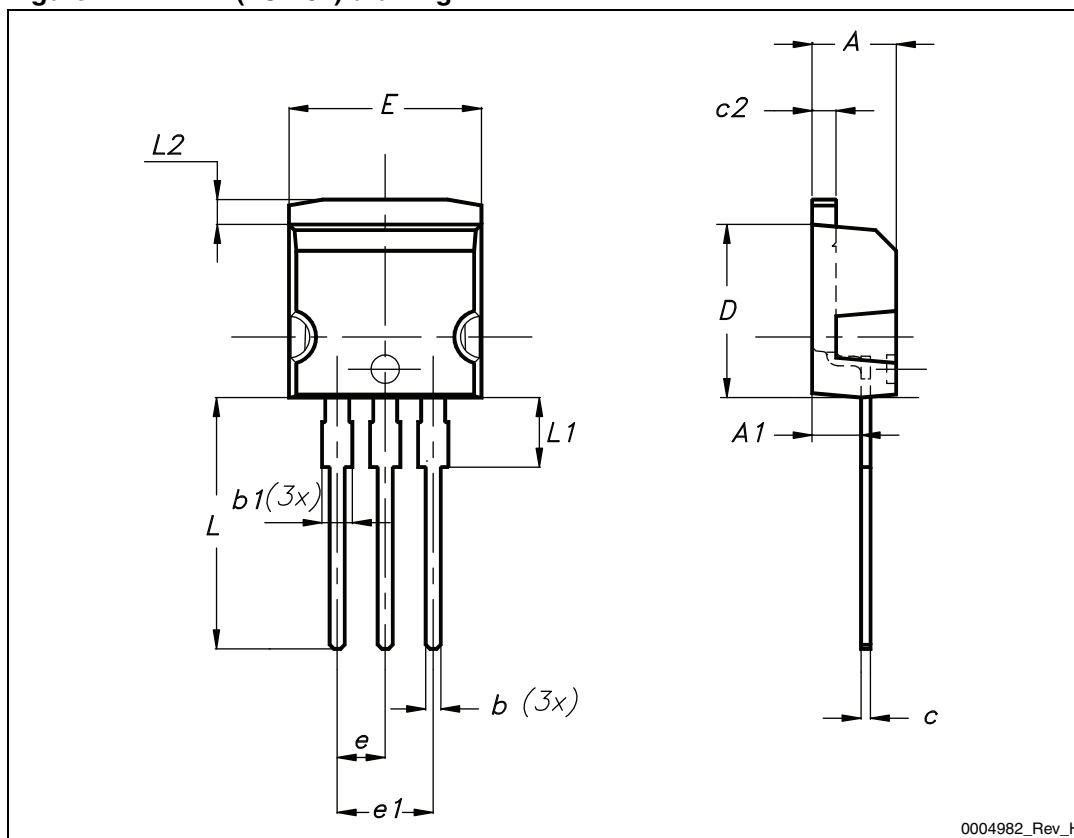
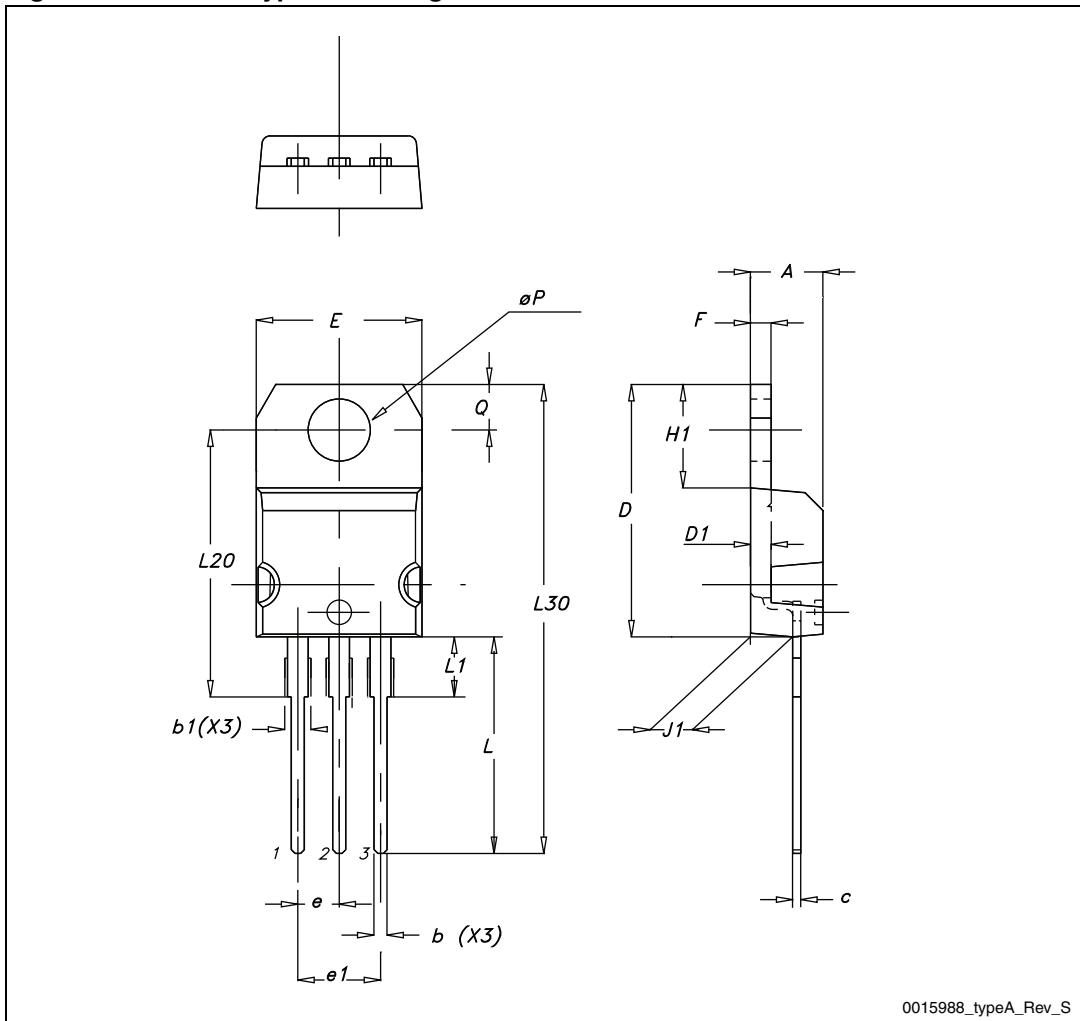


Table 13. TO-220 type A mechanical data

| 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



5 Packaging mechanical data

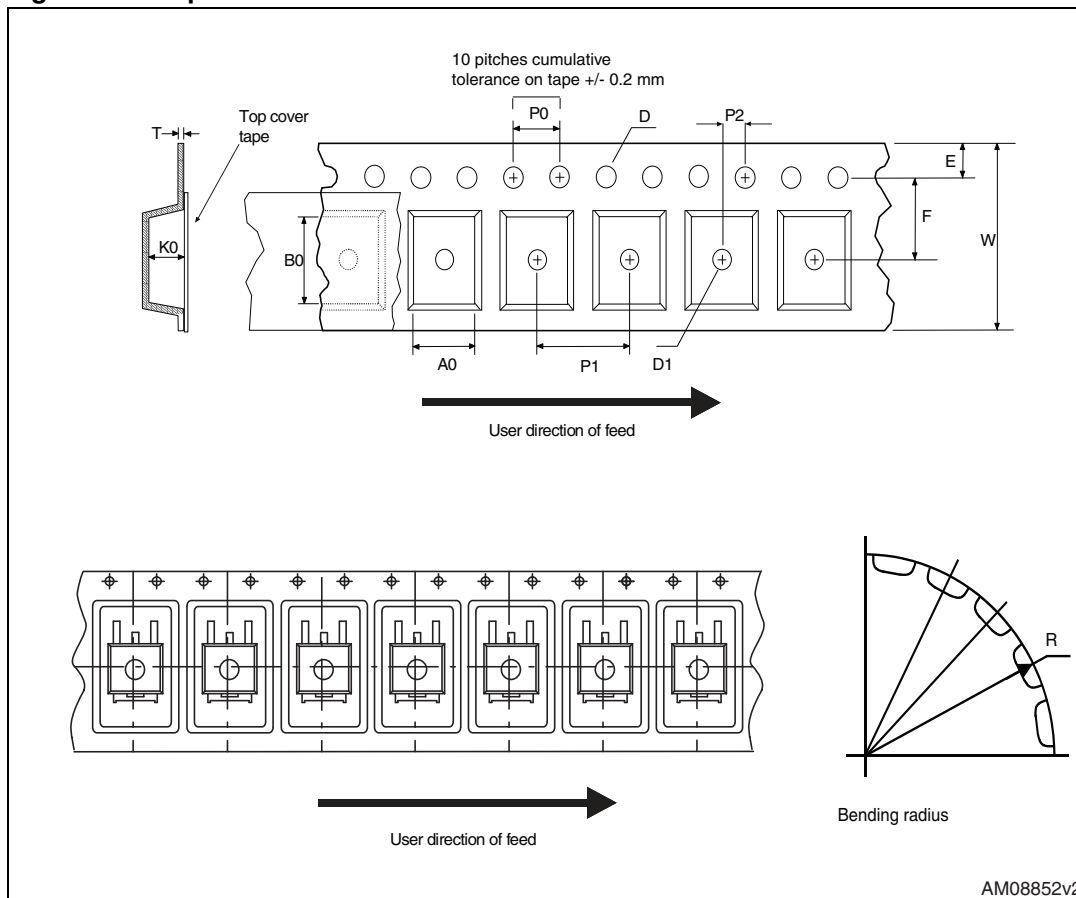
Table 14. D²PAK (TO-263) tape and reel mechanical data

| 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 | | | |

Table 15. DPAK (TO-252) tape and reel mechanical data

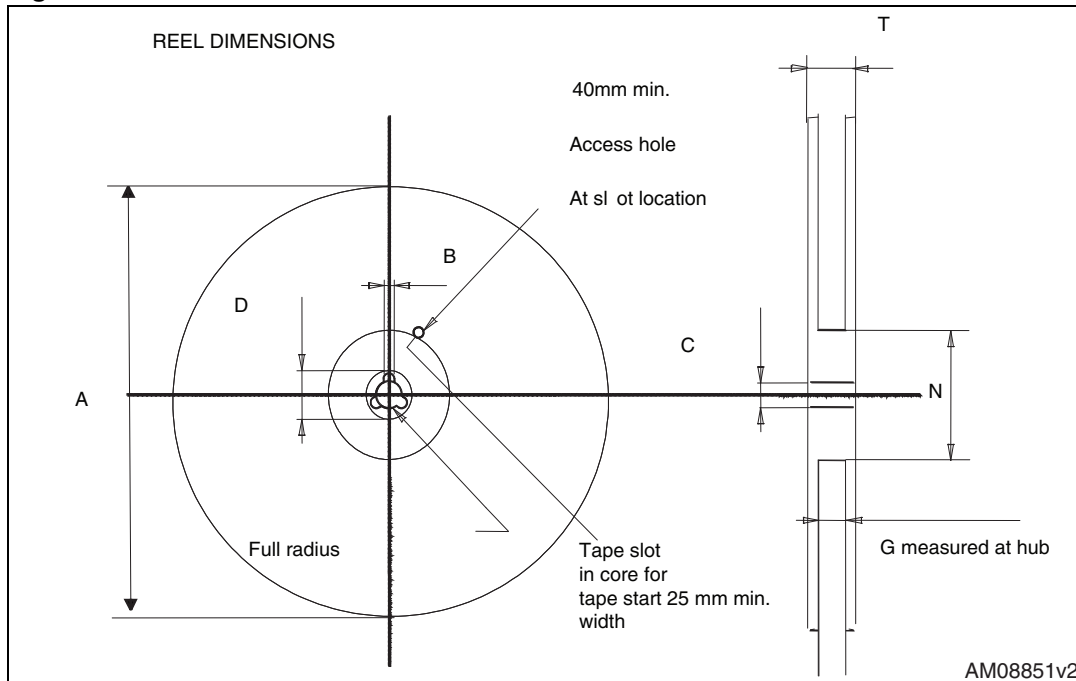
| Tape | | | Reel | | |
|------|------|------|-----------|------|------|
| Dim. | mm | | Dim. | mm | |
| | Min. | Max. | | Min. | Max. |
| A0 | 6.8 | 7 | A | | 330 |
| B0 | 10.4 | 10.6 | B | 1.5 | |
| B1 | | 12.1 | C | 12.8 | 13.2 |
| D | 1.5 | 1.6 | D | 20.2 | |
| D1 | 1.5 | | G | 16.4 | 18.4 |
| E | 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 29. Tape for DPAK and D²PAK



AM08852v2

Figure 30. Reel for DPAK and D²PAK



AM08851v2

6 Revision history

Table 16. Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 26-Nov-2009 | 1 | First release. |
| 02-Dec-2009 | 2 | Inserted table footnote Table 3: Thermal data . |
| 22-Jul-2010 | 3 | Document status promoted from preliminary data to datasheet. |
| 06-Apr-2011 | 4 | Updated E _{AS} in Table 2 . |
| 30-Oct-2012 | 5 | Updated Figure 1: Internal schematic diagram , Table 1: Device summary , Table 2: Absolute maximum ratings , Table 3: Thermal data , Table 5: On /off states . Updated Section 4: Package mechanical data . Minor text changes. |

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