

N-channel 600 V, 0.55 Ω typ., 7.5 A MDmesh™ M2 Power MOSFETs in D²PAK, DPAK, TO-220 and IPAK packages

Datasheet - production data

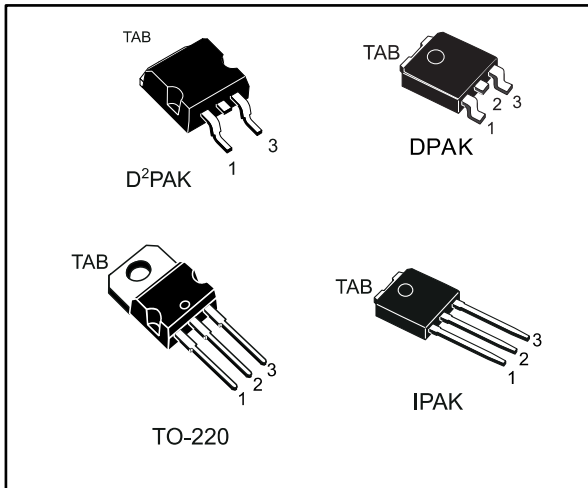
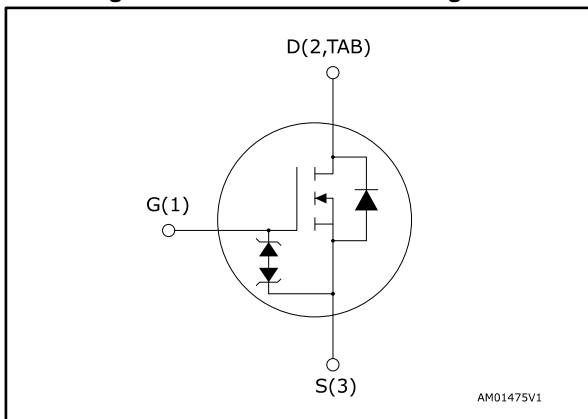


Figure 1: Internal schematic diagram



Features

| Order code | V _{DS@T_{Jmax.}} | R _{DS(on)} max. | I _D |
|------------|-----------------------------------|--------------------------|----------------|
| STB10N60M2 | 650 V | 0.60 Ω | 7.5 A |
| STD10N60M2 | | | |
| STP10N60M2 | | | |
| STU10N60M2 | | | |

- Extremely low gate charge
- Excellent output capacitance (C_{oss}) profile
- 100% avalanche tested
- Zener-protected

Applications

- Switching applications

Description

These devices are N-channel Power MOSFETs developed using MDmesh™ M2 technology. Thanks to their strip layout and improved vertical structure, these devices exhibit low on-resistance and optimized switching characteristics, rendering them suitable for the most demanding high efficiency converters.

Table 1: Device summary

| Order code | Marking | Package | Packing |
|------------|---------|--------------------|---------------|
| STB10N60M2 | 10N60M2 | D ² PAK | Tape and reel |
| STD10N60M2 | | DPAK | |
| STP10N60M2 | | TO-220 | Tube |
| STU10N60M2 | | 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 $T_{case} = 25\text{ °C}$ | 7.5 | A |
| | Drain current (continuous) at $T_{case} = 100\text{ °C}$ | 4.9 | |
| $I_{DM}^{(1)}$ | Drain current (pulsed) | 30 | A |
| P_{TOT} | Total dissipation at $T_{case} = 25\text{ °C}$ | 85 | W |
| $dv/dt^{(2)}$ | Peak diode recovery voltage slope | 15 | V/ns |
| $dv/dt^{(3)}$ | MOSFET dv/dt ruggedness | 50 | |
| T_{stg} | Storage temperature range | -55 to 150 | °C |
| T_j | Operating junction temperature range | | |

Notes:

- (1) Pulse limited by safe operating area.
- (2) $I_{SD} \leq 7.5\text{ A}$, $di/dt \leq 400\text{ A}/\mu\text{s}$; $V_{DS\text{ peak}} < V_{(BR)DSS}$, $V_{DD} = 400\text{ V}$
- (3) $V_{DS} \leq 480\text{ V}$.

Table 3: Thermal data

| Symbol | Parameter | Value | | | | Unit |
|----------------|--|--------------------|------|--------|------|------|
| | | D ² PAK | DPAK | TO-220 | IPAK | |
| $R_{thj-case}$ | Thermal resistance junction-case | 1.47 | | | | °C/W |
| $R_{thj-pcb}$ | Thermal resistance junction-pcb ⁽¹⁾ | 30 | 50 | | | |
| $R_{thj-amb}$ | Thermal resistance junction-ambient | | | 62.5 | 100 | |

Notes:

- (1) When mounted on 1 inch² FR-4, 2 Oz copper board.

Table 4: Avalanche characteristics

| Symbol | Parameter | Value | Unit |
|----------------|---|-------|------|
| $I_{AR}^{(1)}$ | Avalanche current, repetitive or not repetitive | 1.5 | A |
| $E_{AS}^{(2)}$ | Single pulse avalanche energy | 110 | mJ |

Notes:

- (1) Pulse width limited by T_{jmax} .
- (2) Starting $T_j = 25\text{ °C}$, $I_D = I_{AR}$, $V_{DD} = 50\text{ V}$.

2 Electrical characteristics

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

Table 5: Static

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------------------|-----------------------------------|--|------|------|----------|---------------|
| $V_{(\text{BR})\text{DSS}}$ | Drain-source breakdown voltage | $V_{\text{GS}} = 0\text{ V}$, $I_{\text{D}} = 1\text{ mA}$ | 600 | | | V |
| I_{DSS} | Zero gate voltage drain current | $V_{\text{GS}} = 0\text{ V}$, $V_{\text{DS}} = 600\text{ V}$ | | | 1 | μA |
| | | $V_{\text{GS}} = 0\text{ V}$, $V_{\text{DS}} = 600\text{ V}$, $T_{\text{case}} = 125\text{ °C}^{(1)}$ | | | 100 | |
| I_{GSS} | Gate-body leakage current | $V_{\text{DS}} = 0\text{ V}$, $V_{\text{GS}} = \pm 25\text{ V}$ | | | ± 10 | μA |
| $V_{\text{GS(th)}}$ | Gate threshold voltage | $V_{\text{DS}} = V_{\text{GS}}$, $I_{\text{D}} = 250\text{ }\mu\text{A}$ | 2 | 3 | 4 | V |
| $R_{\text{DS(on)}}$ | Static drain-source on-resistance | $V_{\text{GS}} = 10\text{ V}$, $I_{\text{D}} = 3\text{ A}$ | | 0.55 | 0.60 | Ω |

Notes:

⁽¹⁾Defined by design, not subject to production test.

Table 6: Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------------------|-------------------------------|--|------|------|------|-------------|
| C_{ISS} | Input capacitance | $V_{\text{DS}} = 100\text{ V}$, $f = 1\text{ MHz}$, $V_{\text{GS}} = 0\text{ V}$ | - | 400 | - | pF |
| C_{OSS} | Output capacitance | | - | 22 | - | |
| C_{RSS} | Reverse transfer capacitance | | - | 0.84 | - | |
| $C_{\text{OSS eq.}}^{(1)}$ | Equivalent output capacitance | $V_{\text{DS}} = 0\text{ to }480\text{ V}$, $V_{\text{GS}} = 0\text{ V}$ | - | 83 | - | pF |
| R_{G} | Intrinsic gate resistance | $f = 1\text{ MHz}$, $I_{\text{D}} = 0\text{ A}$ | - | 6.4 | - | Ω |
| Q_{g} | Total gate charge | $V_{\text{DD}} = 480\text{ V}$, $I_{\text{D}} = 7.5\text{ A}$, $V_{\text{GS}} = 0\text{ to }10\text{ V}$ (see Figure 17 : "Test circuit for gate charge behavior") | - | 13.5 | - | nC |
| Q_{gs} | Gate-source charge | | - | 2.1 | - | |
| Q_{gd} | Gate-drain charge | | - | 7.2 | - | |

Notes:

⁽¹⁾ $C_{\text{OSS eq.}}$ 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 |
|---------------------|---------------------|---|------|------|------|-------------|
| $t_{\text{d(on)}}$ | Turn-on delay time | $V_{\text{DD}} = 300\text{ V}$, $I_{\text{D}} = 3.75\text{ A}$ $R_{\text{G}} = 4.7\text{ }\Omega$, $V_{\text{GS}} = 10\text{ V}$ (see Figure 16 : "Test circuit for resistive load switching times" and Figure 21 : "Switching time waveform") | - | 8.8 | - | ns |
| t_{r} | Rise time | | - | 8 | - | |
| $t_{\text{d(off)}}$ | Turn-off delay time | | - | 32.5 | - | |
| t_{f} | Fall time | | - | 13.2 | - | |

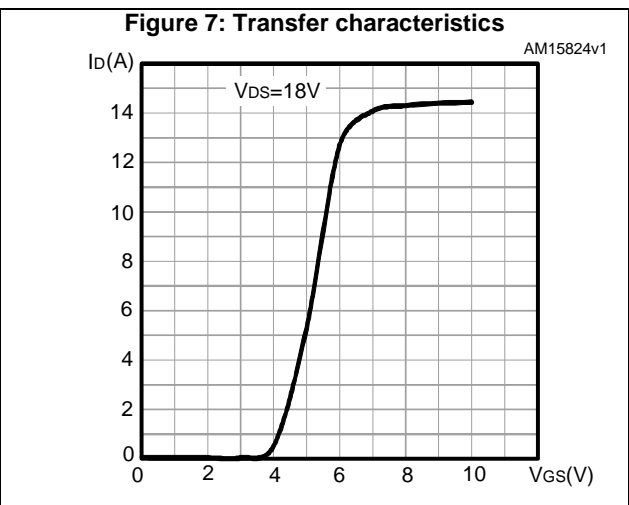
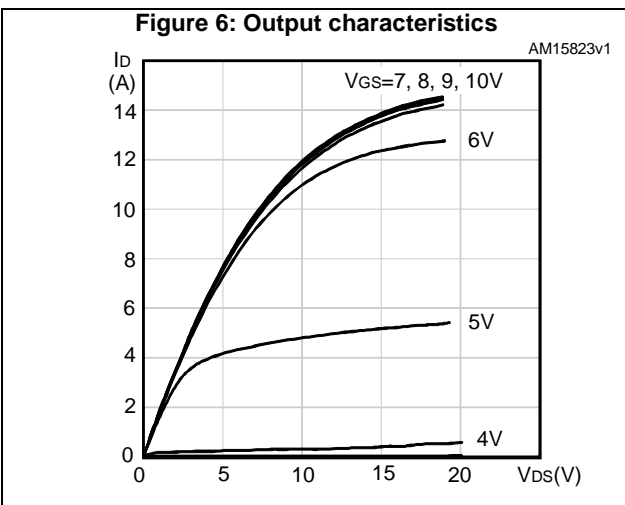
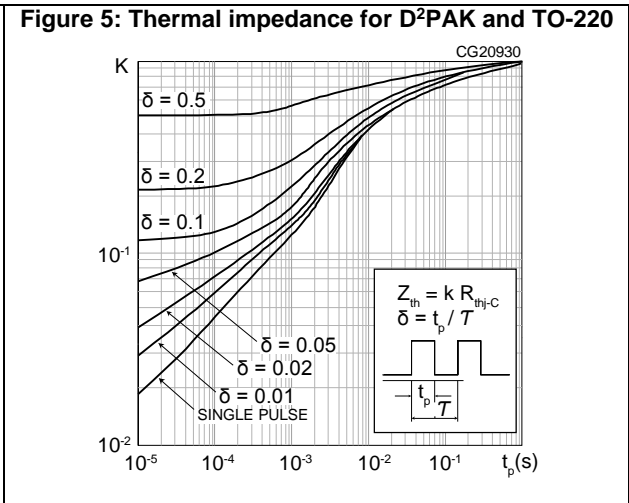
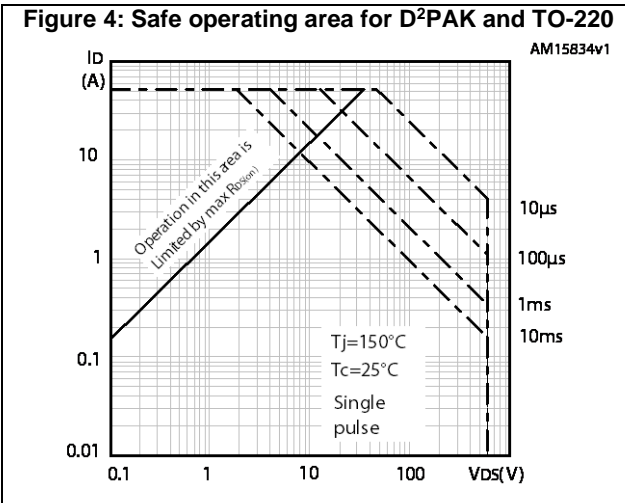
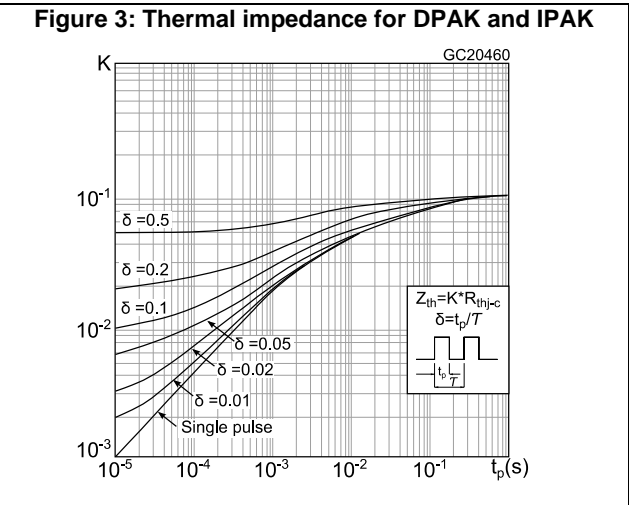
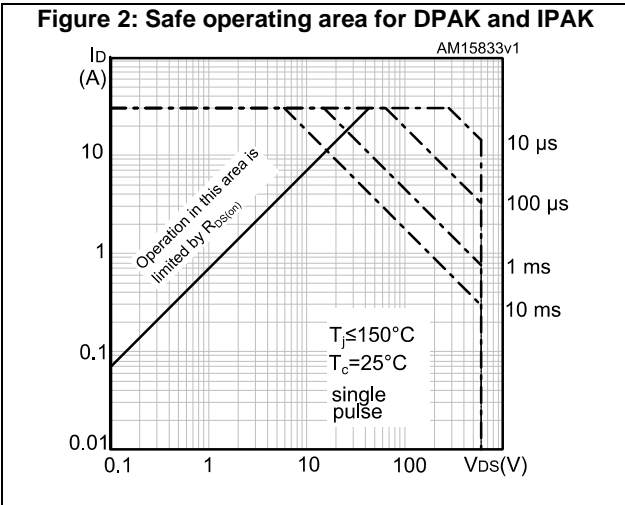
Table 8: Source-drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|--|------|------|------|---------------|
| I_{SD} | Source-drain current | | - | | 7.5 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | - | | 30 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $V_{GS} = 0\text{ V}$, $I_{SD} = 7.5\text{ A}$ | - | | 1.6 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 7.5\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 60\text{ V}$ (see Figure 18 : "Test circuit for inductive load switching and diode recovery times") | - | 270 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 2 | | μC |
| I_{RRM} | Reverse recovery current | | - | 14.4 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 7.5\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 60\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$ (see Figure 18 : "Test circuit for inductive load switching and diode recovery times") | - | 376 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 2.8 | | μC |
| I_{RRM} | Reverse recovery current | | - | 15 | | A |

Notes:

- (1) Pulse width is limited by safe operating area.
(2) Pulse test: pulse duration = 300 μs , duty cycle 1.5%.

2.1 Electrical characteristics (curves)



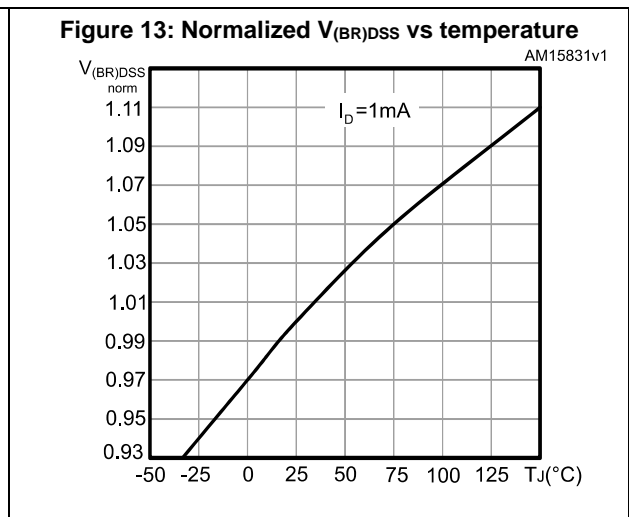
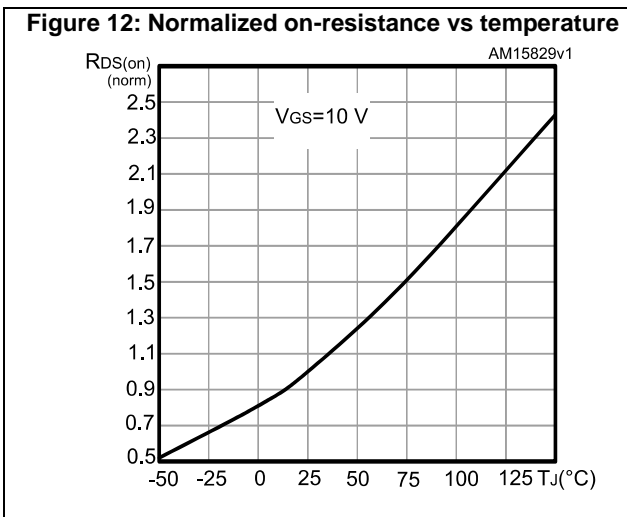
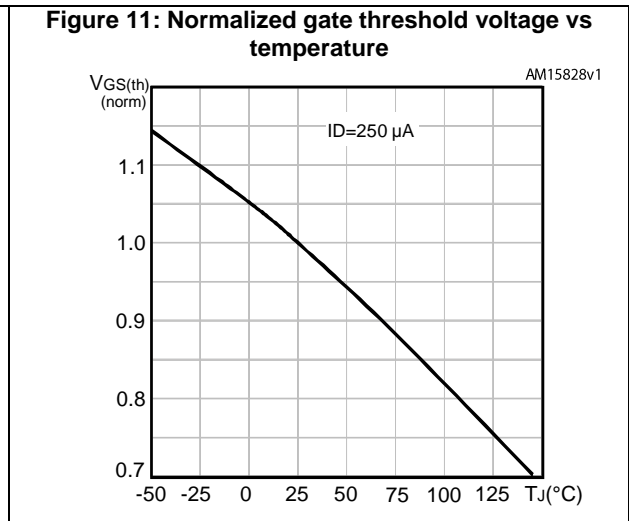
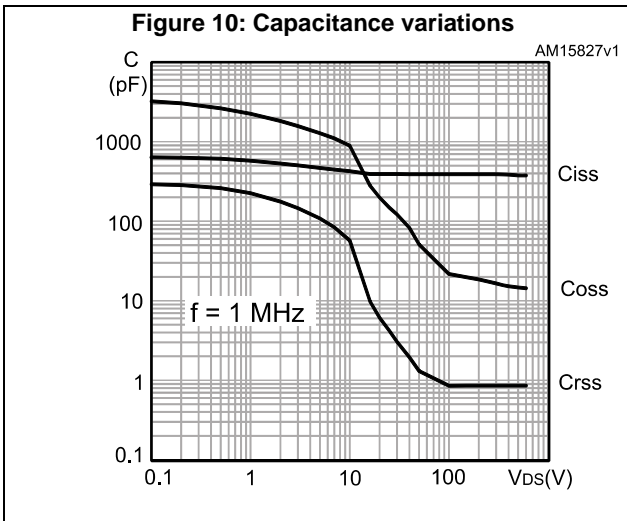
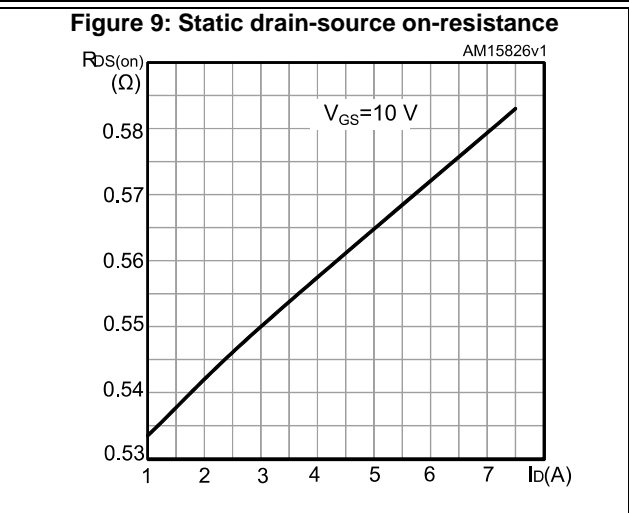
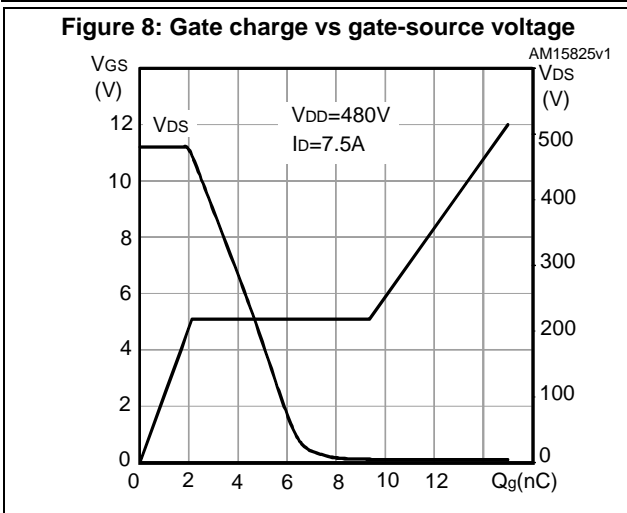


Figure 14: Source-drain diode forward characteristics

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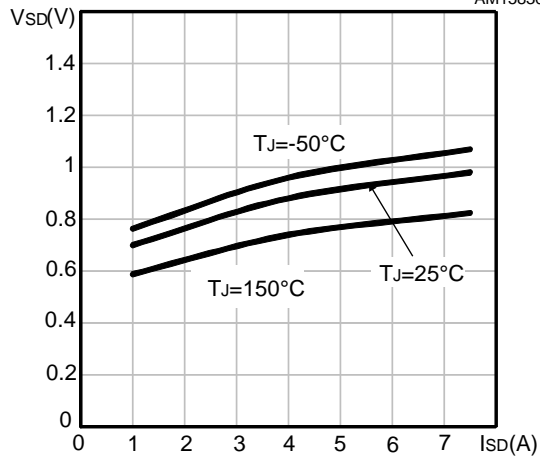
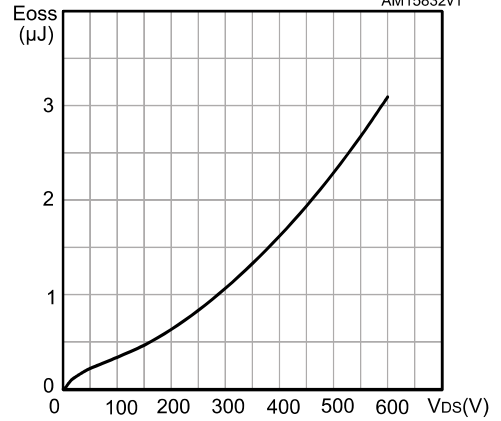


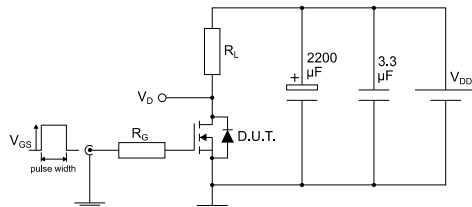
Figure 15: Output capacitance stored energy

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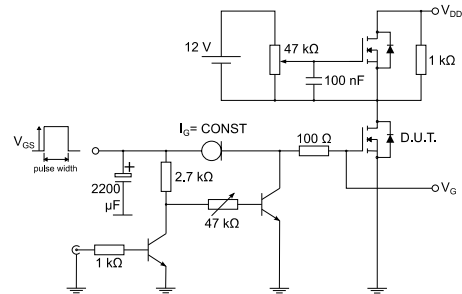
3 Test circuits

Figure 16: Test circuit for resistive load switching times



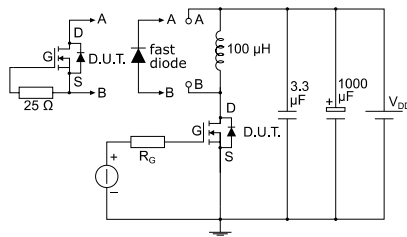
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Figure 17: Test circuit for gate charge behavior



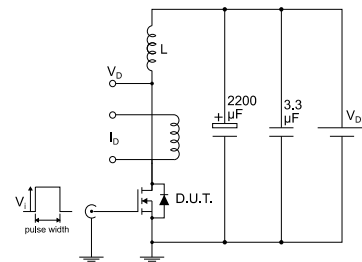
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Figure 18: Test circuit for inductive load switching and diode recovery times



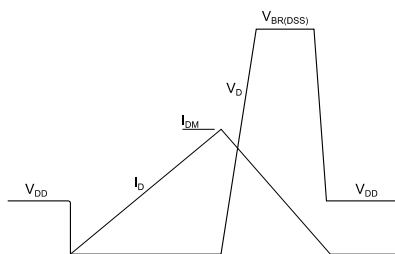
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Figure 19: Unclamped inductive load test circuit



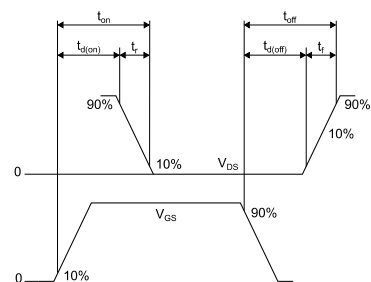
AM01471v1

Figure 20: Unclamped inductive waveform



AM01472v1

Figure 21: 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 D²PAK (TO-263) type A package information

Figure 22: D²PAK (TO-263) type A package outline

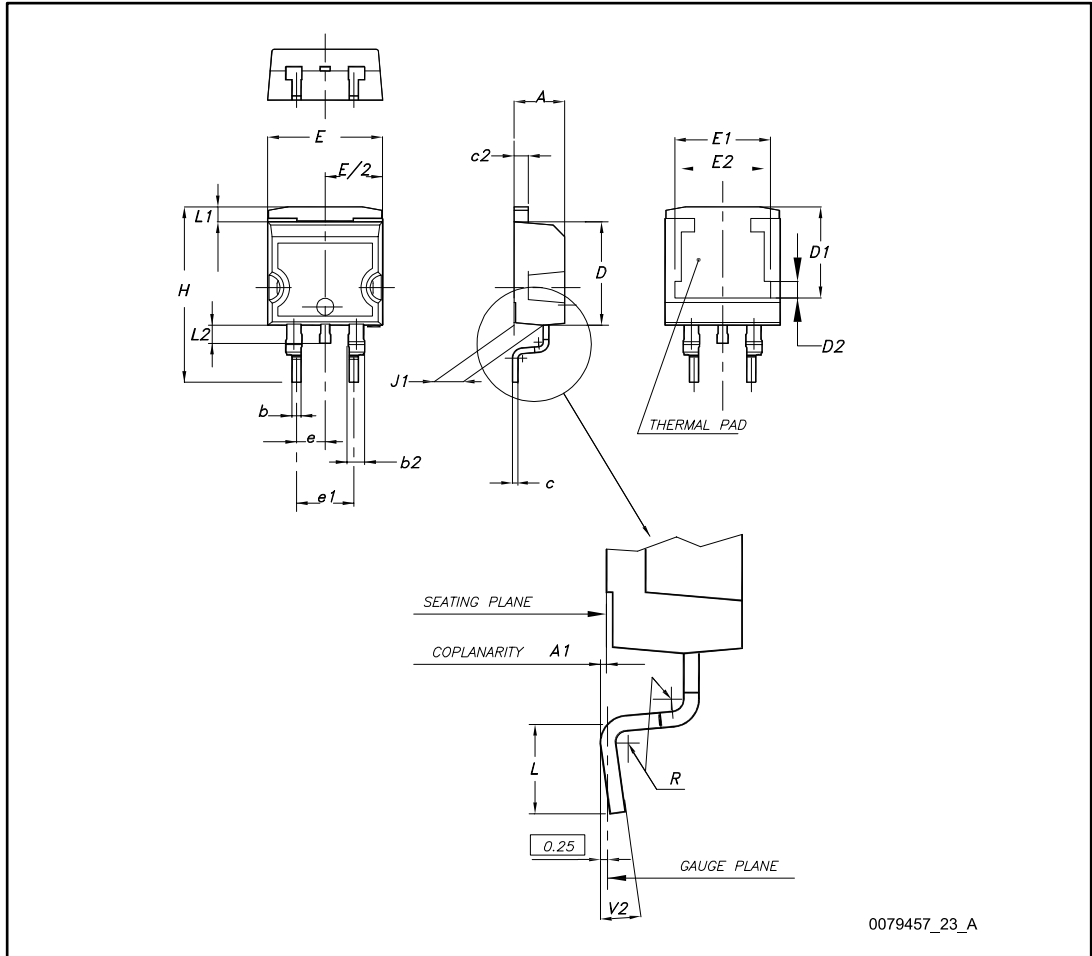
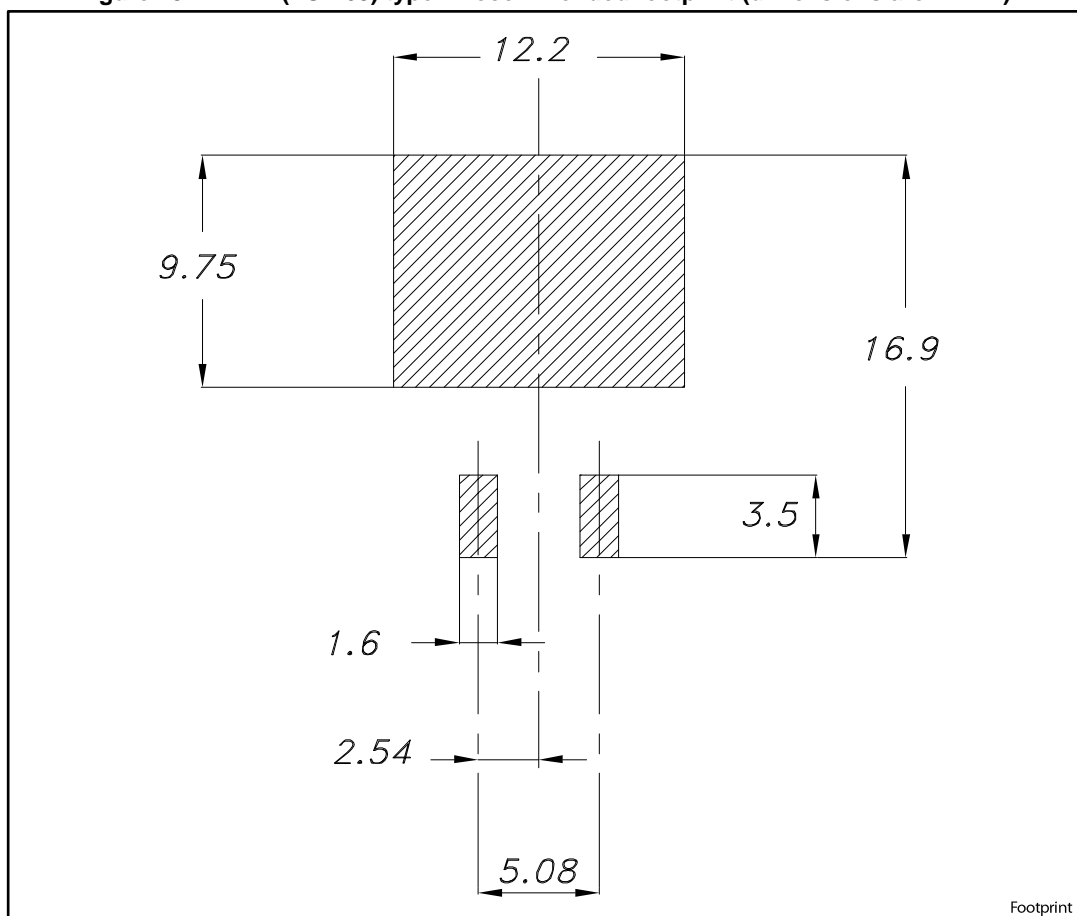


Table 9: D²PAK (TO-263) type A package mechanical data

| 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 | 7.75 | 8.00 |
| D2 | 1.10 | 1.30 | 1.50 |
| E | 10.00 | | 10.40 |
| E1 | 8.50 | 8.70 | 8.90 |
| E2 | 6.85 | 7.05 | 7.25 |
| e | | 2.54 | |
| e1 | 4.88 | | 5.28 |
| H | 15.00 | | 15.85 |
| J1 | 2.49 | | 2.69 |
| L | 2.29 | | 2.79 |
| L1 | 1.27 | | 1.40 |
| L2 | 1.30 | | 1.75 |
| R | | 0.40 | |
| V2 | 0° | | 8° |

Figure 23: D²PAK (TO-263) type A recommended footprint (dimensions are in mm)



4.2 DPAK (TO-252) type A package information

Figure 24: DPAK (TO-252) type A package outline

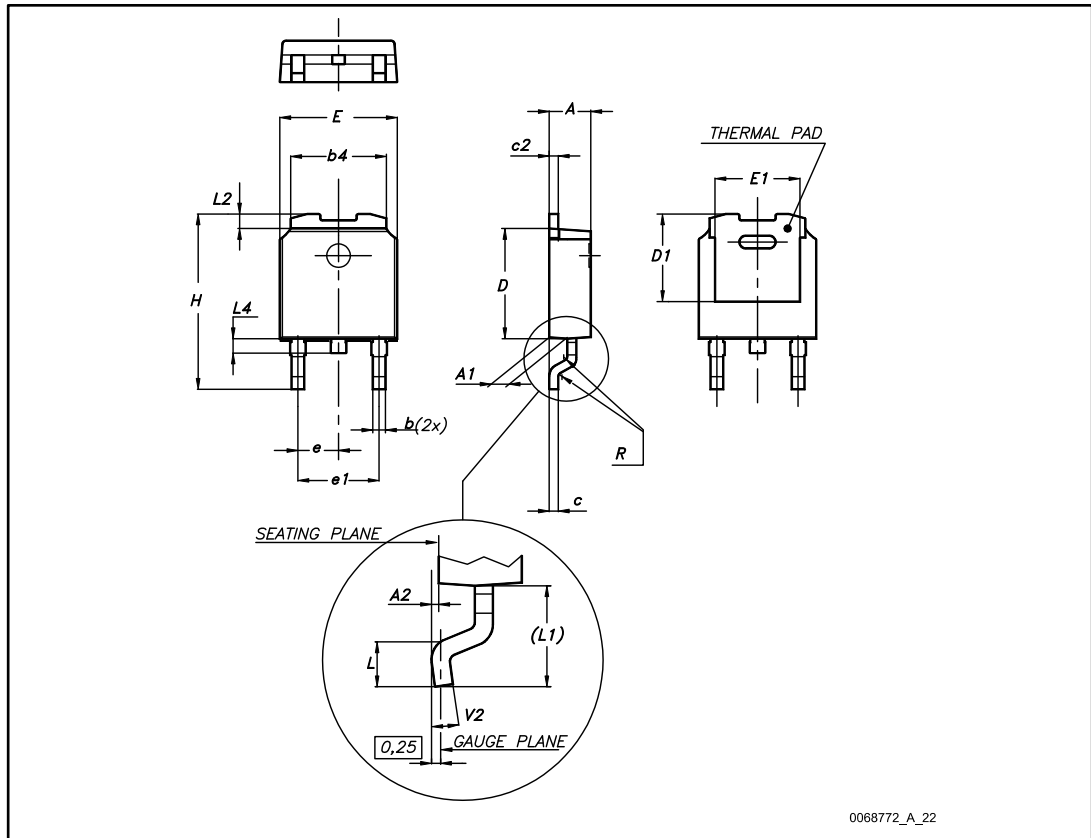


Table 10: DPAK (TO-252) type A mechanical data

| 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 | 4.95 | 5.10 | 5.25 |
| E | 6.40 | | 6.60 |
| E1 | 4.60 | 4.70 | 4.80 |
| e | 2.16 | 2.28 | 2.40 |
| e1 | 4.40 | | 4.60 |
| H | 9.35 | | 10.10 |
| L | 1.00 | | 1.50 |
| (L1) | 2.60 | 2.80 | 3.00 |
| L2 | 0.65 | 0.80 | 0.95 |
| L4 | 0.60 | | 1.00 |
| R | | 0.20 | |
| V2 | 0° | | 8° |

4.3 DPAK (TO-252) type C package information

Figure 25: DPAK (TO-252) type C package outline

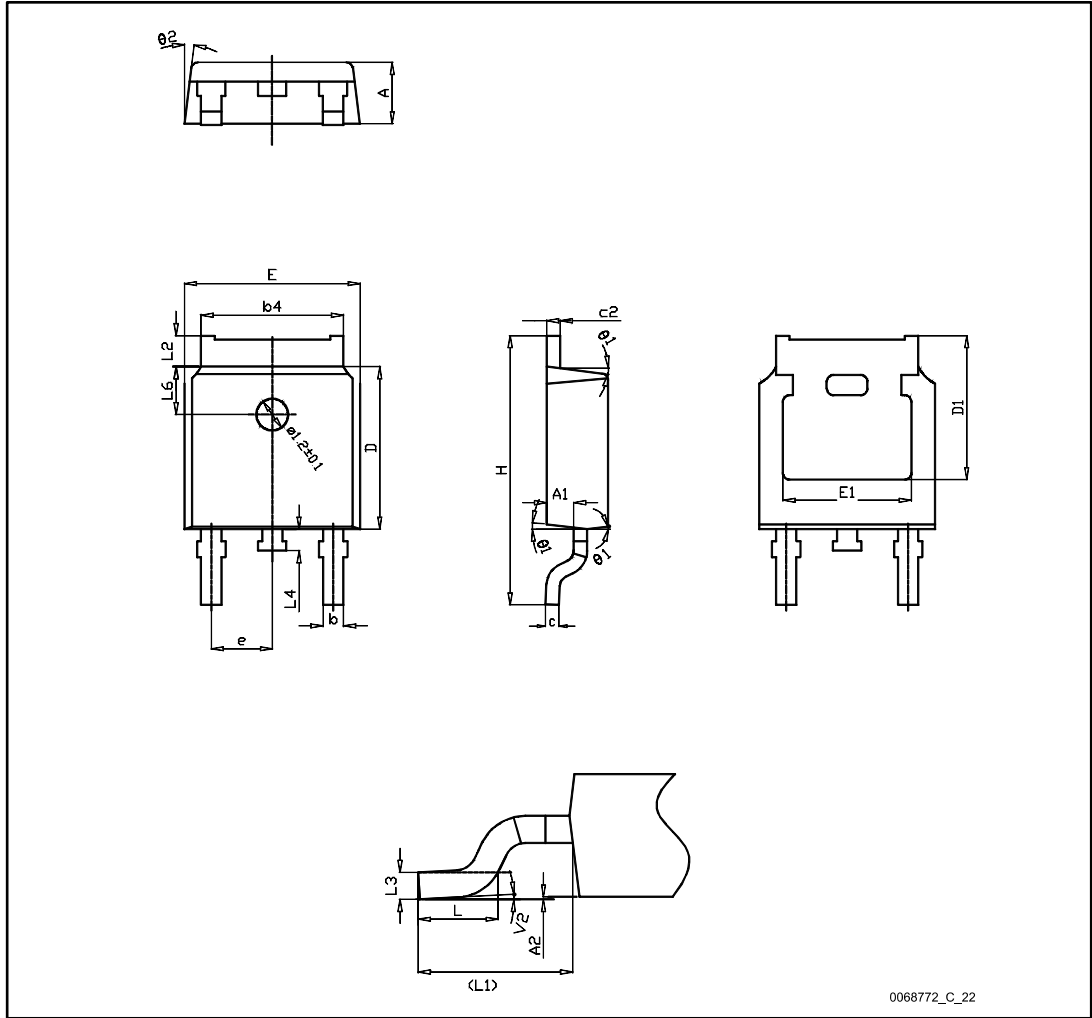
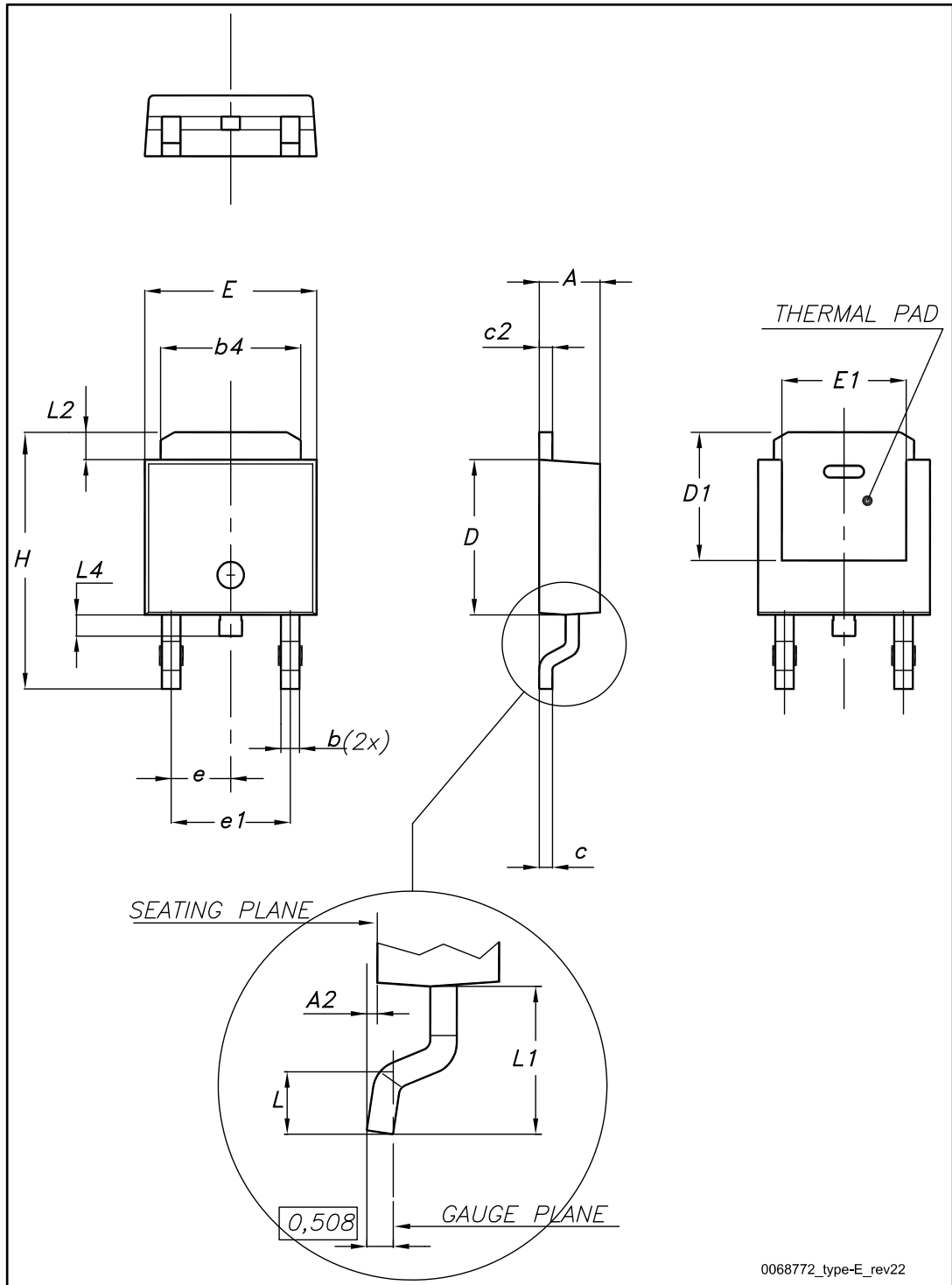


Table 11: DPAK (TO-252) type C mechanical data

| Dim. | mm | | |
|------|----------|-------|-------|
| | Min. | Typ. | Max. |
| A | 2.20 | 2.30 | 2.38 |
| A1 | 0.90 | 1.01 | 1.10 |
| A2 | 0.00 | | 0.10 |
| b | 0.72 | | 0.85 |
| b4 | 5.13 | 5.33 | 5.46 |
| c | 0.47 | | 0.60 |
| c2 | 0.47 | | 0.60 |
| D | 6.00 | 6.10 | 6.20 |
| D1 | 5.25 | | |
| E | 6.50 | 6.60 | 6.70 |
| E1 | 4.70 | | |
| e | 2.186 | 2.286 | 2.386 |
| H | 9.80 | 10.10 | 10.40 |
| L | 1.40 | 1.50 | 1.70 |
| L1 | 2.90 REF | | |
| L2 | 0.90 | | 1.25 |
| L3 | 0.51 BSC | | |
| L4 | 0.60 | 0.80 | 1.00 |
| L6 | 1.80 BSC | | |
| θ1 | 5° | 7° | 9° |
| θ2 | 5° | 7° | 9° |
| V2 | 0° | | 8° |

4.4 DPAK (TO-252) type E package information

Figure 26: DPAK (TO-252) type E package outline

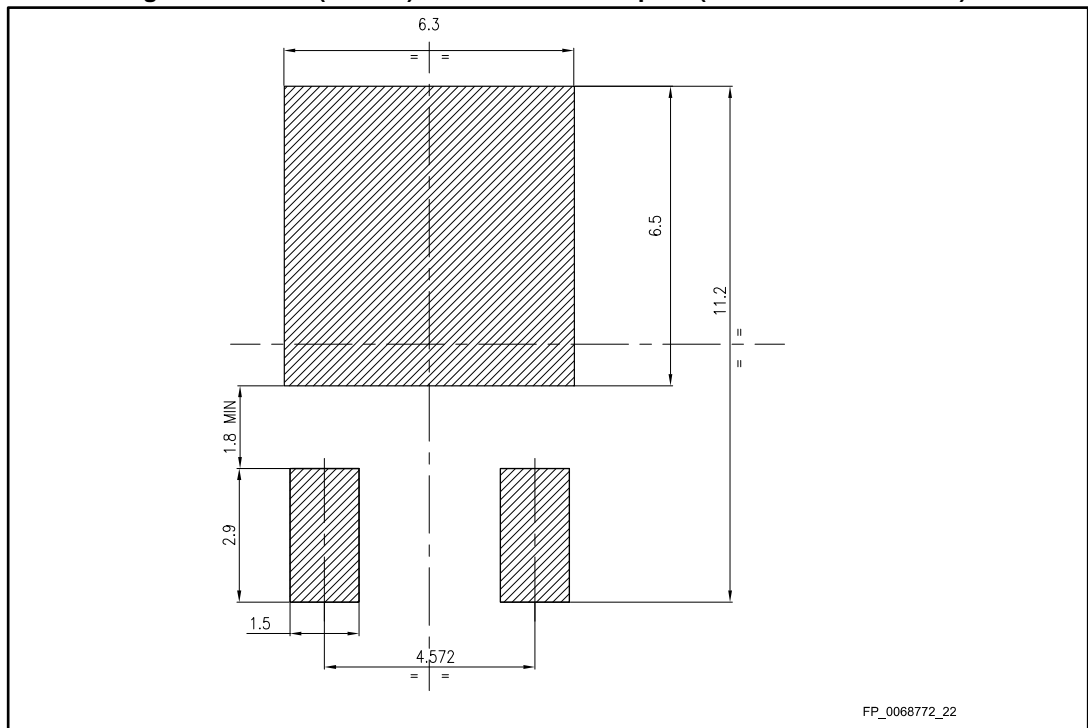


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Table 12: DPAK (TO-252) type E mechanical data

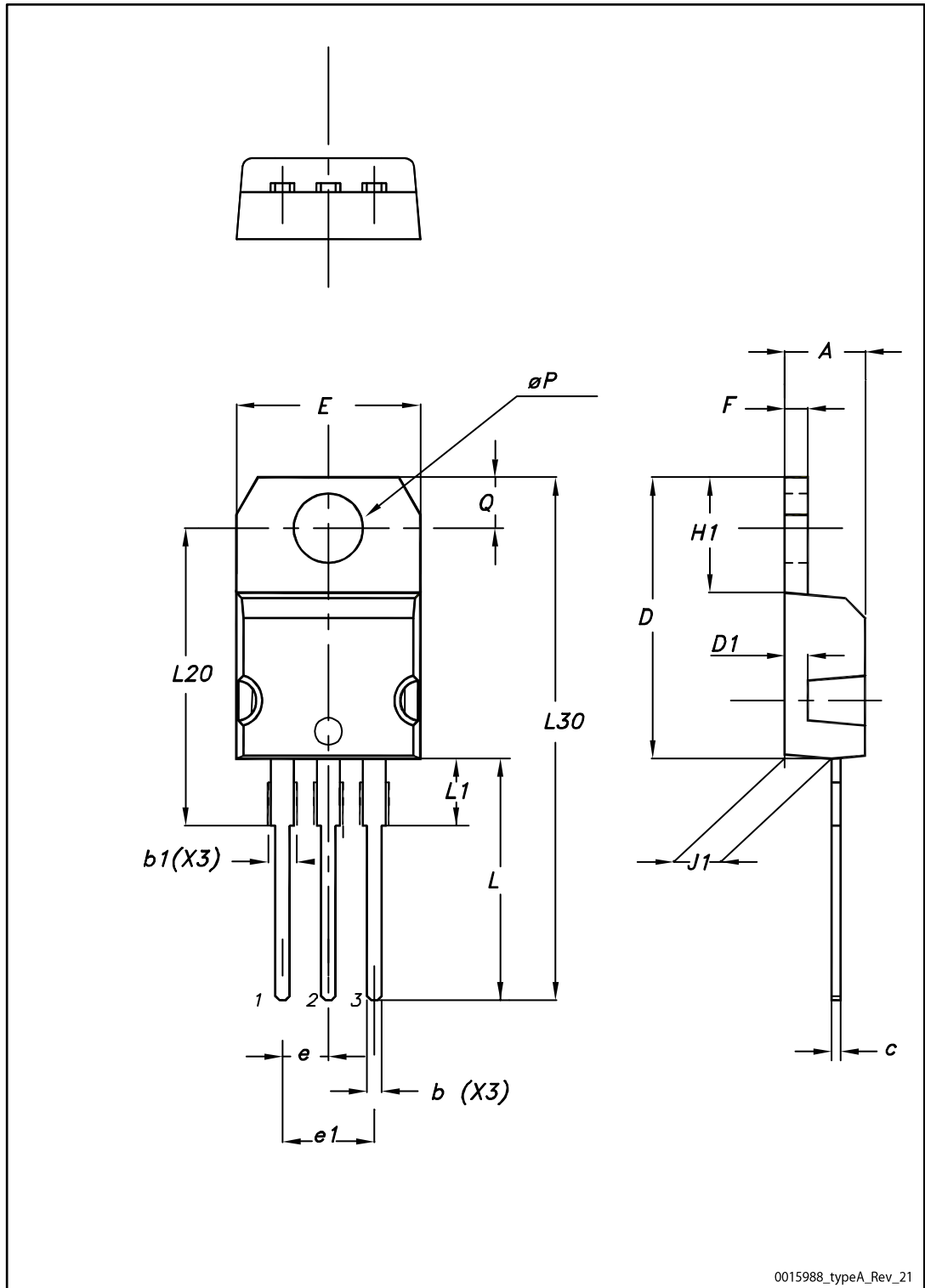
| Dim. | mm | | |
|------|------|-------|-------|
| | Min. | Typ. | Max. |
| A | 2.18 | | 2.39 |
| A2 | | | 0.13 |
| b | 0.65 | | 0.884 |
| b4 | 4.95 | | 5.46 |
| c | 0.46 | | 0.61 |
| c2 | 0.46 | | 0.60 |
| D | 5.97 | | 6.22 |
| D1 | 5.21 | | |
| E | 6.35 | | 6.73 |
| E1 | 4.32 | | |
| e | | 2.286 | |
| e1 | | 4.572 | |
| H | 9.94 | | 10.34 |
| L | 1.50 | | 1.78 |
| L1 | | 2.74 | |
| L2 | 0.89 | | 1.27 |
| L4 | | | 1.02 |

Figure 27: DPAK (TO-252) recommended footprint (dimensions are in mm)



4.5 TO-220 type A package information

Figure 28: TO-220 type A package outline



0015988_typeA_Rev_21

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 | | 1.55 |
| c | 0.48 | | 0.70 |
| D | 15.25 | | 15.75 |
| D1 | | 1.27 | |
| E | 10.00 | | 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 | 13.00 | | 14.00 |
| L1 | 3.50 | | 3.93 |
| L20 | | 16.40 | |
| L30 | | 28.90 | |
| øP | 3.75 | | 3.85 |
| Q | 2.65 | | 2.95 |

4.6 IPAK (TO-251) type A package information

Figure 29: IPAK (TO-251) type A package outline

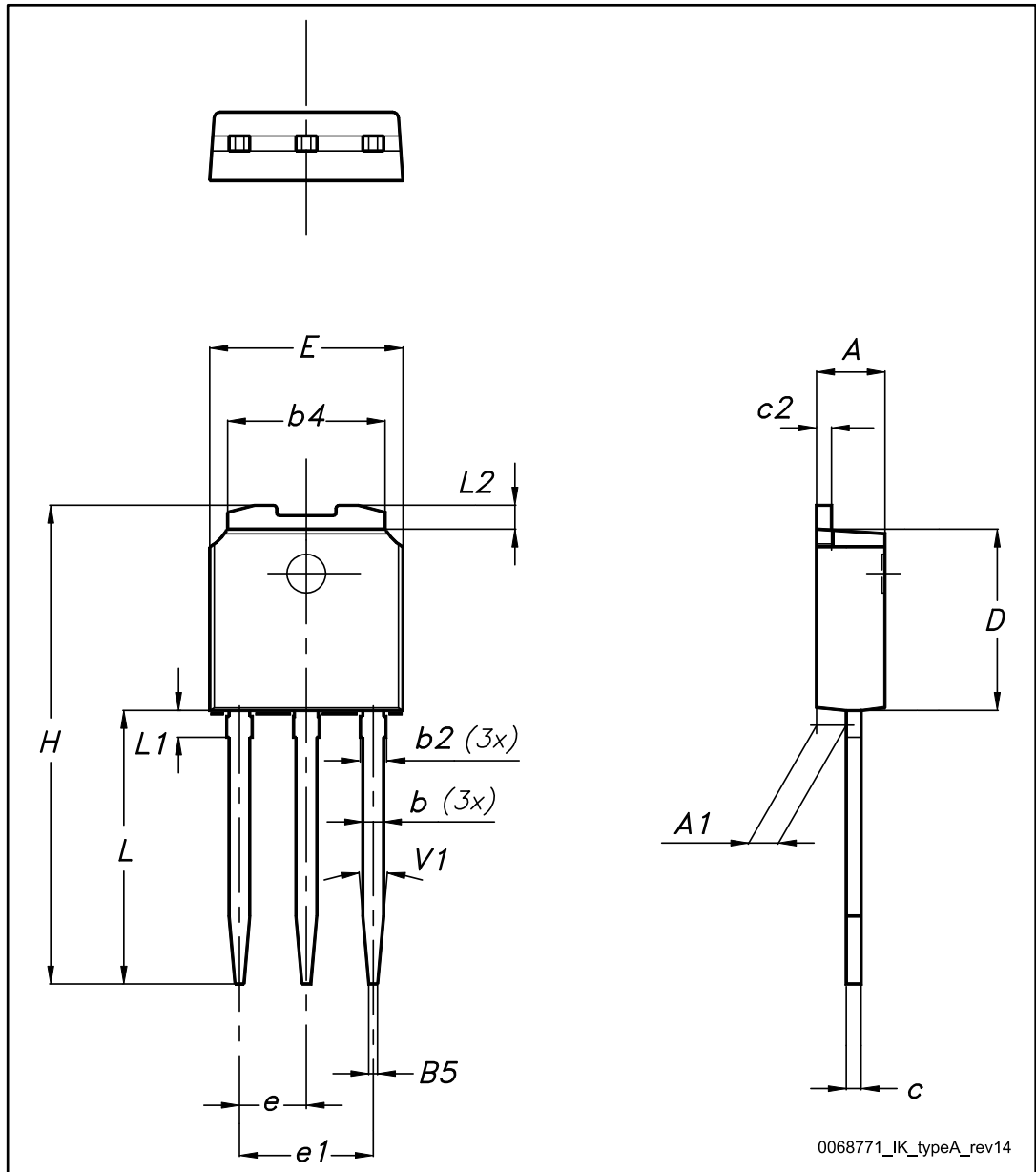
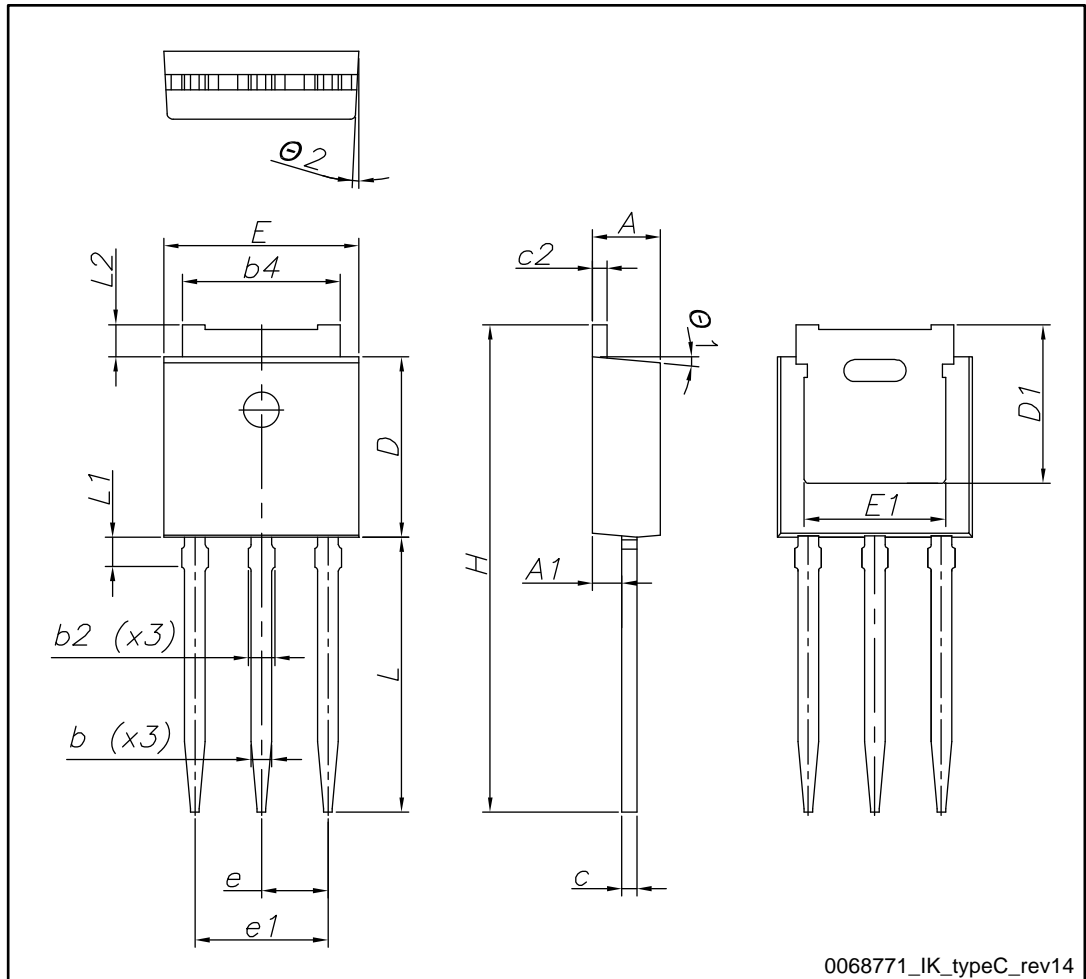


Table 14: IPAK (TO-251) type A package mechanical data

| 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° | |

4.7 IPAK (TO-251) type C package information

Figure 30: IPAK (TO-251) type C package outline



0068771_IK_typeC_rev14

Table 15: IPAK (TO-251) type C package mechanical data

| Dim. | mm | | |
|------|-------|-------|-------|
| | Min. | Typ. | Max. |
| A | 2.20 | 2.30 | 2.35 |
| A1 | 0.90 | 1.00 | 1.10 |
| b | 0.66 | | 0.79 |
| b2 | | | 0.90 |
| b4 | 5.23 | 5.33 | 5.43 |
| c | 0.46 | | 0.59 |
| c2 | 0.46 | | 0.59 |
| D | 6.00 | 6.10 | 6.20 |
| D1 | 5.20 | 5.37 | 5.55 |
| E | 6.50 | 6.60 | 6.70 |
| E1 | 4.60 | 4.78 | 4.95 |
| e | 2.20 | 2.25 | 2.30 |
| e1 | 4.40 | 4.50 | 4.60 |
| H | 16.18 | 16.48 | 16.78 |
| L | 9.00 | 9.30 | 9.60 |
| L1 | 0.80 | 1.00 | 1.20 |
| L2 | 0.90 | 1.08 | 1.25 |
| θ1 | 3° | 5° | 7° |
| θ2 | 1° | 3° | 5° |

4.8 D²PAK and DPAK packing information

Figure 31: Tape outline

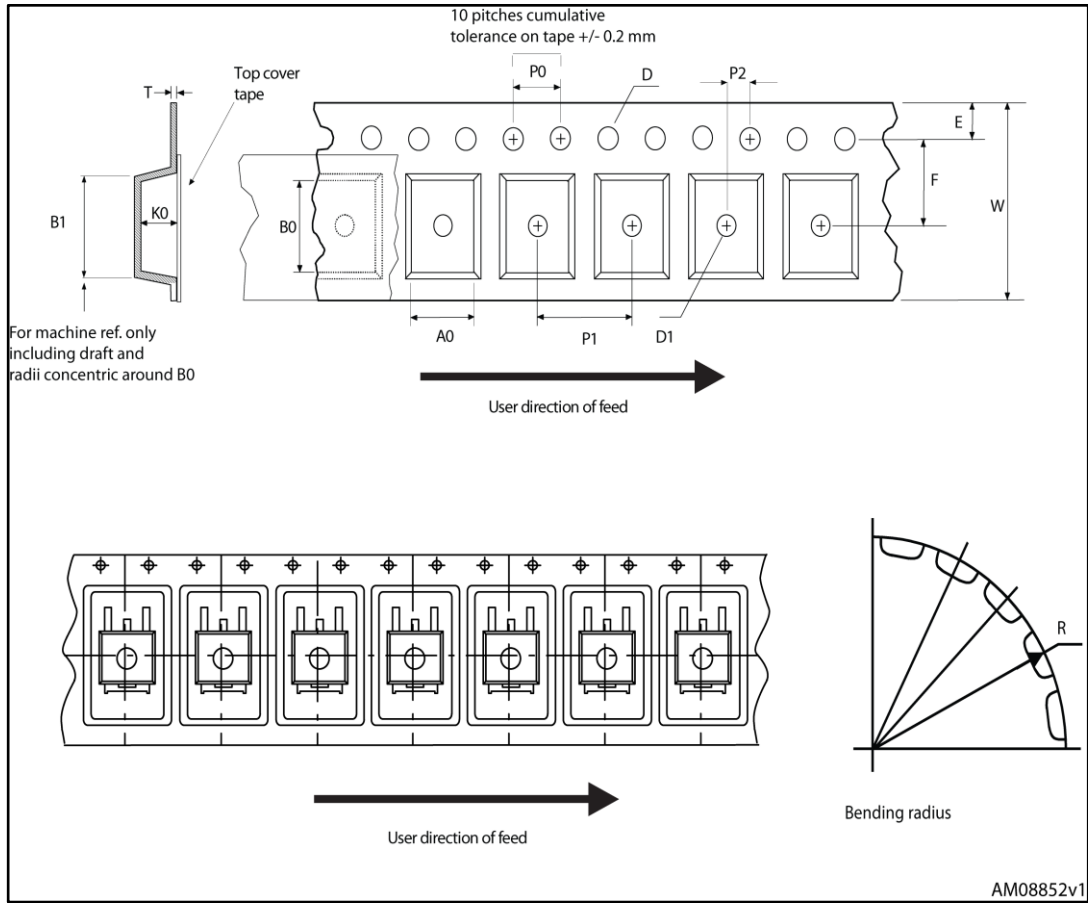
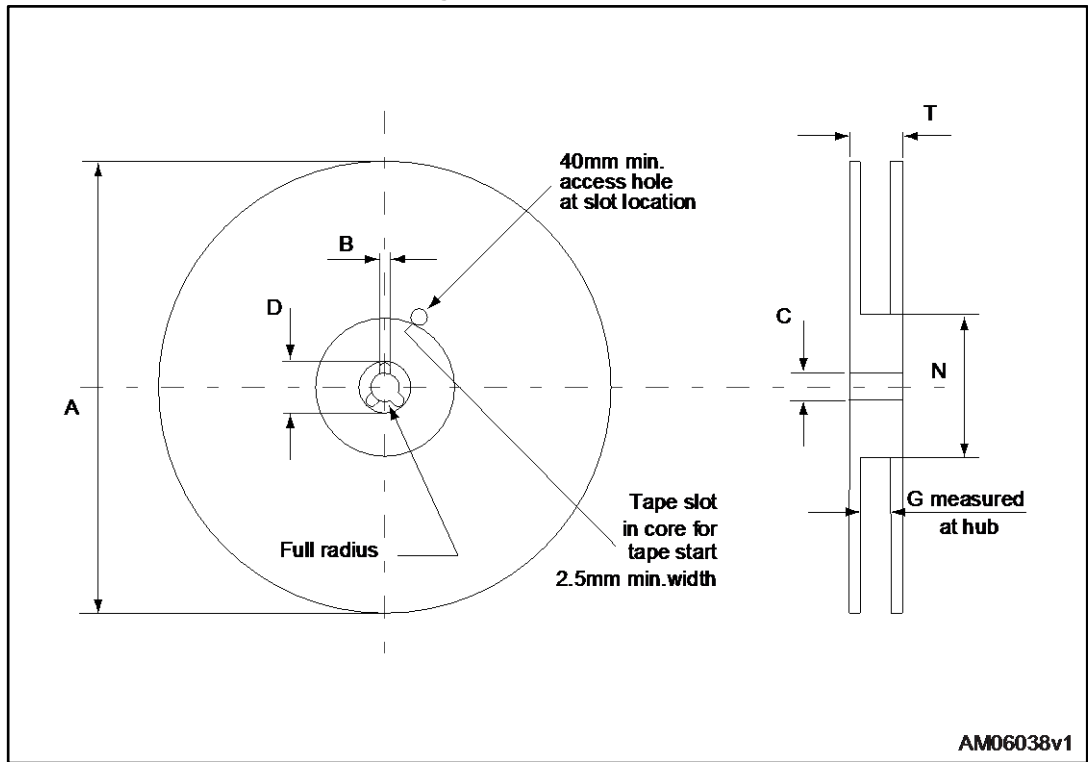


Figure 32: Reel outline



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Table 16: D²PAK 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 quantity | | 1000 |
| P2 | 1.9 | 2.1 | Bulk quantity | | 1000 |
| R | 50 | | | | |
| T | 0.25 | 0.35 | | | |
| W | 23.7 | 24.3 | | | |

Table 17: DPAK 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 | | | |

5 Revision history

Table 18: Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 29-May-2013 | 1 | First release. |
| 06-Dec-2013 | 2 | <ul style="list-style-type: none"> – Added: D²PAK package – Modified: title and R_{DS(on)} values in cover page – Modified: R_{DS(on)} values in <i>Table 5</i> – Modified: R_G value in <i>Table 6</i> – Modified: <i>Figure 9</i> and I_D value in <i>Figure 12</i> – Added: <i>Table 9, 13, Figure 22 and 23</i> – Updated: <i>Table 10, 11, Figure 24, 25 and 26</i> – Minor text changes |
| 13-Mar-2017 | 3 | <p>Updated the title and the description in cover page. Updated Table 4: "Avalanche characteristics". Updated Section 4.2: "DPAK (TO-252) type A package information". Added Section 4.4: "DPAK (TO-252) type E package information" and Section 4.7: "IPAK (TO-251) type C package information". Minor text changes.</p> |

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