

N-channel 800 V, 2.1 Ω typ., 3 A MDmesh™ K5 Power MOSFETs
in DPAK, TO-220FP, TO-220 and IPAK packages

Datasheet - production data

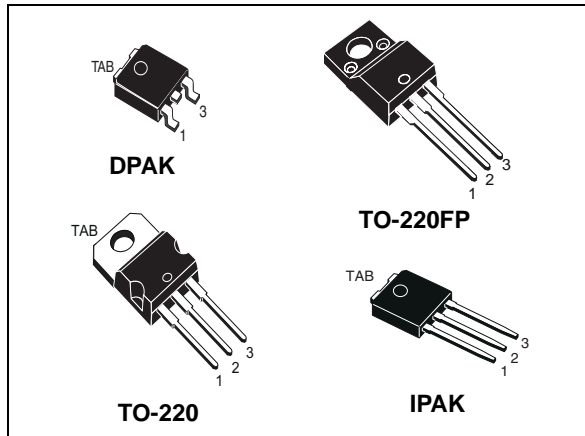
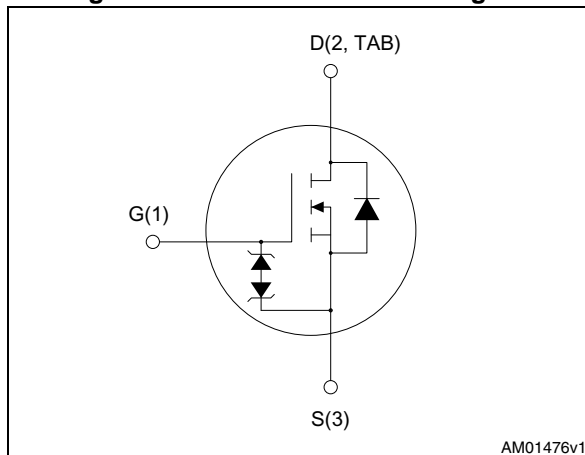


Figure 1. Internal schematic diagram



Features

| Order code | V_{DS} | $R_{DS(on)}$ max. | I_D | P_{TOT} |
|------------|----------|-------------------|-------|-----------|
| STD4N80K5 | 800 V | 2.5 Ω | 3 A | 60 W |
| STF4N80K5 | | | | 20 W |
| STP4N80K5 | | | | 60 W |
| STU4N80K5 | | | | |

- Industry's lowest $R_{DS(on)}$ x area
- Industry's best figure of merit (FoM)
- Ultra low gate charge
- 100% avalanche tested
- Zener-protected

Applications

- Switching applications

Description

These very high voltage N-channel Power MOSFETs are designed using MDmesh™ K5 technology based on an innovative proprietary vertical structure. The result is a dramatic reduction in on-resistance and ultra-low gate charge for applications requiring superior power density and high efficiency.

Table 1. Device summary

| Order code | Marking | Packages | Packaging |
|------------|---------|----------|---------------|
| STD4N80K5 | 4N80K5 | DPAK | Tape and reel |
| STF4N80K5 | | TO-220FP | Tube |
| STP4N80K5 | | TO-220 | |
| STU4N80K5 | | IPAK | |

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1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | | | Unit |
|-------------------------|---|------------|--------------------|--------|------|
| | | DPAK, IPAK | TO-220FP | TO-220 | |
| V_{DS} | Drain-source voltage | 800 | | | V |
| V_{GS} | Gate- source voltage | ±30 | | | V |
| I_D | Drain current (continuous) at $T_C = 25\text{ °C}$ | 3 | 3 ⁽¹⁾ | 3 | A |
| I_D | Drain current (continuous) at $T_C = 100\text{ °C}$ | 1.7 | 1.7 ⁽¹⁾ | 1.7 | A |
| I_{DM} ⁽²⁾ | Drain current (pulsed) | 12 | 12 ⁽¹⁾ | 12 | A |
| P_{TOT} | Total dissipation at $T_C = 25\text{ °C}$ | 60 | 20 | 60 | W |
| I_{AR} | Avalanche current, repetitive or not-repetitive (pulse width limited by T_J max) | 1 | | | A |
| E_{AS} | Single pulse avalanche energy (starting $T_J = 25\text{ °C}$, $I_D = I_{AR}$, $V_{DD} = 50\text{ V}$) | 74.5 | | | mJ |
| dv/dt ⁽³⁾ | Peak diode recovery voltage slope | 4.5 | | | V/ns |
| dv/dt ⁽⁴⁾ | MOSFET dv/dt ruggedness | 50 | | | V/ns |
| V_{ISO} | Insulation withstand voltage (RMS) from all three leads to external heat sink ($t = 1\text{ s}$, $T_C = 25\text{ °C}$) | | 2500 | | V |
| T_J | Operating junction temperature | -55 to 150 | | | °C |
| T_{stg} | Storage temperature | | | | °C |

1. Limited by maximum junction temperature
2. Pulse width limited by safe operating area
3. $I_{SD} < 3\text{ A}$, $di/dt < 100\text{ A}/\mu\text{s}$, $V_{DS(peak)} \leq V_{(BR)DSS}$
4. $V_{DS} \leq 640\text{ V}$

Table 3. Thermal data

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

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

2 Electrical characteristics

(T_{case} =25 °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 mA, V _{GS} = 0 | 800 | | | V |
| I _{DSS} | Zero gate voltage drain current (V _{GS} = 0) | V _{DS} = 800 V | | | 1 | μA |
| | | V _{DS} = 800 V, T _C =125 °C | | | 50 | μA |
| I _{GSS} | Gate-body leakage current (V _{DS} = 0) | V _{GS} = ± 20 V | | | ±10 | μA |
| V _{GS(th)} | Gate threshold voltage | V _{DS} = V _{GS} , I _D = 100 μA | 3 | 4 | 5 | V |
| R _{DS(on)} | Static drain-source on-resistance | V _{GS} = 10 V, I _D = 1.5 A | | 2.1 | 2.5 | Ω |

Table 5. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------------------------|---------------------------------------|---|------|------|------|------|
| C _{iss} | Input capacitance | V _{DS} = 100 V, f = 1 MHz, V _{GS} = 0 | - | 175 | - | pF |
| C _{oss} | Output capacitance | | - | 18 | - | pF |
| C _{riss} | Reverse transfer capacitance | | - | 0.5 | - | pF |
| C _{o(tr)} ⁽¹⁾ | Equivalent capacitance time related | V _{DS} = 0 to 640 V, V _{GS} = 0 | - | 26 | - | pF |
| C _{o(er)} ⁽²⁾ | Equivalent capacitance energy related | V _{DS} = 0 to 640 V, V _{GS} = 0 | - | 11 | - | pF |
| R _g | Gate input resistance | f=1 MHz, I _D = 0 | - | 15 | - | Ω |
| Q _g | Total gate charge | V _{DD} = 640 V, I _D = 3 A, V _{GS} = 10 V (see Figure 19) | - | 10.5 | - | nC |
| Q _{gs} | Gate-source charge | | - | 2 | - | nC |
| Q _{gd} | Gate-drain charge | | - | 7.5 | - | nC |

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 |
|--------------|---------------------|---|------|------|------|------|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD} = 400\text{ V}$, $I_D = 1.5\text{ A}$, $R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$ (see Figure 18) | - | 16.5 | - | ns |
| t_r | Rise time | | - | 15 | - | ns |
| $t_{d(off)}$ | Turn-off-delay time | | - | 36 | - | ns |
| t_f | Fall time | | - | 21 | - | ns |

Table 7. Source drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|---|------|------|------|---------------|
| I_{SD} | Source-drain current | | - | | 3 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | | | 12 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD} = 3\text{ A}$, $V_{GS} = 0$ | - | | 1.5 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 3\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$ (see Figure 20) | - | 242 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 1.42 | | μC |
| I_{RRM} | Reverse recovery current | | - | 12 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 3\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$, $T_J = 150\text{ }^\circ\text{C}$ (see Figure 20) | - | 373 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 1.98 | | μC |
| I_{RRM} | Reverse recovery current | | - | 10.5 | | A |

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

Table 8. Gate-source Zener diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------|-------------------------------|--|------|------|------|------|
| $V_{(BR)GSO}$ | Gate-source breakdown voltage | $I_{GS} = \pm 1\text{ mA}$, $I_D = 0$ | 30 | - | - | V |

The built-in back-to-back Zener diodes have been specifically designed to enhance the ESD capability of the device. The Zener voltage is appropriate for efficient and cost-effective intervention to protect the device integrity. These integrated Zener diodes thus eliminate the need for external components.

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for DPAK and IPAK

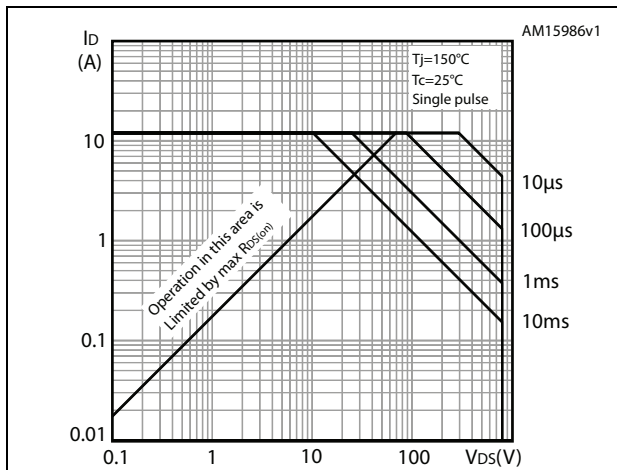


Figure 3. Thermal impedance for DPAK and IPAK

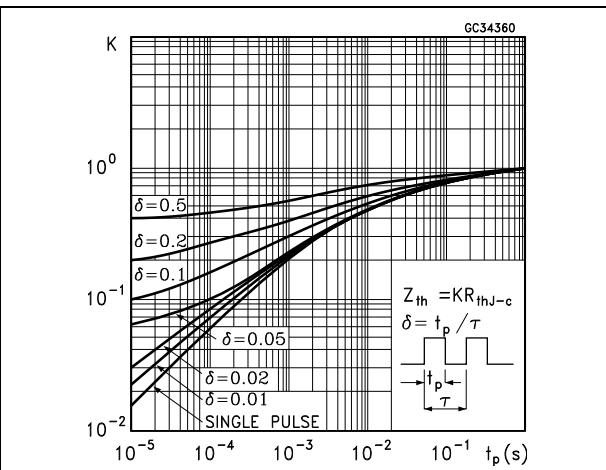


Figure 4. Safe operating area for TO-220FP

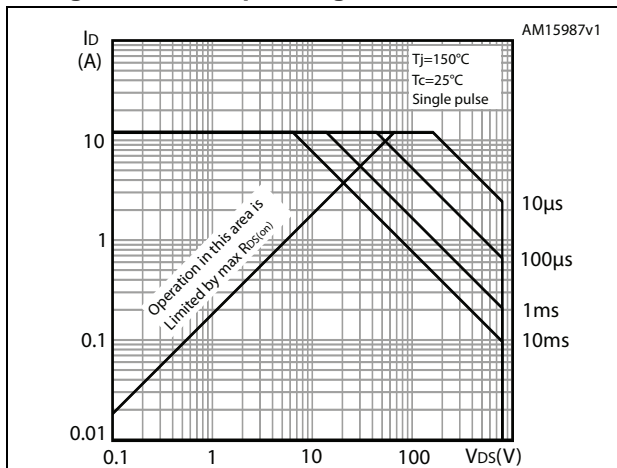


Figure 5. Thermal impedance for TO-220FP

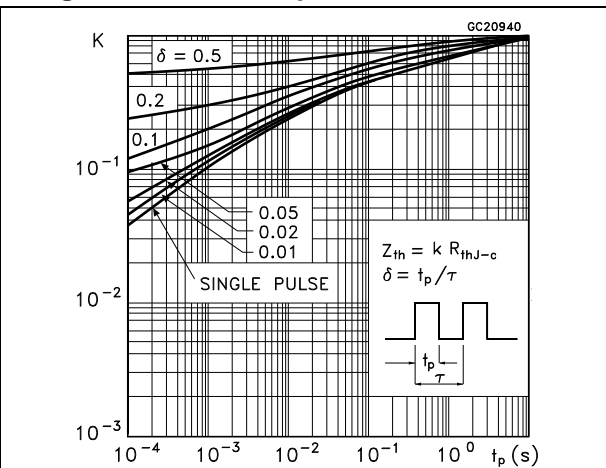


Figure 6. Safe operating area for TO-220

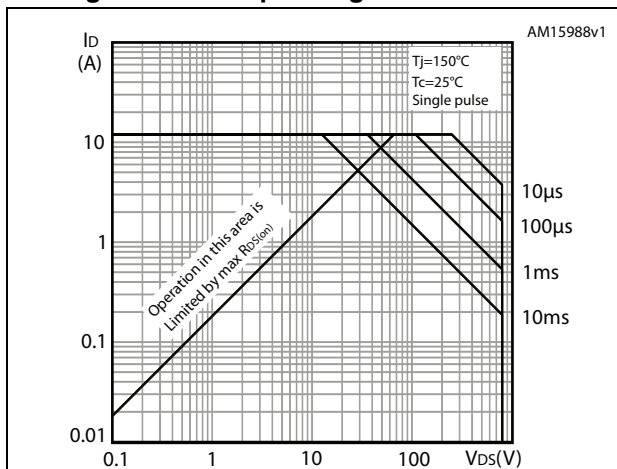


Figure 7. Thermal impedance for TO-220

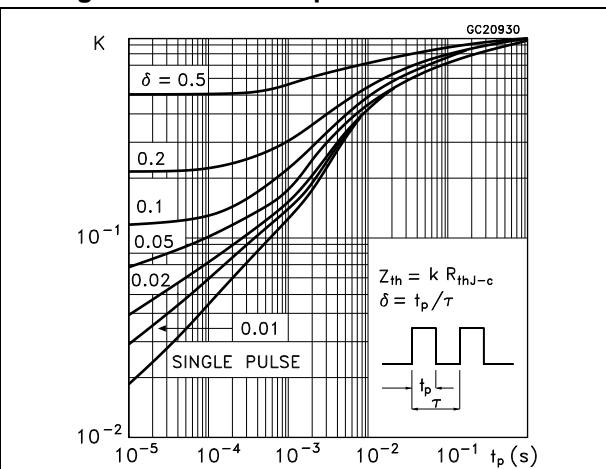


Figure 8. Output characteristics

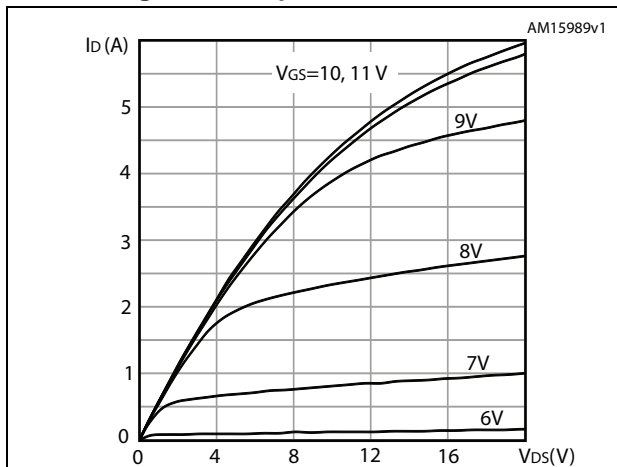


Figure 9. Transfer characteristics

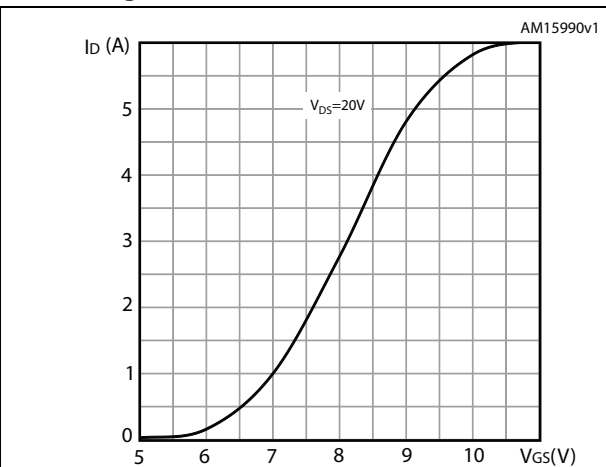


Figure 10. Gate charge vs gate-source voltage

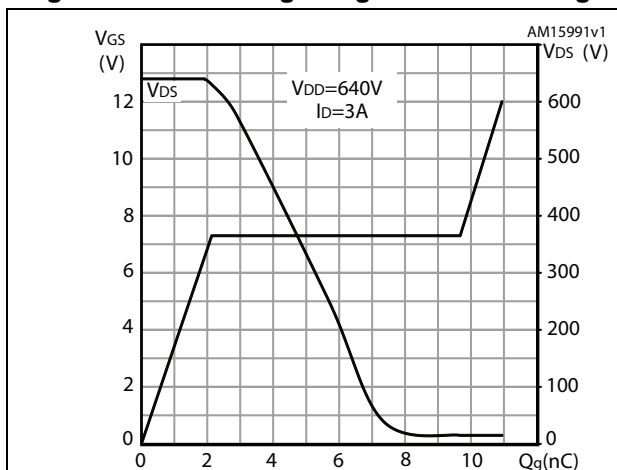


Figure 11. Static drain-source on-resistance

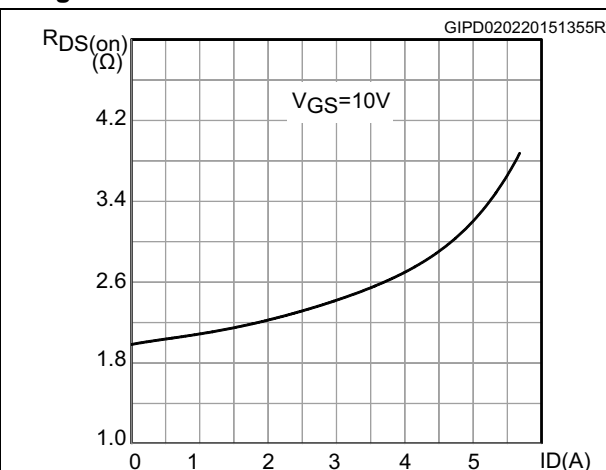


Figure 12. Capacitance variations

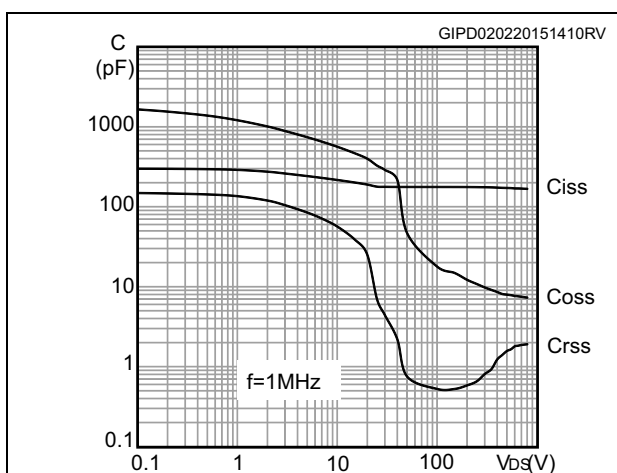


Figure 13. Normalized gate threshold voltage vs temperature

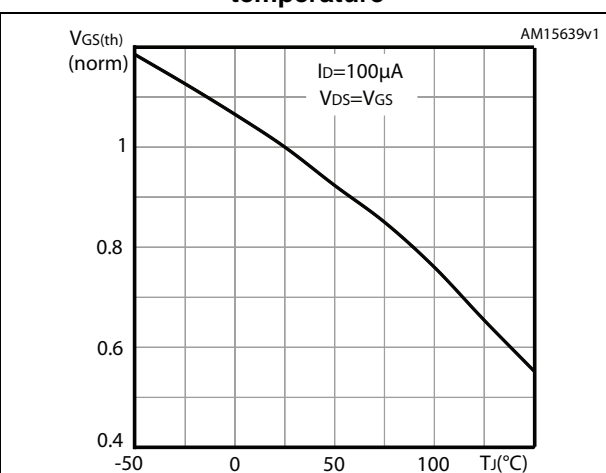


Figure 14. Normalized on-resistance vs temperature

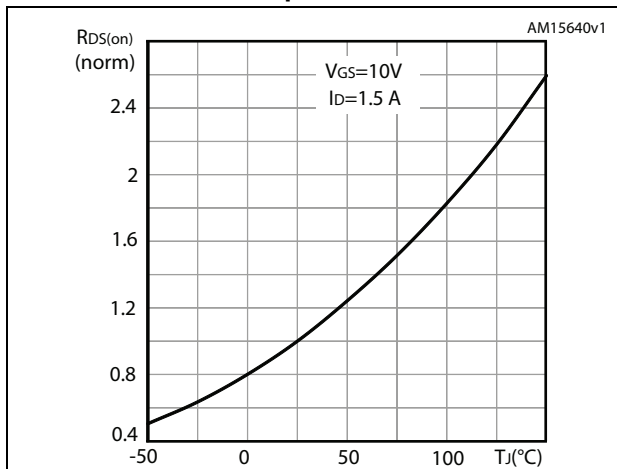


Figure 15. Source-drain diode forward characteristics

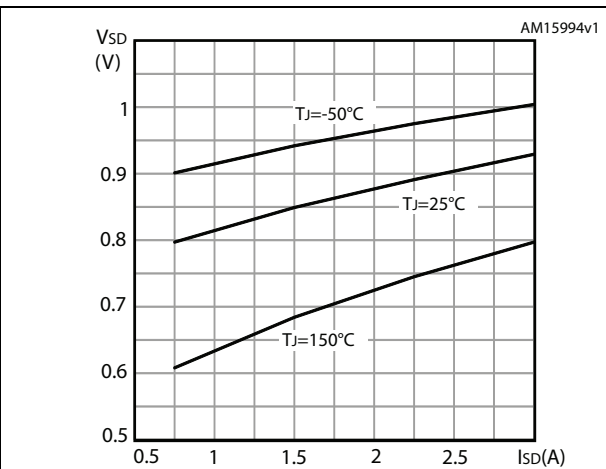


Figure 16. Normalized V_{DS} vs temperature

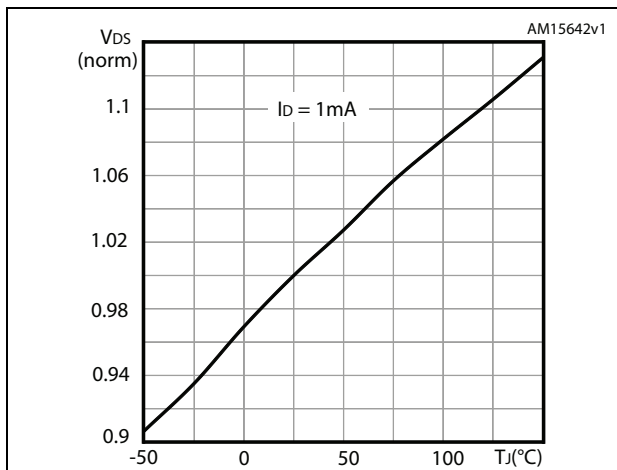
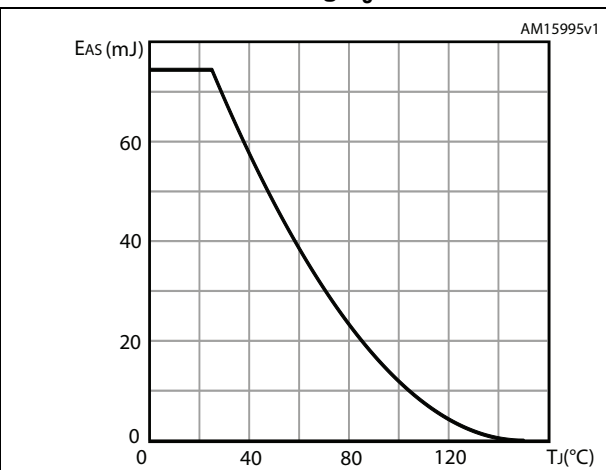


Figure 17. Maximum avalanche energy vs. starting T_J



3 Test circuits

Figure 18. Switching times test circuit for resistive load



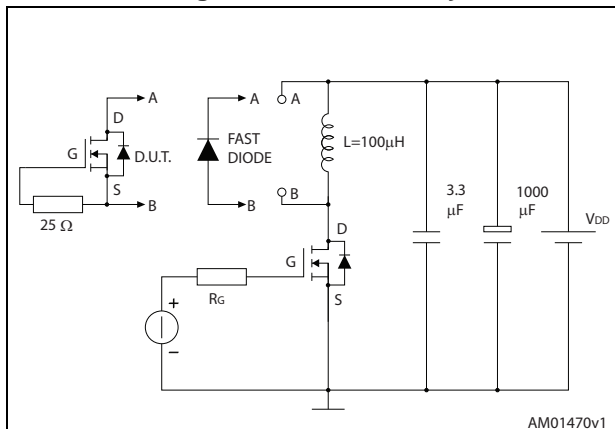
AM01468v1

Figure 19. Gate charge test circuit



AM01469v1

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



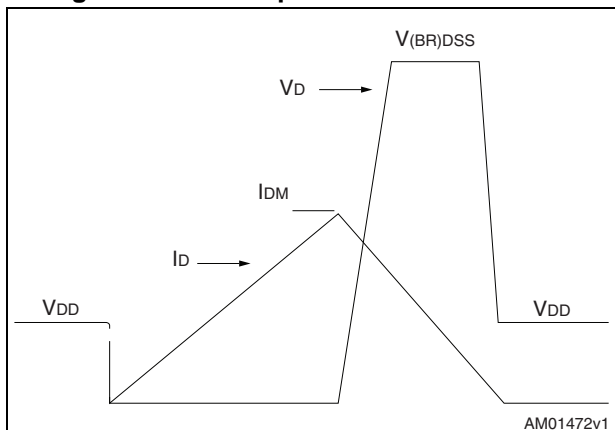
AM01470v1

Figure 21. Unclamped inductive load test circuit



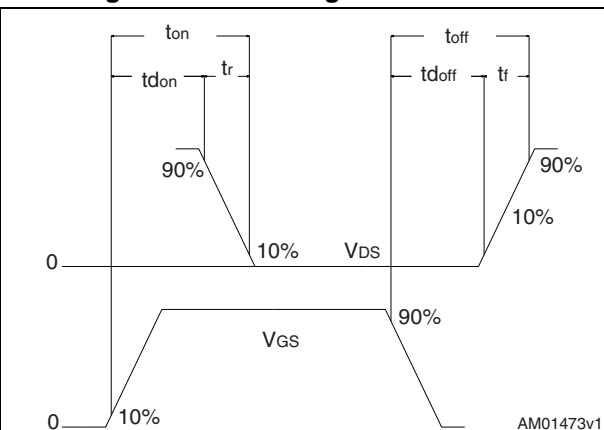
AM01471v1

Figure 22. Unclamped inductive waveform



AM01472v1

Figure 23. Switching time waveform



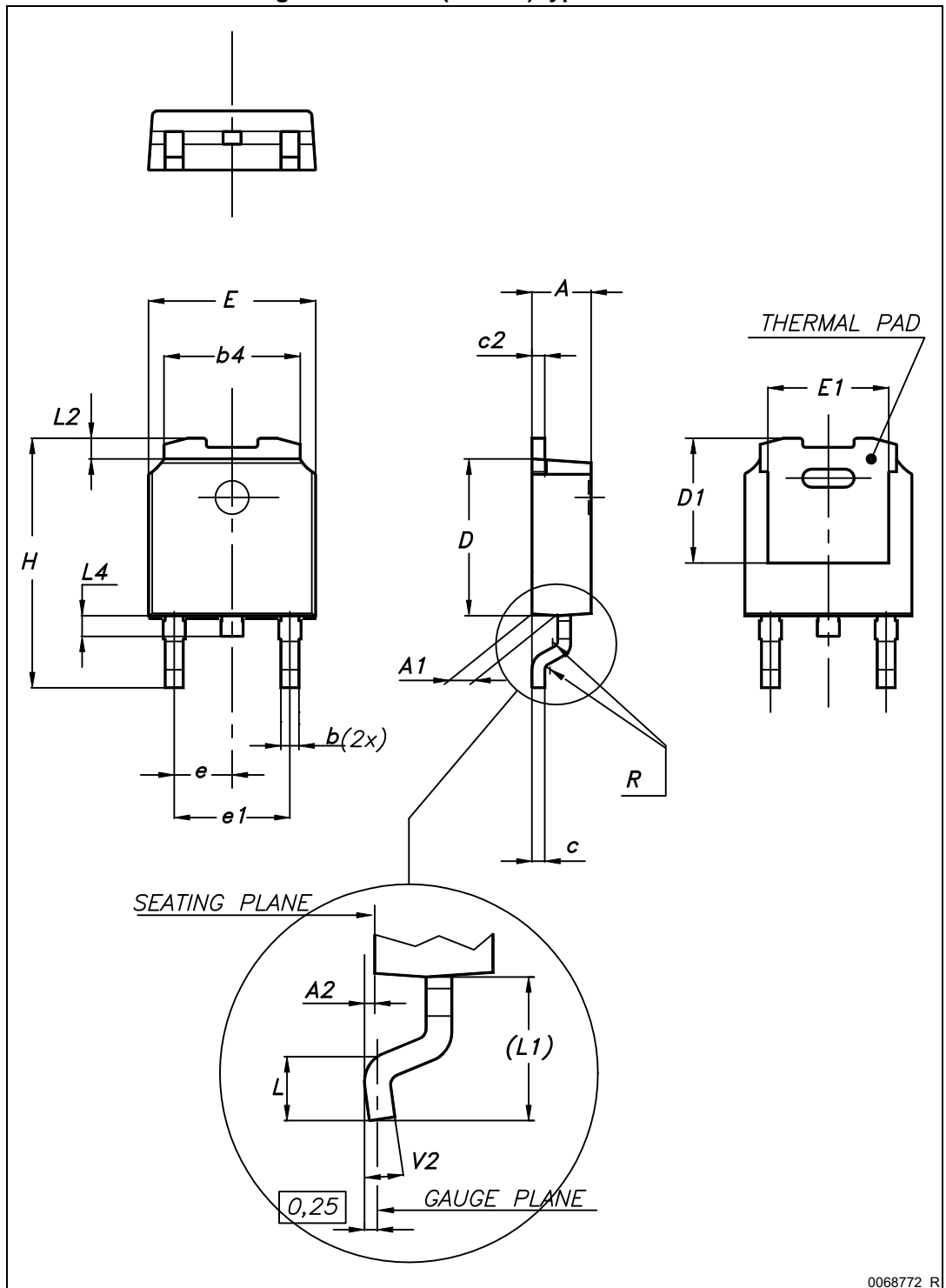
AM01473v1

4 Package information

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(TO-252), package information

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

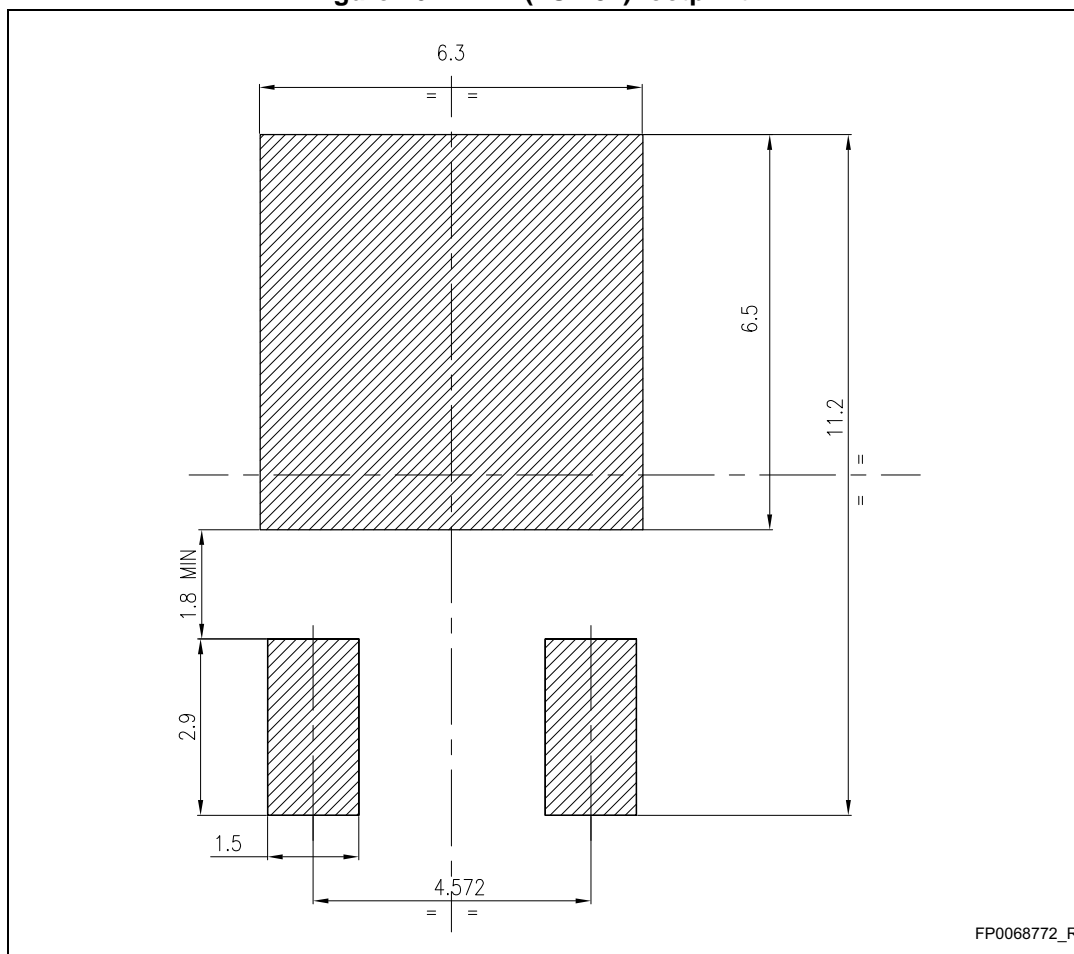


0068772_R

Figure 25. 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° |

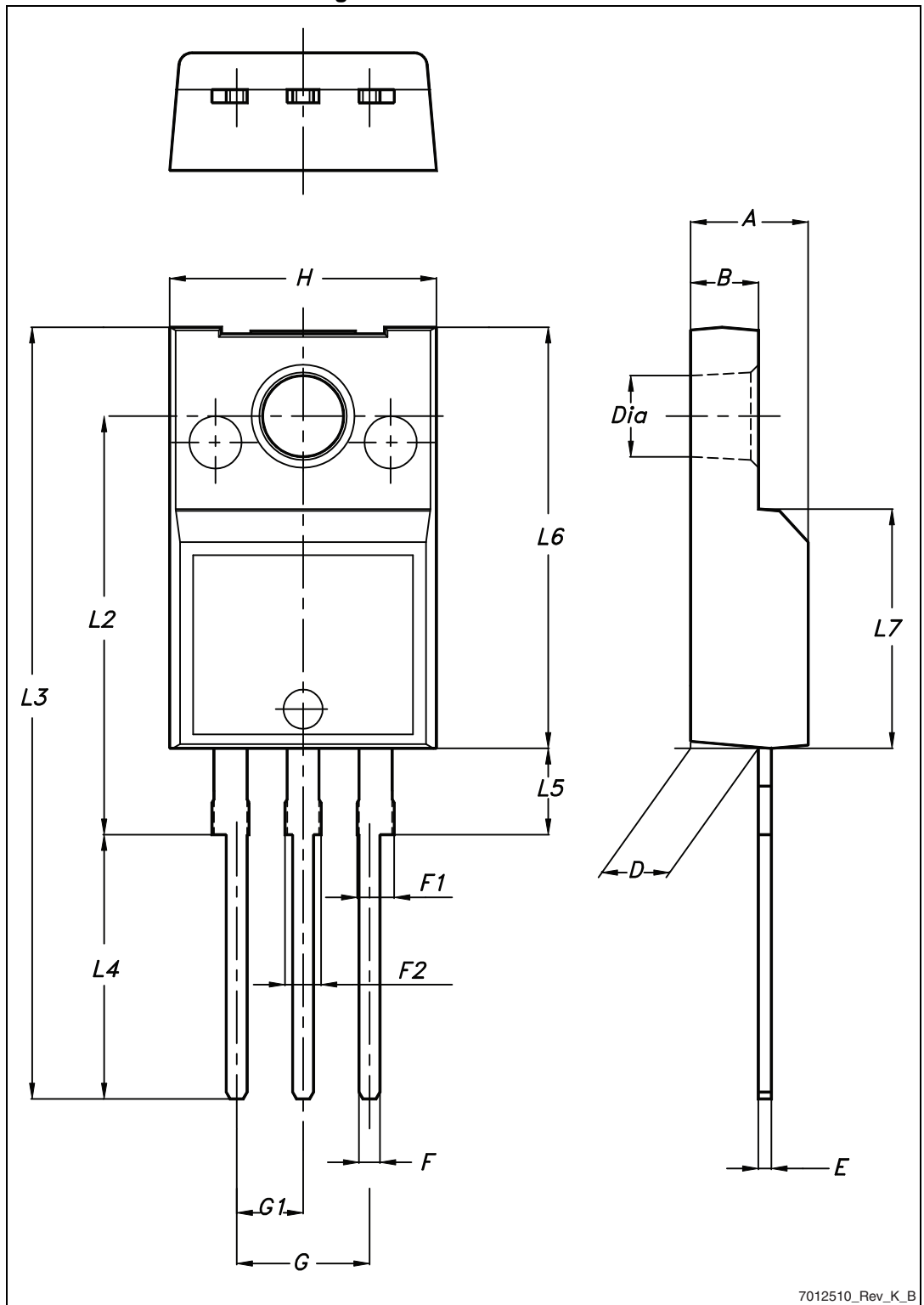
Figure 26. DPAK (TO-252) footprint (a)



a. All dimensions are in millimeters

4.2 TO-220FP, package information

Figure 27. TO-220FP outline



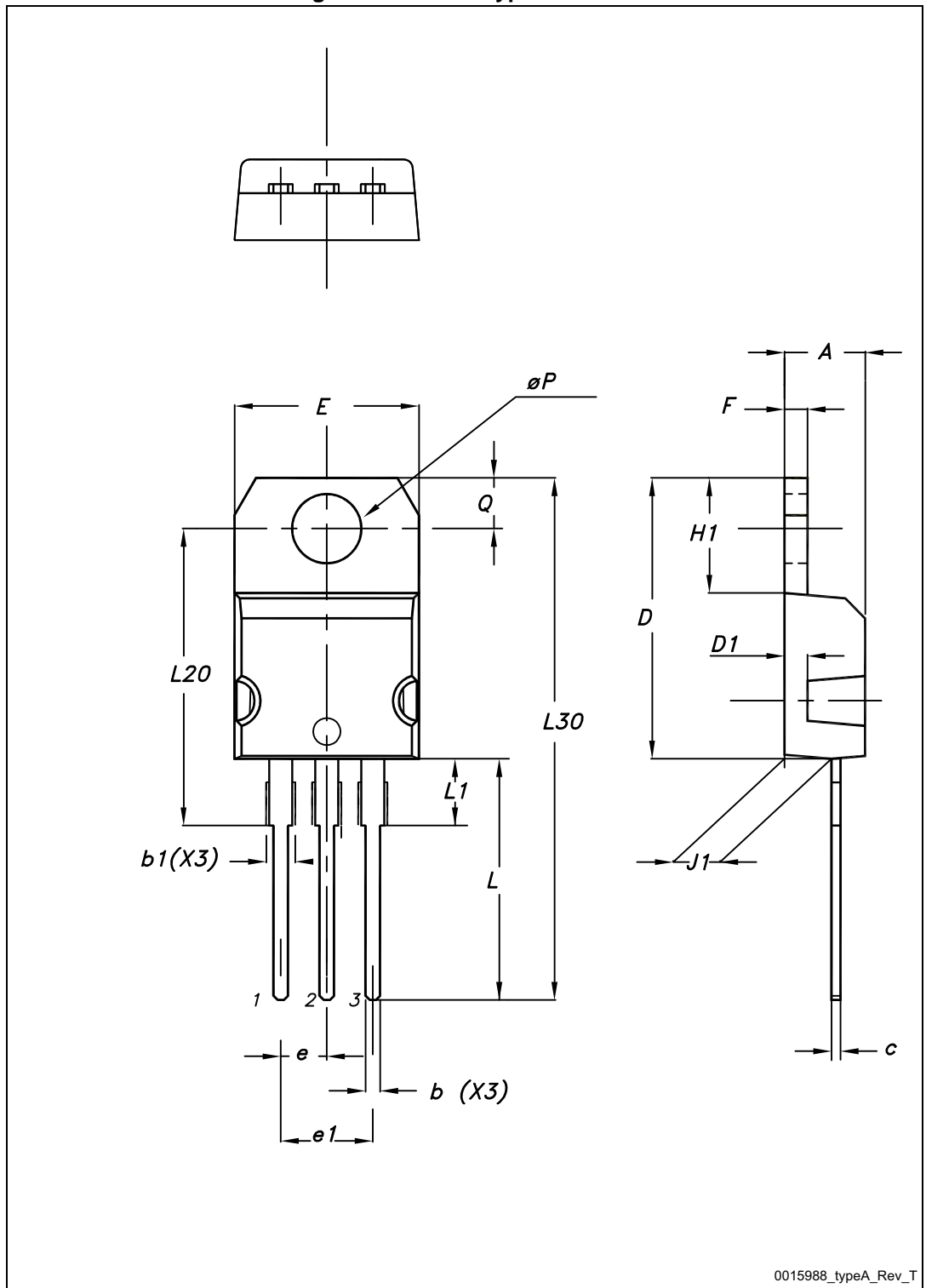
7012510_Rev_K_B

Table 9. 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 |

4.3 TO-220, package information

Figure 28. TO-220 type A outline



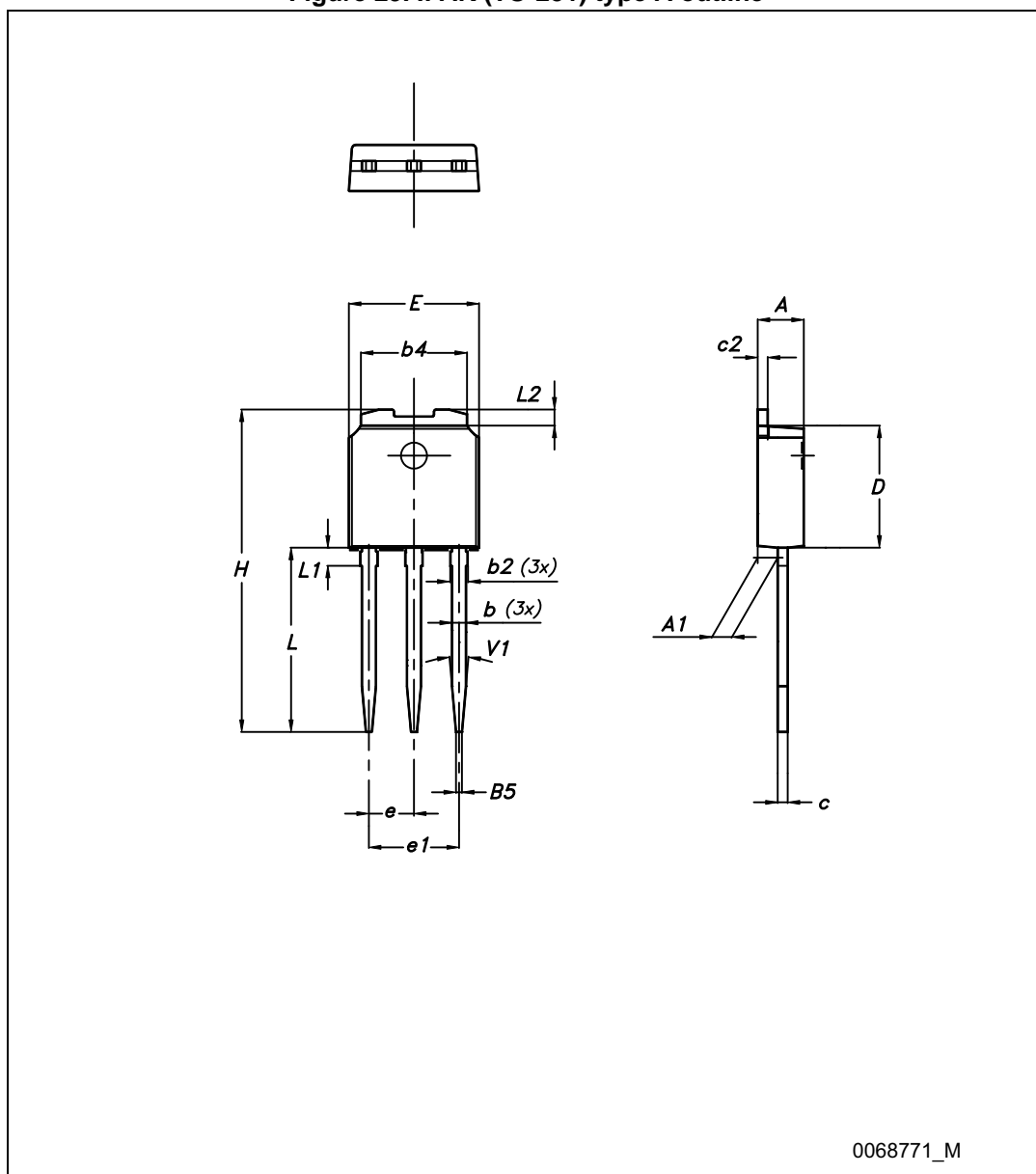
0015988_typeA_Rev_T

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 |

4.4 IPAK(TO-251), package information

Figure 29. IPAK (TO-251) type A outline



0068771_M

Table 11. IPAK (TO-251) type A 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

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 30. Tape for DPAK (TO-252)

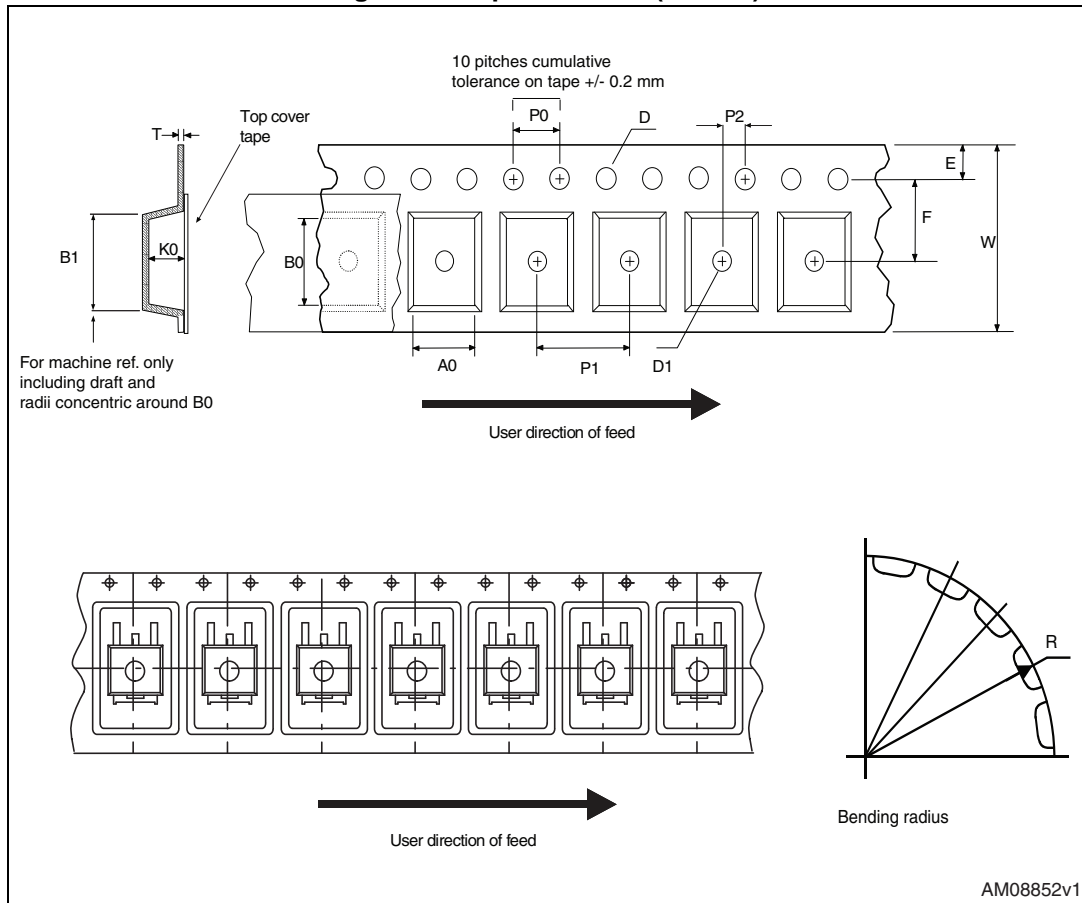
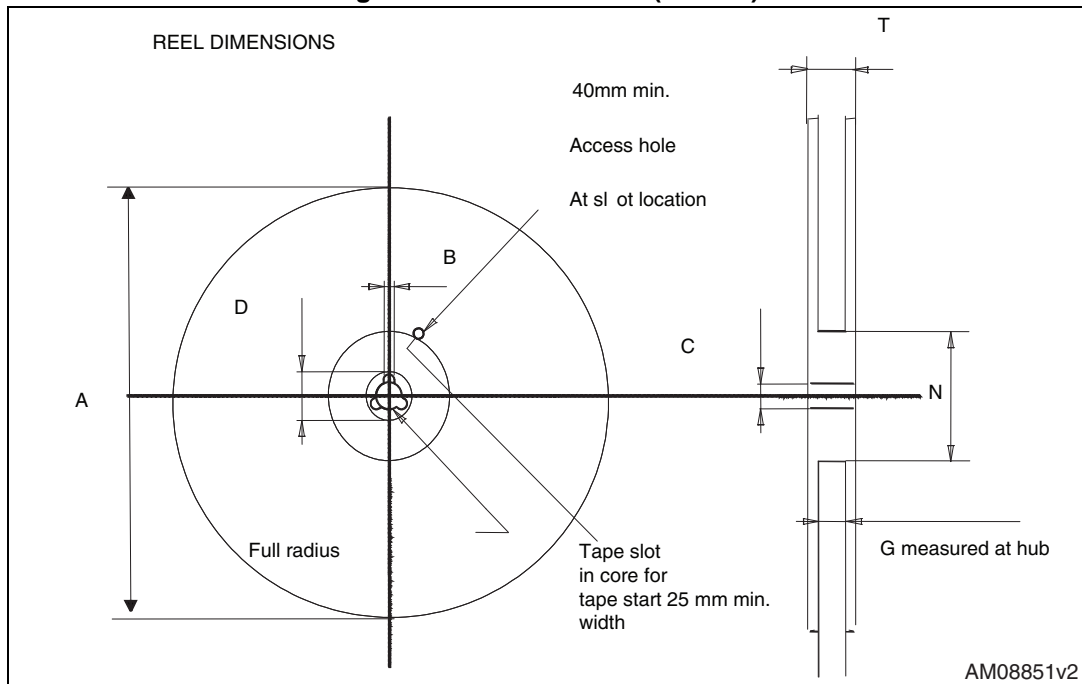


Figure 31. Reel for DPAK (TO-252)



6 Revision history

Table 13. Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 09-Aug-2013 | 1 | First release |
| 13-Dec-2013 | 2 | <ul style="list-style-type: none">– Added: IPAK package– Added: Table 11 and Figure 29– Minor text changes |
| 04-Feb-2015 | 3 | <ul style="list-style-type: none">– Updated title and description in cover page.– Updated Table 2.: Absolute maximum ratings, Table 5.: Dynamic and Table 7.: Source drain diode.– Updated 4: Package information and 5: Packaging mechanical data.– Minor text changes. |

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