

N-channel 600 V, 0.86 Ω typ., 5 A MDmesh II Plus™ low Q_g
Power MOSFET in DPAK, TO-220 and IPAK packages

Datasheet - production data

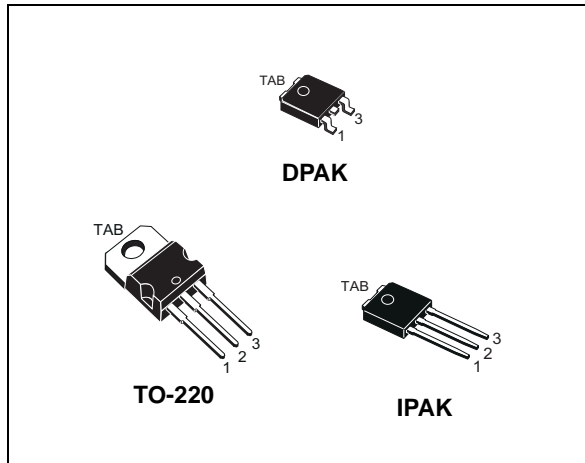
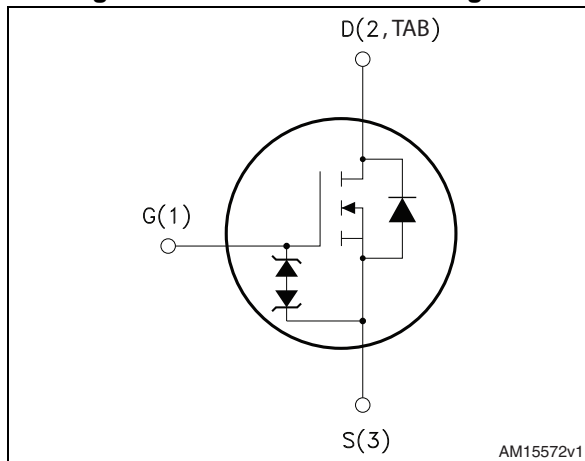


Figure 1. Internal schematic diagram



Features

| Order codes | $V_{DS} @ T_{Jmax}$ | $R_{DS(on) max}$ | I_D |
|-------------|---------------------|------------------|-------|
| STD7N60M2 | 650 V | 0.95 Ω | 5 A |
| STP7N60M2 | | | |
| STU7N60M2 | | | |

- Extremely low gate charge
- Lower $R_{DS(on)}$ x area vs previous generation
- Low gate input resistance
- 100% avalanche tested
- Zener-protected

Applications

- Switching applications

Description

These devices are N-channel Power MOSFETs developed using a new generation of MDmesh™ technology: MDmesh II Plus™ low Q_g . These revolutionary Power MOSFETs associate a vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. They are therefore suitable for the most demanding high efficiency converters.

Table 1. Device summary

| Order codes | Marking | Package | Packaging |
|-------------|---------|---------|---------------|
| STD7N60M2 | 7N60M2 | DPAK | Tape and reel |
| STP7N60M2 | | TO-220 | Tube |
| STU7N60M2 | | IPAK | |

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1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|----------------|---|-------------|------------------|
| V_{GS} | Gate-source voltage | ± 25 | V |
| I_D | Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$ | 5 | A |
| I_D | Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$ | 3.5 | A |
| $I_{DM}^{(1)}$ | Drain current (pulsed) | 20 | A |
| P_{TOT} | Total dissipation at $T_C = 25\text{ }^\circ\text{C}$ | 60 | W |
| $dv/dt^{(1)}$ | Peak diode recovery voltage slope | 15 | V/ns |
| $dv/dt^{(2)}$ | MOSFET dv/dt ruggedness | 50 | |
| T_{stg} | Storage temperature | - 55 to 150 | $^\circ\text{C}$ |
| T_j | Max. operating junction temperature | | |

- $I_{SD} \leq 5\text{ A}$, $di/dt \leq 400\text{ A}/\mu\text{s}$; $V_{DS\text{ peak}} < V_{(BR)DSS}$, $V_{DD}=400\text{ V}$
- $V_{DS} \leq 480\text{ V}$

Table 3. Thermal data

| Symbol | Parameter | Value | | | Unit |
|----------------|--|-------|--------|------|---------------------------|
| | | DPAK | TO-220 | IPAK | |
| $R_{thj-case}$ | Thermal resistance junction-case max | 2.08 | 2.08 | | $^\circ\text{C}/\text{W}$ |
| $R_{thj-pcb}$ | Thermal resistance junction-pcb max ⁽¹⁾ | 50 | | | $^\circ\text{C}/\text{W}$ |
| $R_{thj-amb}$ | Thermal resistance junction-ambient max | | 62.5 | 100 | $^\circ\text{C}/\text{W}$ |

- 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}) | 1.5 | A |
| E_{AS} | Single pulse avalanche energy (starting $T_j=25\text{ }^\circ\text{C}$, $I_D=I_{AR}$; $V_{DD}=50$) | 99 | 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 | $I_D = 1\text{ mA}$, $V_{GS} = 0$ | 600 | | | V |
| I_{DSS} | Zero gate voltage drain current ($V_{GS} = 0$) | $V_{DS} = 600\text{ V}$ | | | 1 | μA |
| | | $V_{DS} = 600\text{ V}$, $T_C = 125\text{ °C}$ | | | 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 | $V_{GS} = 10\text{ V}$, $I_D = 2.5\text{ A}$ | | 0.86 | 0.95 | Ω |

Table 6. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------------------|-------------------------------|--|------|------|------|----------|
| C_{iss} | Input capacitance | $V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0$ | - | 271 | - | pF |
| C_{oss} | Output capacitance | | - | 15.7 | - | pF |
| C_{rss} | Reverse transfer capacitance | | - | 0.68 | - | pF |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{DS} = 0\text{ to }480\text{ V}$, $V_{GS} = 0$ | - | 75.5 | - | pF |
| R_G | Intrinsic gate resistance | $f = 1\text{ MHz}$ open drain | - | 7.2 | - | Ω |
| Q_g | Total gate charge | $V_{DD} = 480\text{ V}$, $I_D = 5\text{ A}$, $V_{GS} = 10\text{ V}$ (see Figure 17) | - | 8.8 | - | nC |
| Q_{gs} | Gate-source charge | | - | 1.8 | - | nC |
| Q_{gd} | Gate-drain charge | | - | 4.3 | - | 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 | $V_{DD} = 300\text{ V}$, $I_D = 2.5\text{ A}$, $R_G = 4.7\text{ }\Omega$, $V_{GS} = 10\text{ V}$ (see Figure 16 and 21) | - | 7.6 | - | ns |
| t_r | Rise time | | - | 7.2 | - | ns |
| $t_{d(off)}$ | Turn-off delay time | | - | 19.3 | - | ns |
| t_f | Fall time | | - | 15.9 | - | 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 | $I_{SD} = 5 \text{ A}, V_{GS} = 0$ | - | | 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 18) | - | 275 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 1.55 | | nC |
| I_{RRM} | Reverse recovery current | | - | 11 | | 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 18) | - | 376 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 2.1 | | nC |
| I_{RRM} | Reverse recovery current | | - | 11 | | 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

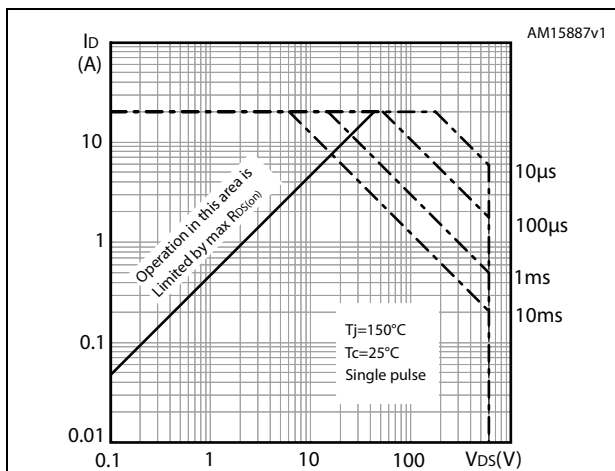


Figure 3. Thermal impedance for DPAK and IPAK

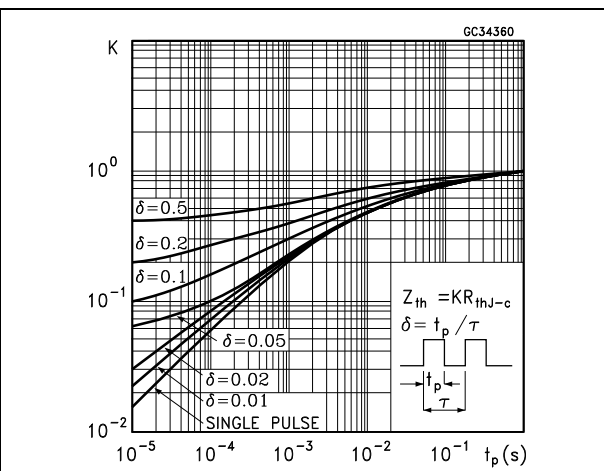


Figure 4. Safe operating area for TO-220

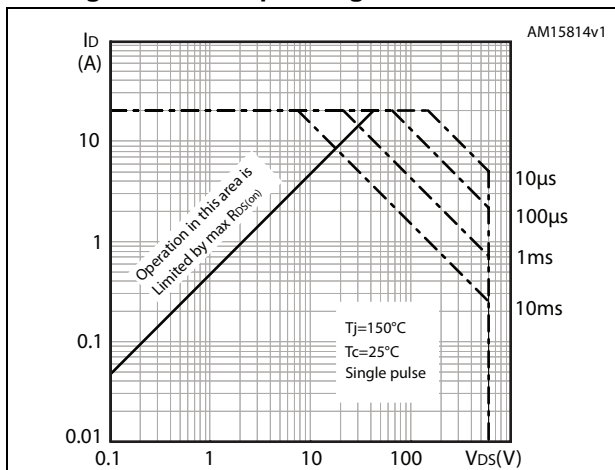


Figure 5. Thermal impedance for TO-220

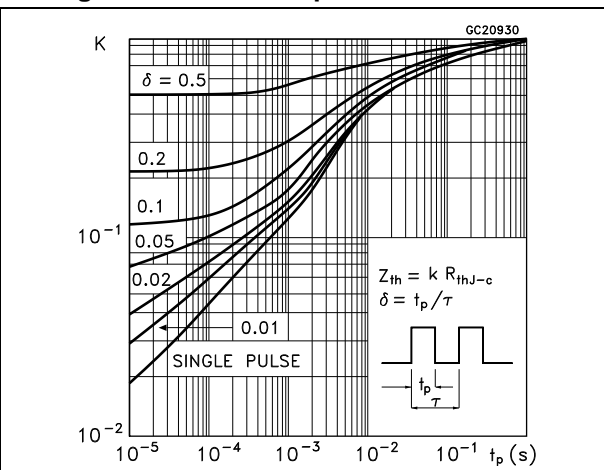


Figure 6. Output characteristics

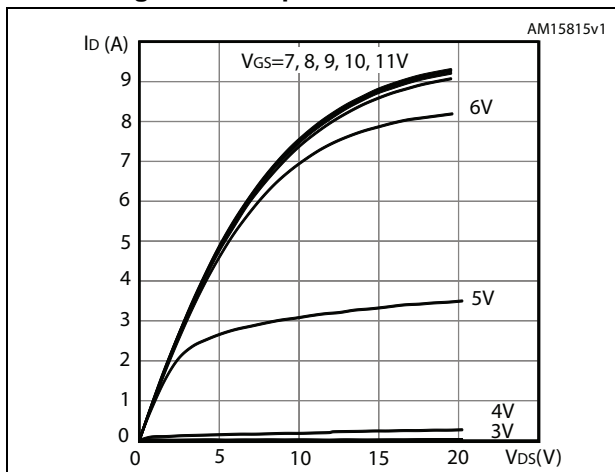


Figure 7. Transfer characteristics

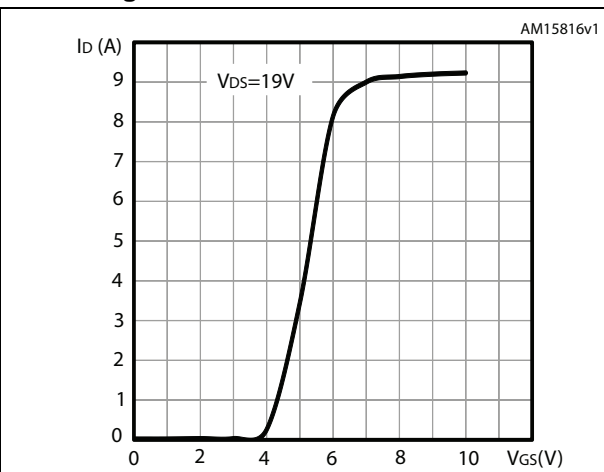


Figure 8. Gate charge vs gate-source voltage

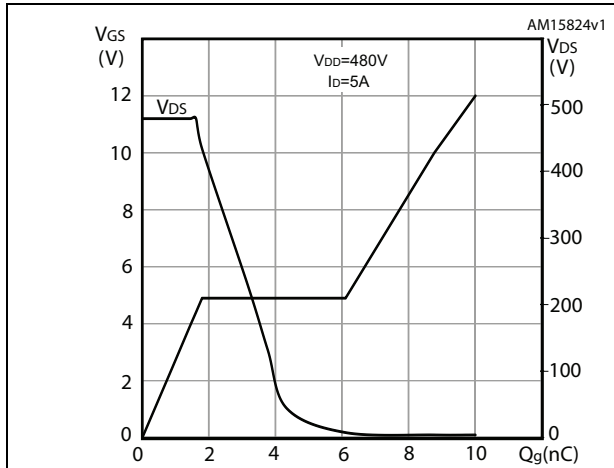


Figure 9. Static drain-source on-resistance

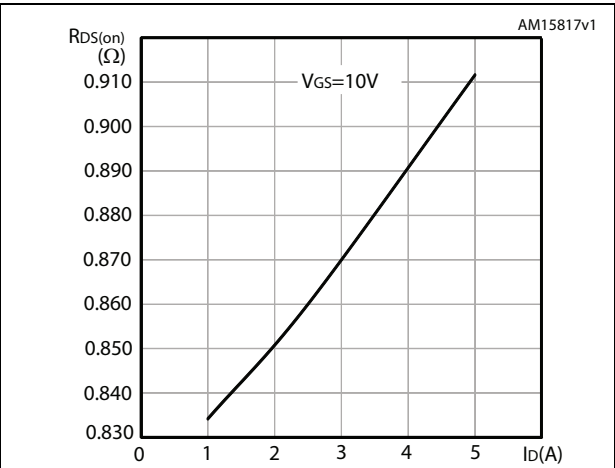


Figure 10. Capacitance variations

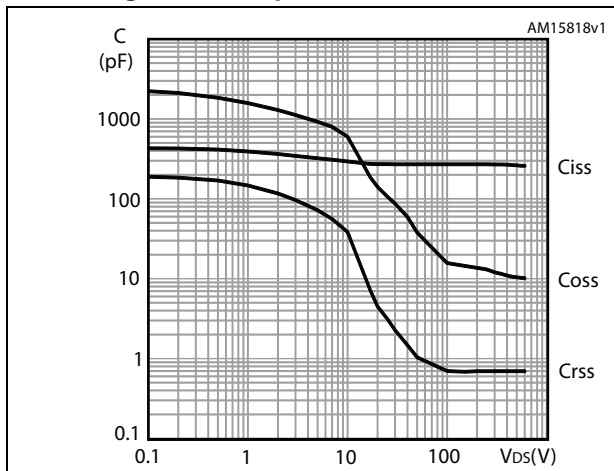


Figure 11. Output capacitance stored energy

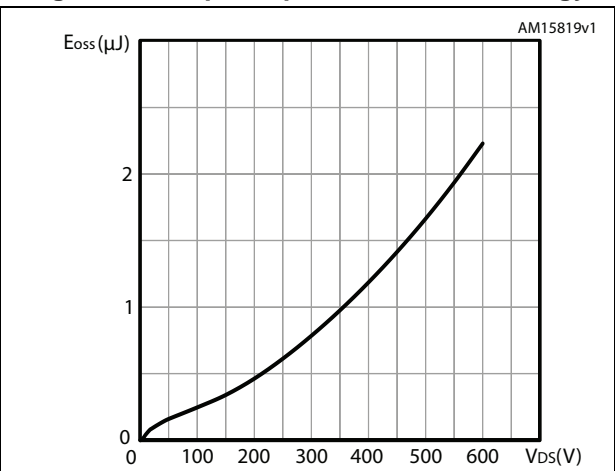


Figure 12. Normalized gate threshold voltage vs. temperature

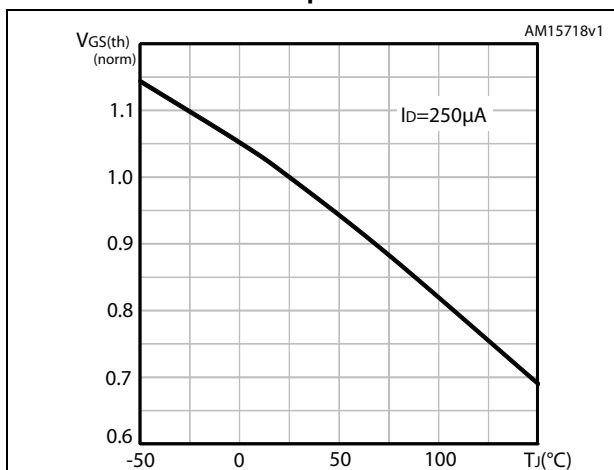


Figure 13. Normalized on-resistance vs. temperature

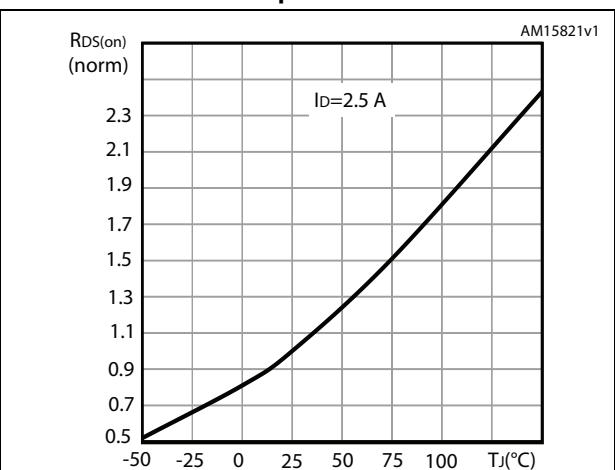


Figure 14. Drain-source diode forward characteristics

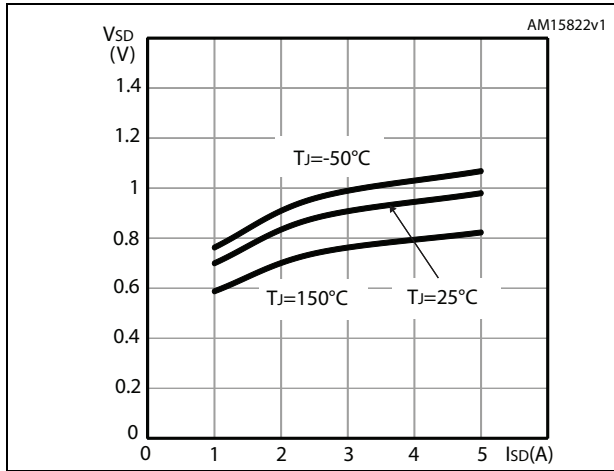
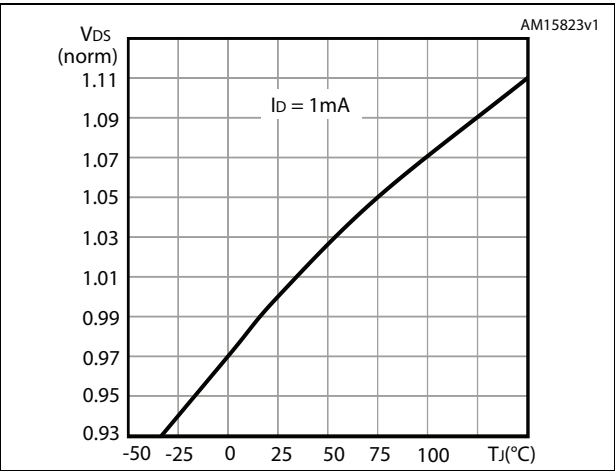
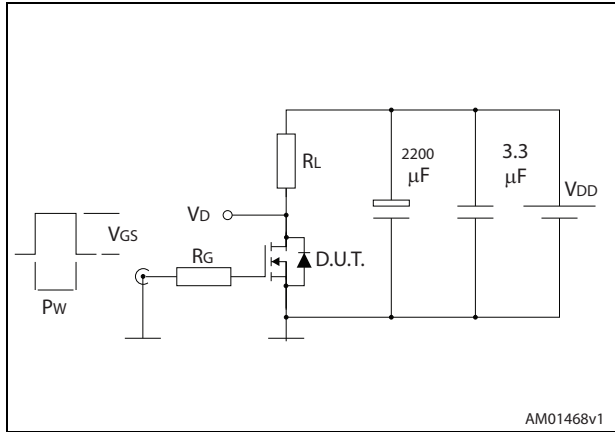


Figure 15. Normalized V_{DS} vs. temperature



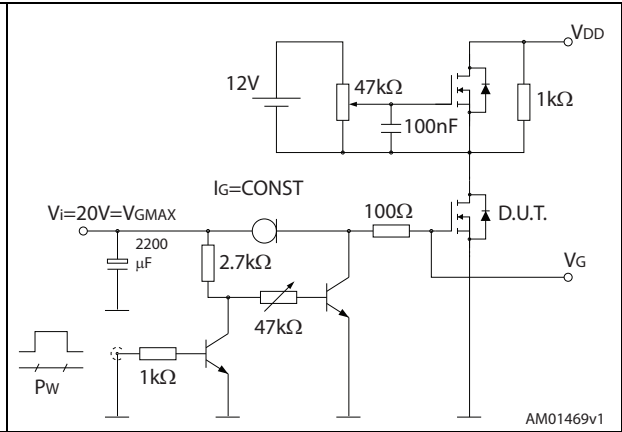
3 Test circuits

Figure 16. Switching times test circuit for resistive load



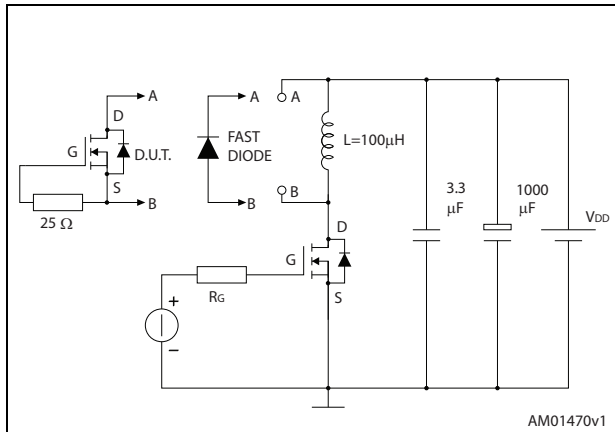
AM01468v1

Figure 17. Gate charge test circuit



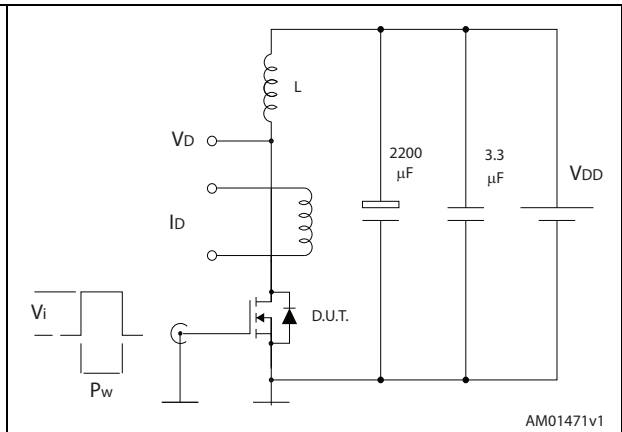
AM01469v1

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



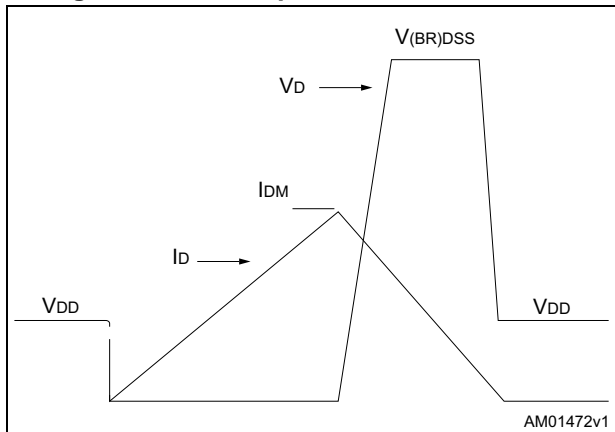
AM01470v1

Figure 19. Unclamped inductive load test circuit



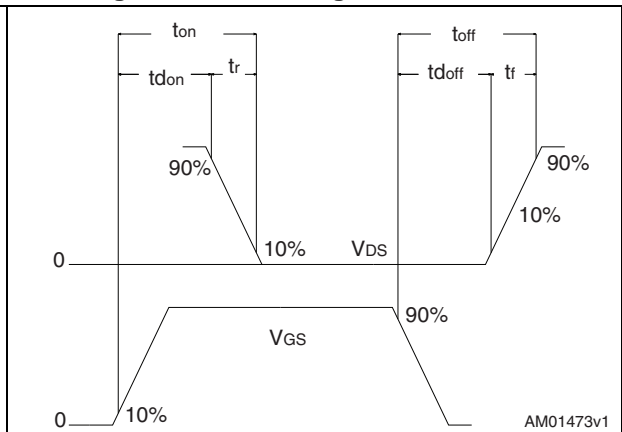
AM01471v1

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. 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 | 1.00 | | 1.50 |
| (L1) | | 2.80 | |
| L2 | | 0.80 | |
| L4 | 0.60 | | 1.00 |
| R | | 0.20 | |
| V2 | 0° | | 8° |

Figure 22. DPAK (TO-252) drawing

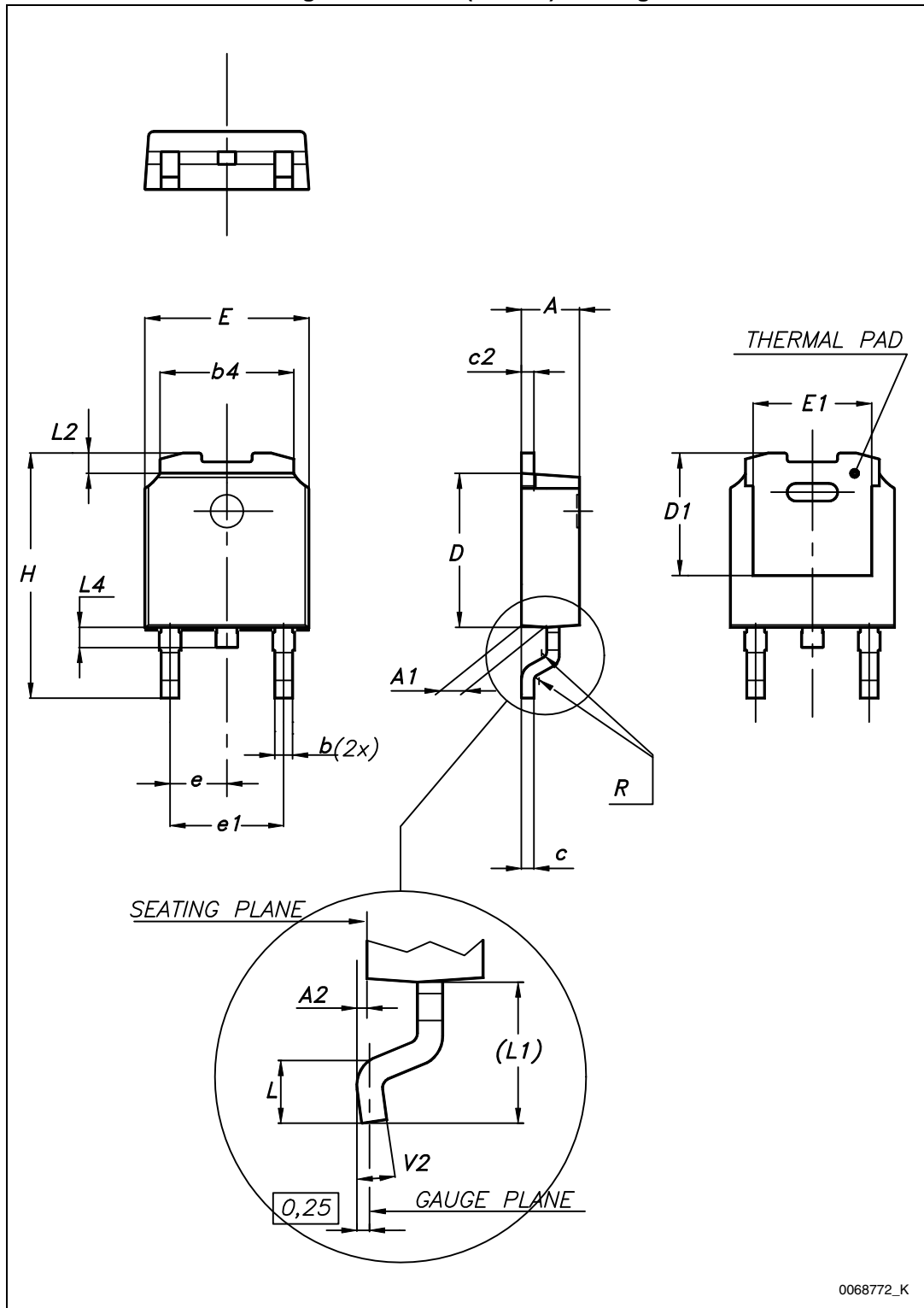
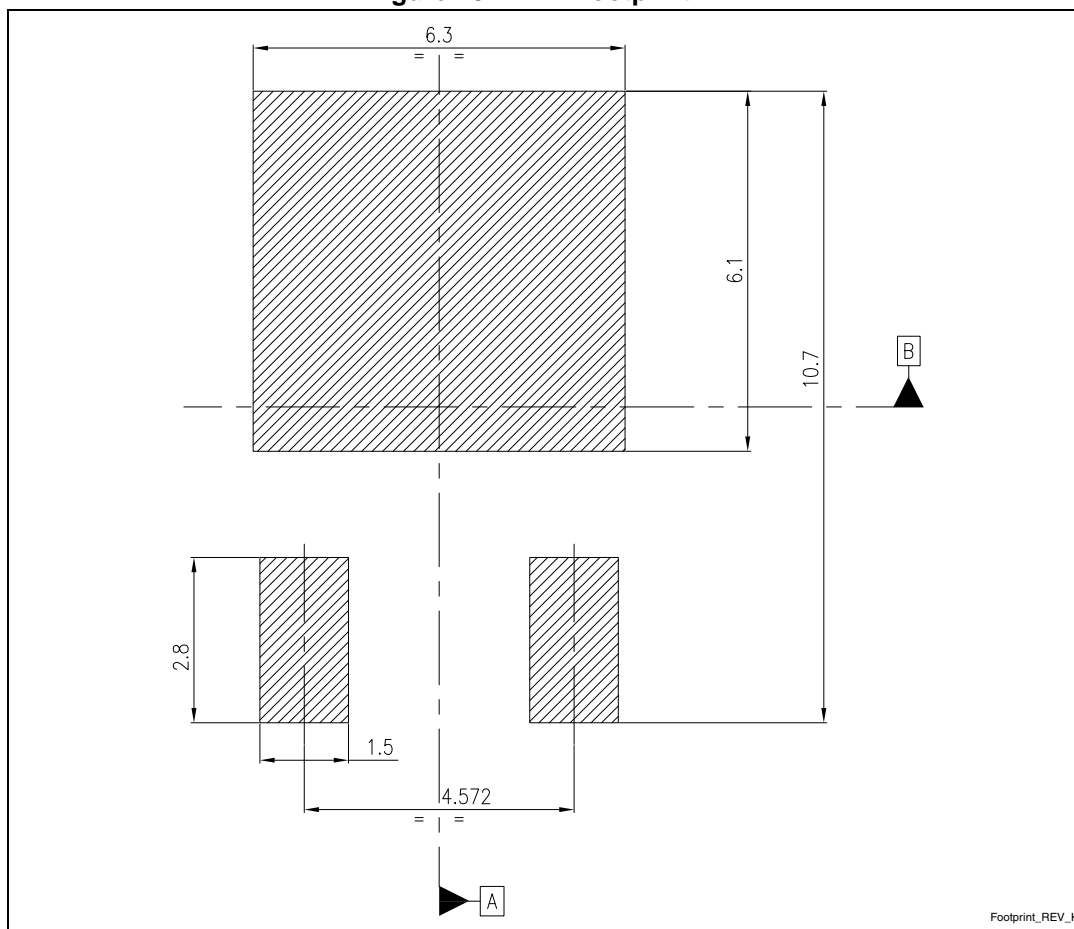


Figure 23. DPAK footprint (a)



a. All dimensions are in millimeters

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 24. TO-220 type A drawing

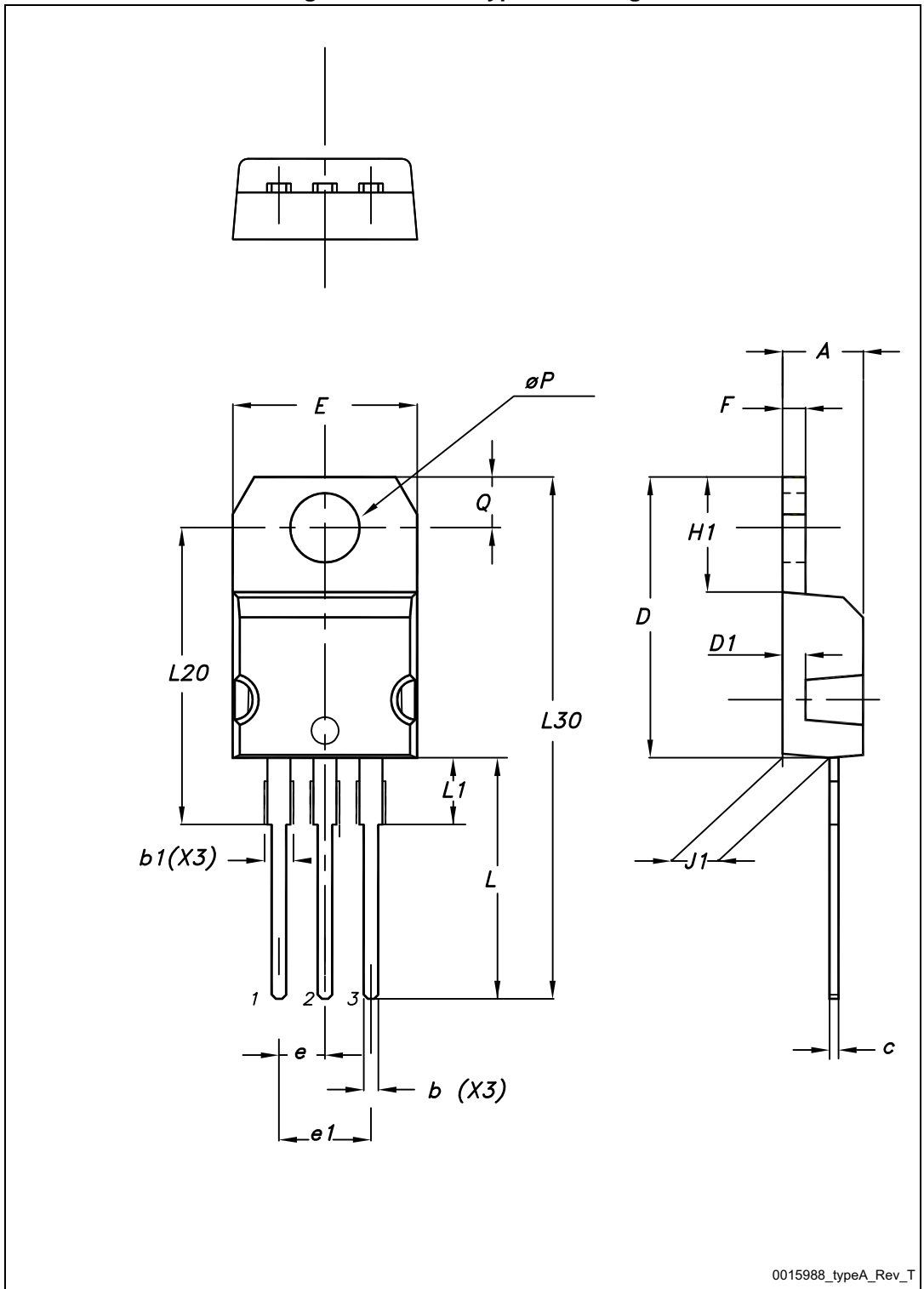
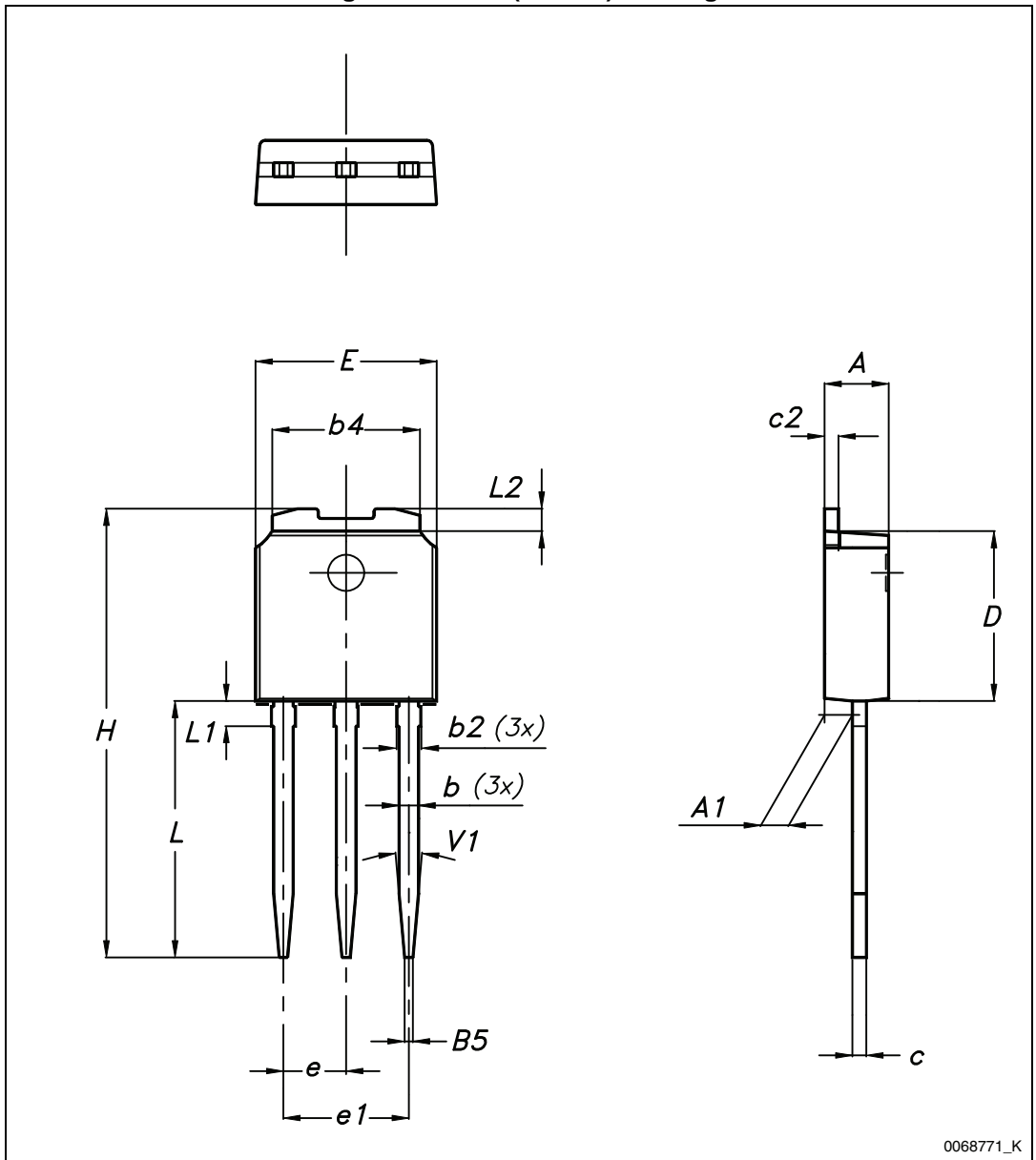


Table 11. IPAK (TO-251) mechanical data

| 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° | |

Figure 25. IPAK (TO-251) drawing



0068771_K

5 Packaging mechanical data

Table 12. 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 26. Tape

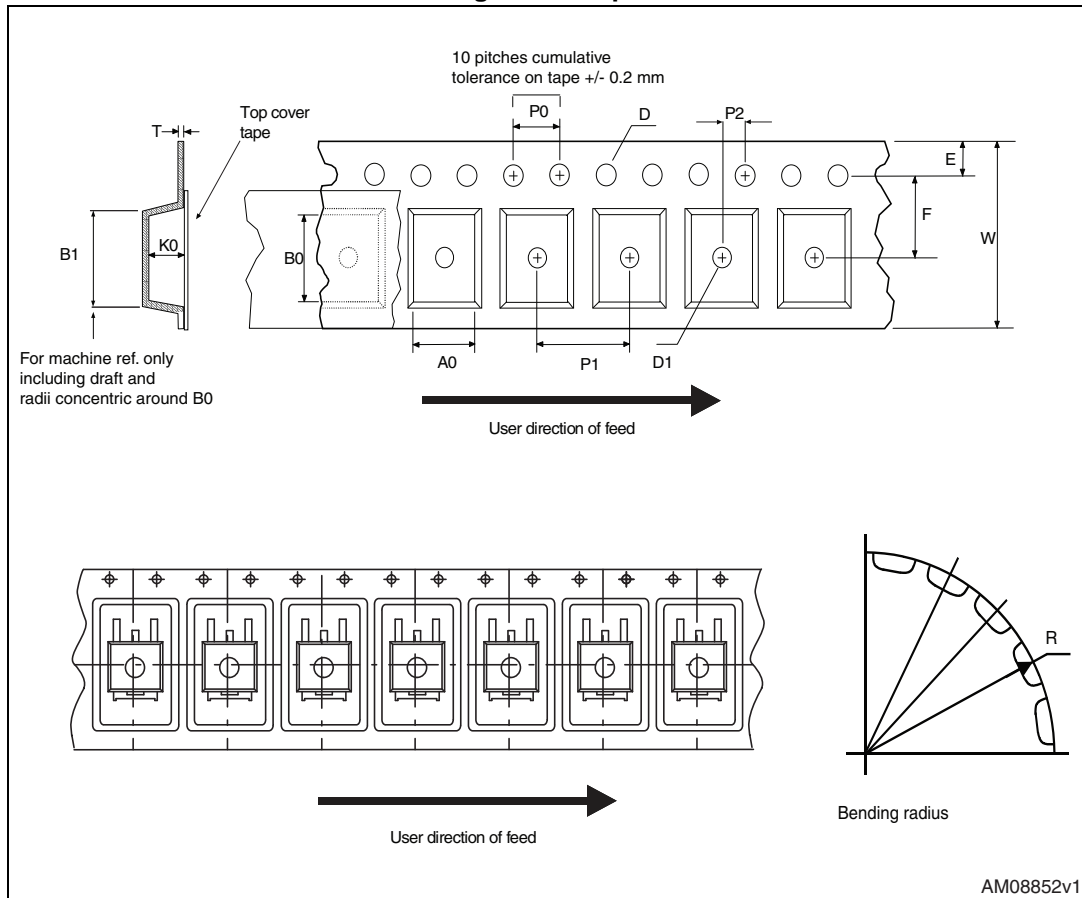
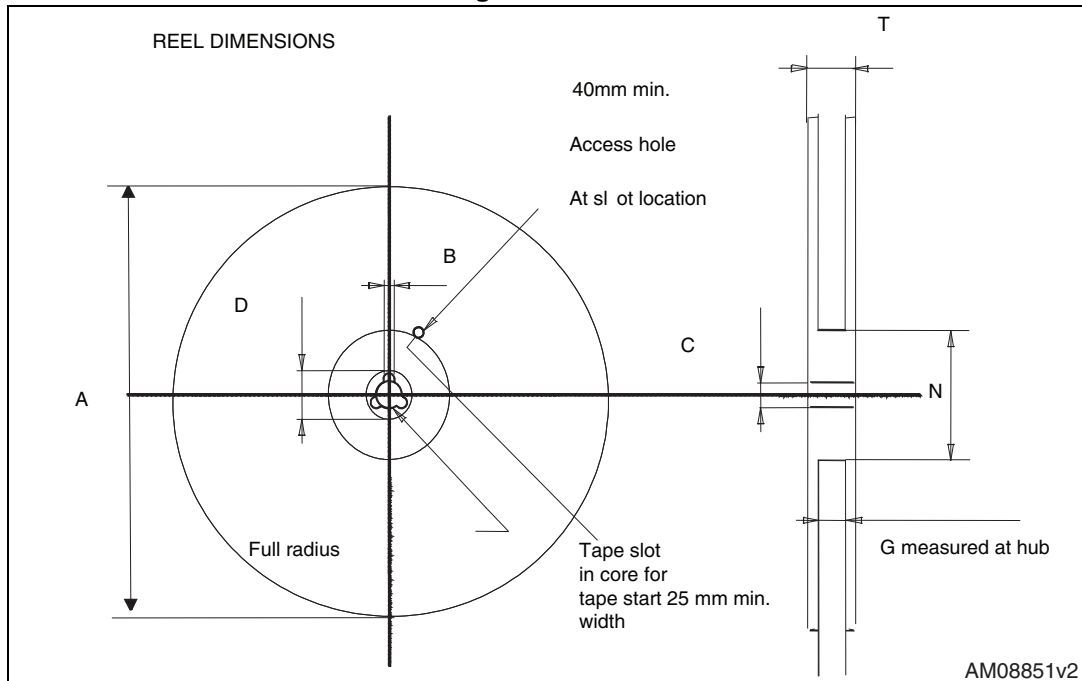


Figure 27. Reel



6 Revision history

Table 13. Document revision history

| Date | Revision | Changes |
|-------------|----------|----------------|
| 06-Jun-2013 | 1 | First release. |

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