

N-channel 800 V, 3.8 Ω typ., 2.5 A SuperMESH™
Power MOSFETs in IPAK, DPAK, TO-220FP, TO-220 packages

Datasheet - production data

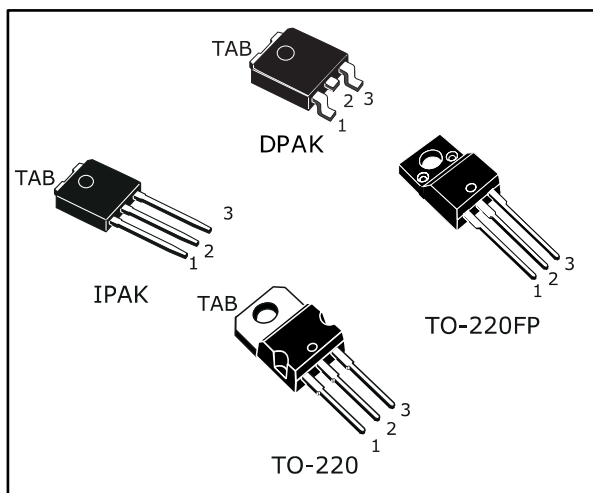
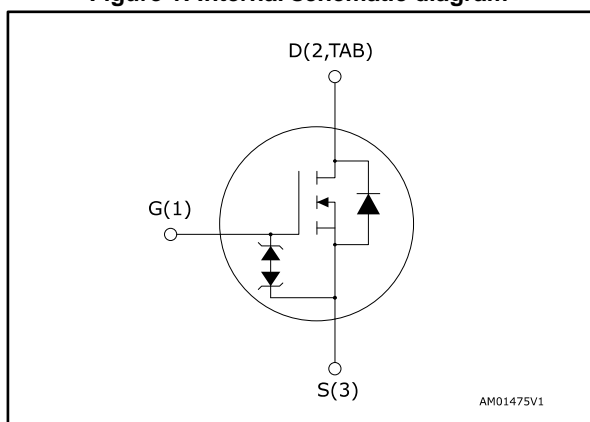


Figure 1: Internal schematic diagram



Features

| Order code | V _{DS} | R _{DS(on)} max. | I _D |
|-------------|-----------------|--------------------------|----------------|
| STD3NK80Z-1 | 800 V | 4.5 Ω | 2.5 A |
| STD3NK80ZT4 | 800 V | 4.5 Ω | 2.5 A |
| STF3NK80Z | 800 V | 4.5 Ω | 2.5 A |
| STP3NK80Z | 800 V | 4.5 Ω | 2.5 A |

- Extremely high dv/dt capability
- 100% avalanche tested
- Gate charge minimized
- Zener-protected

Applications

- Switching applications

Description

These high voltage devices are Zener-protected N-channel Power MOSFETs developed using the SuperMESH™ technology by STMicroelectronics, an optimization of the well-established PowerMESH™. In addition to a significant reduction in on-resistance, these devices are designed to ensure a high level of dv/dt capability for the most demanding applications. Such series complements ST's full range of high voltage MOSFETs including the revolutionary MDmesh™ products.

Table 1: Device summary

| Order code | Marking | Package | Packaging |
|-------------|---------|----------|---------------|
| STD3NK80Z-1 | D3NK80Z | IPAK | Tube |
| STD3NK80ZT4 | D3NK80Z | DPAK | Tape and reel |
| STF3NK80Z | F3NK80Z | TO-220FP | Tube |
| STP3NK80Z | P3NK80Z | TO-220 | Tube |

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1 Electrical ratings

Table 2: Absolute maximum ratings

| Symbol | Parameter | Value | | Unit |
|--------------------------------|--|--------------------------|---------------------|------|
| | | TO-220, DPAK, IPAK | TO-220FP | |
| V _{DS} | Drain-source voltage | 800 | | V |
| V _{GS} | Gate-source voltage | ±30 | | V |
| I _D | Drain current (continuous) at T _C = 25 °C | 2.5 | 2.5 ⁽¹⁾ | A |
| | Drain current (continuous) at T _C = 100 °C | 1.57 | 1.57 ⁽¹⁾ | A |
| I _{DM} ⁽²⁾ | Drain current (pulsed) | 10 | 10 ⁽¹⁾ | A |
| P _{TOT} | Total dissipation at T _C = 25 °C | 70 | 25 | W |
| ESD | Gate-source, human body model, R = 1.5 kΩ, C = 100 pF | 2 | | kV |
| dv/dt ⁽³⁾ | Peak diode recovery voltage slope | 4.5 | | V/ns |
| V _{ISO} | Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s, T _C = 25 °C) | | 2.5 | kV |
| T _{stg} | Storage temperature range | -55 to 150 | | °C |
| T _j | Operation junction temperature range | | | |

Notes:

⁽¹⁾This value is limited by package.

⁽²⁾Pulse width is limited by safe operating area.

⁽³⁾I_{SD} ≤ 2.5 A, di/dt ≤ 200 A/μs, V_{DS(peak)} < V_{(BR)DSS}, V_{DD} = 640 V

Table 3: Thermal data

| Symbol | Parameter | Value | | | | Unit |
|-------------------------------------|-------------------------------------|--------|----------|------|------|------|
| | | TO-220 | TO-220FP | DPAK | IPAK | |
| R _{thj-case} | Thermal resistance junction-case | 1.78 | 5 | 1.78 | | °C/W |
| R _{thj-amb} | Thermal resistance junction-ambient | 62.5 | | | 100 | °C/W |
| R _{thj-pcb} ⁽¹⁾ | Thermal resistance junction-pcb | | | 50 | | °C/W |

Notes:

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

Table 4: Avalanche characteristics

| Symbol | Parameter | Value | Unit |
|-----------------|--|-------|------|
| I _{AR} | Avalanche current, repetitive or non-repetitive (pulse width limited by T _{J max}) | 2.5 | A |
| E _{AS} | Single pulse avalanche energy (starting T _J = 25 °C, I _D = I _{AR} , V _{DD} = 50 V) | 170 | 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 | $V_{GS} = 0\text{ V}$, $I_D = 1\text{ mA}$ | 800 | | | V |
| I_{DSS} | Zero gate voltage drain current | $V_{GS} = 0\text{ V}$, $V_{DS} = 800\text{ V}$ | | | 1 | μA |
| | | $V_{GS} = 0\text{ V}$, $V_{DS} = 800\text{ V}$, $T_C = 125\text{ °C}^{(1)}$ | | | 50 | μA |
| I_{GSS} | Gate-body leakage current | $V_{DS} = 0\text{ V}$, $V_{GS} = \pm 20\text{ V}$ | | | ± 10 | μA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS} = V_{GS}$, $I_D = 50\text{ }\mu\text{A}$ | 3 | 3.75 | 4.5 | V |
| $R_{DS(on)}$ | Static drain-source on- resistance | $V_{GS} = 10\text{ V}$, $I_D = 1.25\text{ A}$ | | 3.8 | 4.5 | 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 | $V_{GS} = 0\text{ V}$, $V_{DS} = 25\text{ V}$, $f = 1\text{ MHz}$ | - | 485 | - | pF |
| C_{oss} | Output capacitance | | - | 57 | - | pF |
| C_{rss} | Reverse transfer capacitance | | - | 11 | - | pF |
| $C_{oss\ eq}^{(1)}$ | Equivalent output capacitance | $V_{GS} = 0\text{ V}$, $V_{DS} = 0\text{ to }640\text{ V}$ | - | 22 | - | pF |
| Q_g | Total gate charge | $V_{DD} = 640\text{ V}$, $I_D = 2.5\text{ A}$, $V_{GS} = 0\text{ to }10\text{ V}$ (see Figure 17: "Test circuit for gate charge behavior") | - | 19 | - | nC |
| Q_{gs} | Gate-source charge | | - | 3.2 | - | nC |
| Q_{gd} | Gate-drain charge | | - | 10.8 | - | nC |

Notes:

⁽¹⁾ $C_{oss\ eq}$ is defined as a constant equivalent capacitance giving the same charging time as C_{oss} when V_{DS} increases from 0 to 80%

Table 7: Switching times

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------------|---------------------|--|------|------|------|------|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD} = 400\text{ V}$, $I_D = 1.25\text{ A}$, $R_G = 4.7\text{ }\Omega$, $V_{GS} = 10\text{ V}$ (see Figure 16: "Test circuit for resistive load switching times" and Figure 21: "Switching time waveform") | - | 17 | - | ns |
| t_r | Rise time | | - | 27 | - | ns |
| $t_{d(off)}$ | Turn-off delay time | | - | 36 | - | ns |
| t_f | Fall time | | - | 40 | - | ns |

Table 8: Source drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|---|------|------|------|---------------|
| I_{SD} | Source-drain current | | - | | 2.5 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | - | | 10 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD} = 2.5 \text{ A}$, $V_{GS} = 0 \text{ V}$ | - | | 1.6 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 2.5 \text{ A}$, $di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 50 \text{ V}$ (see <i>Figure 18: "Test circuit for inductive load switching and diode recovery times"</i>) | - | 384 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 1.6 | | μC |
| I_{RRM} | Reverse recovery current | | - | 8.4 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 2.5 \text{ A}$, $di/dt = 100 \text{ A}/\mu\text{s}$, $V_{DD} = 50 \text{ V}$, $T_J = 150 \text{ }^\circ\text{C}$ (see <i>Figure 18: "Test circuit for inductive load switching and diode recovery times"</i>) | - | 474 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 2.1 | | μC |
| I_{RRM} | Reverse recovery current | | - | 8.8 | | A |

Notes:

(1) Pulsed: pulse duration = 300 μs , duty cycle 1.5%.

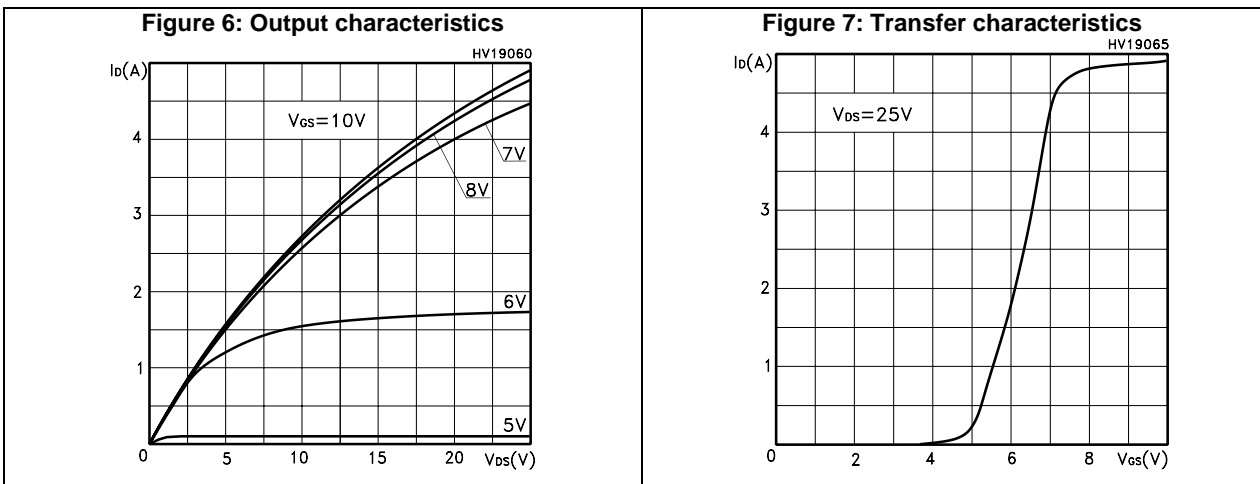
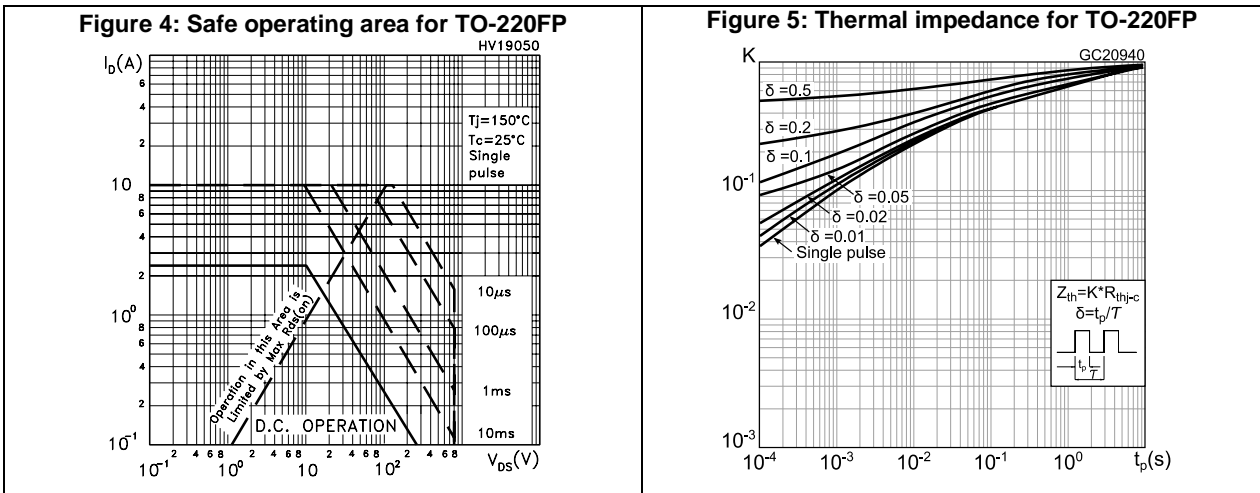
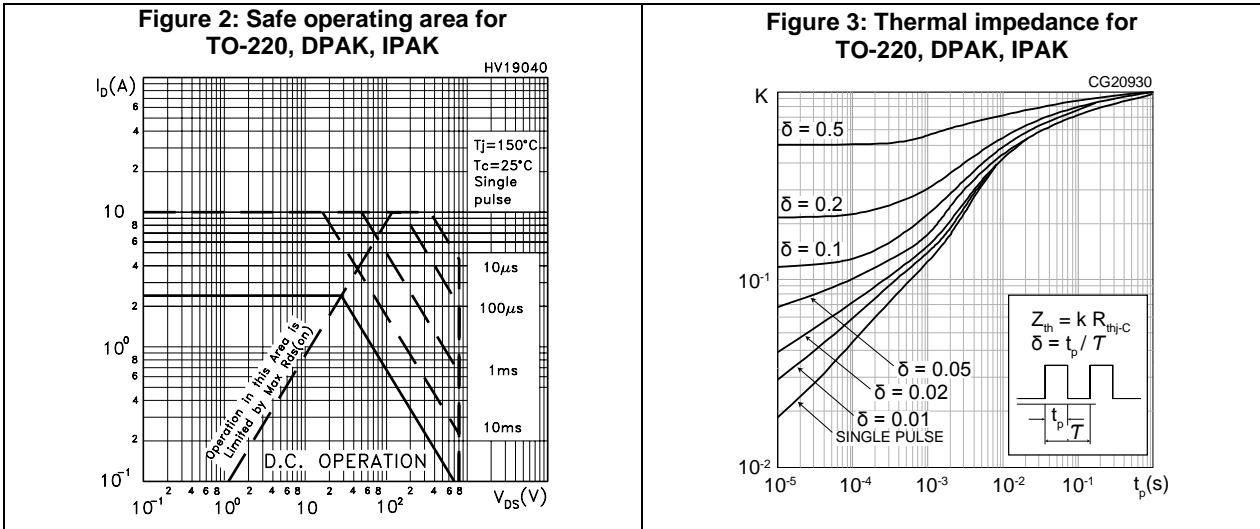
(2) Pulse width is limited by safe operating area.

Table 9: Gate-source Zener diode

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

The built-in back-to-back Zener diodes are specifically designed to enhance the ESD performance of the device. The Zener voltage facilitates efficient and cost-effective device integrity protection, thus eliminating the need for additional external componentry.

2.1 Electrical characteristics (curves)



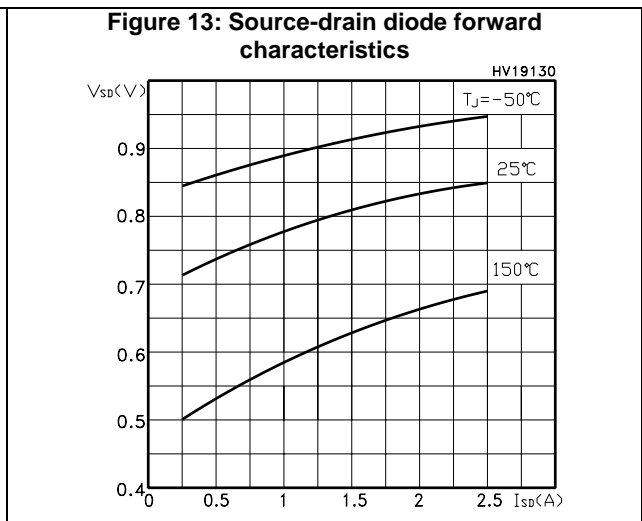
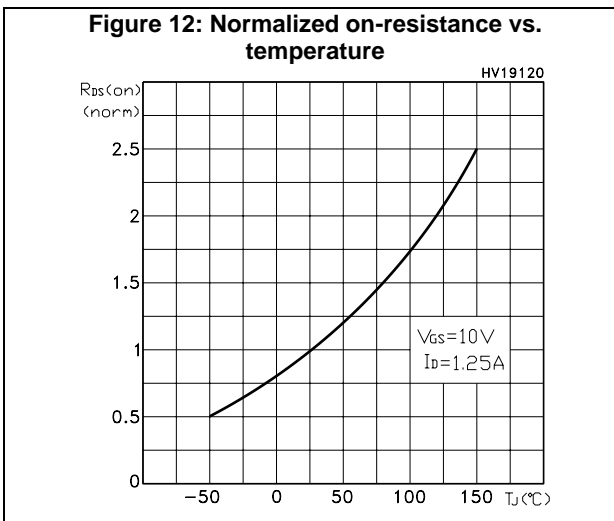
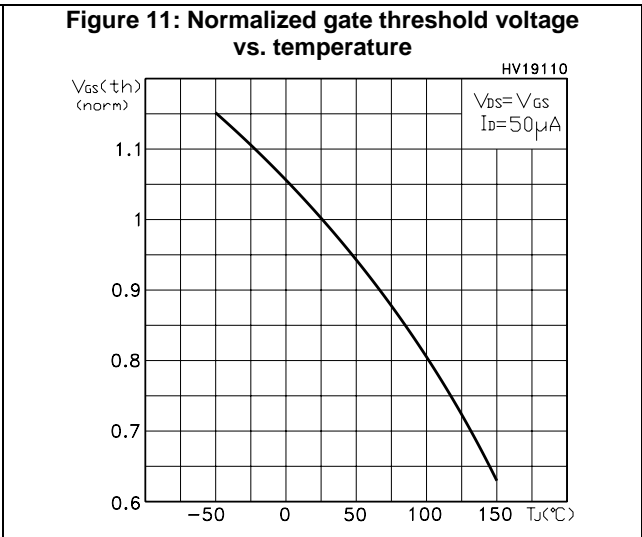
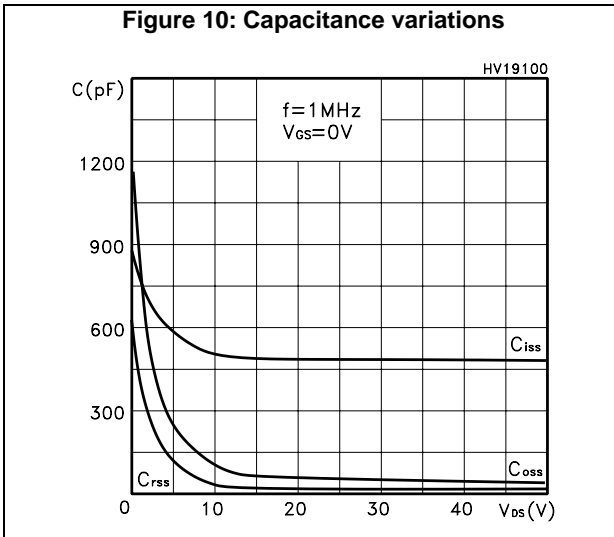
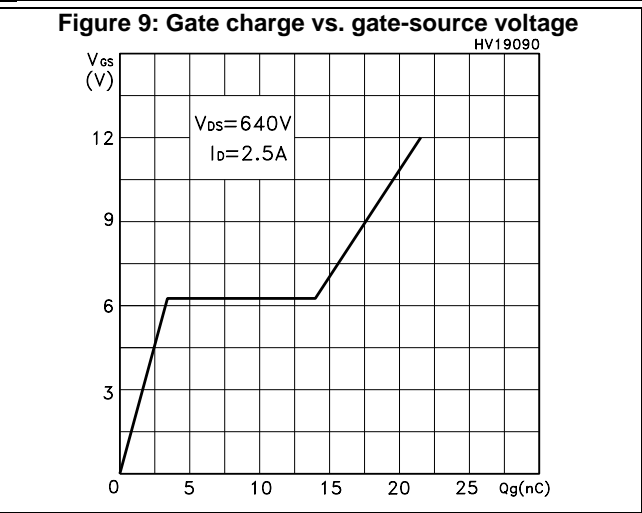
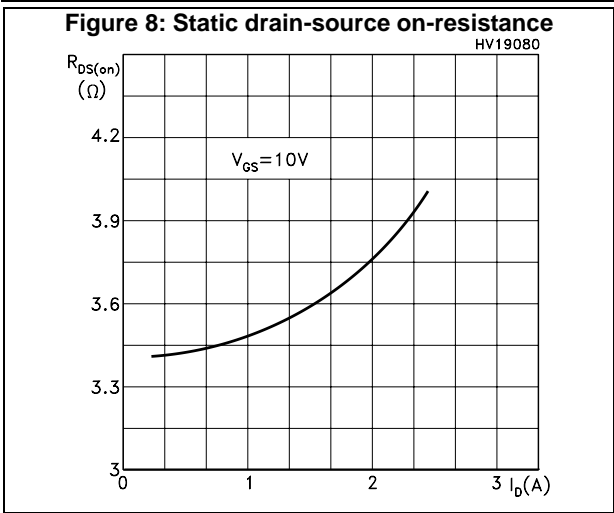


Figure 14: Normalized $V_{(BR)DSS}$ vs. temperature

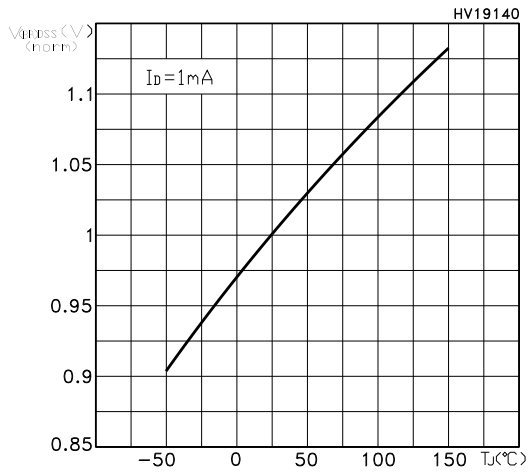
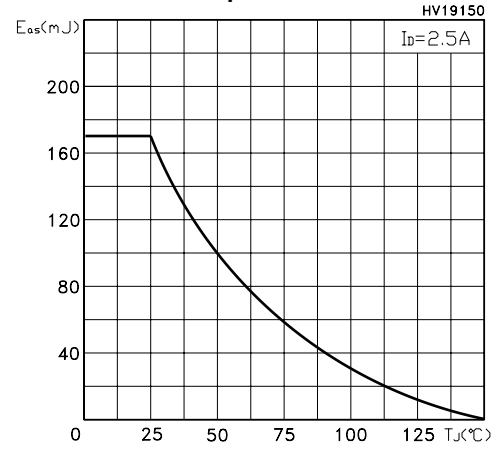
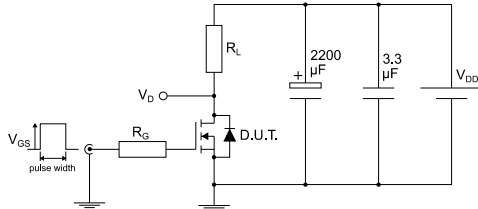


Figure 15: Maximum avalanche energy vs. temperature



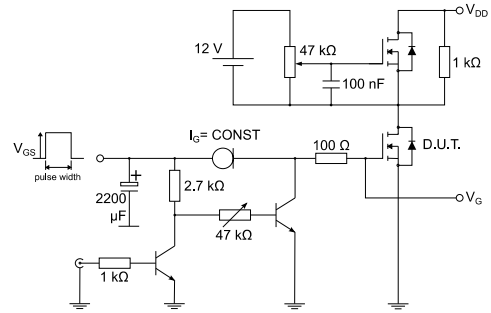
3 Test circuits

Figure 16: Test circuit for resistive load switching times



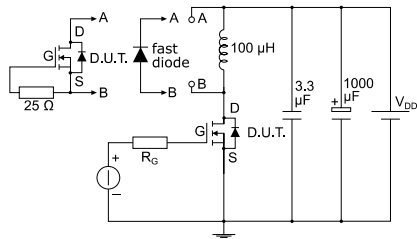
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Figure 17: Test circuit for gate charge behavior



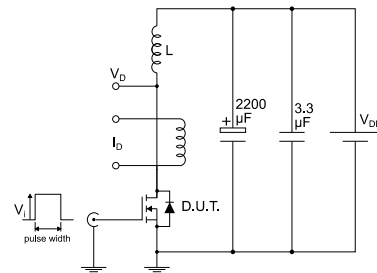
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Figure 18: Test circuit for inductive load switching and diode recovery times



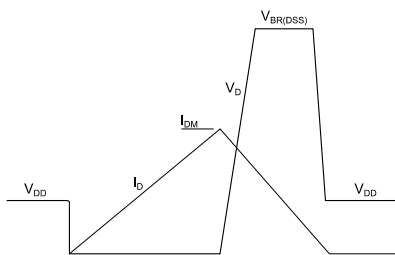
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Figure 19: Unclamped inductive load test circuit



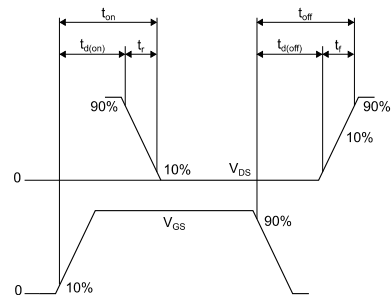
AM01471v1

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 IPAK (TO-251) type A package information

Figure 22: IPAK (TO-251) type A package outline

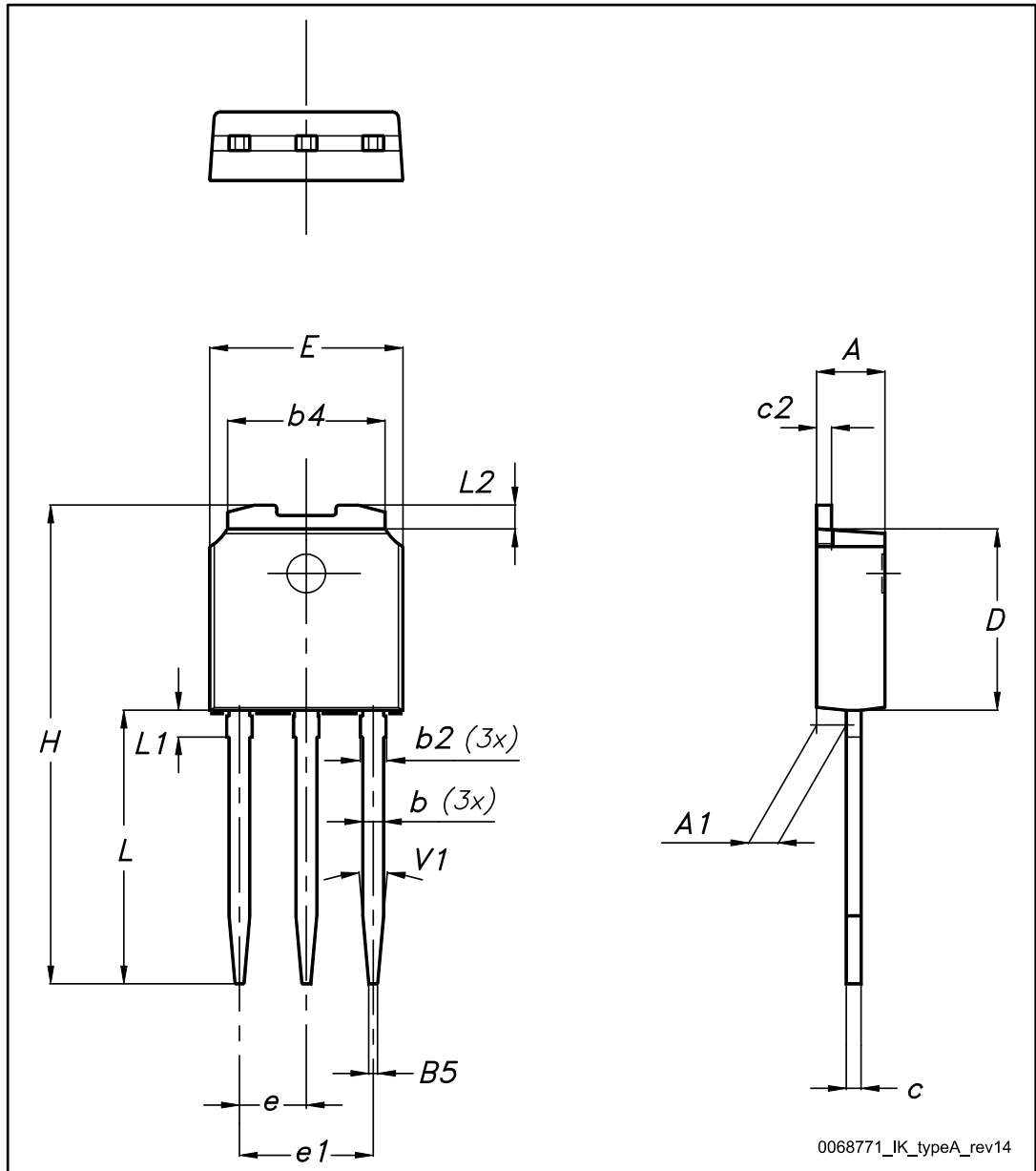


Table 10: IPAK (TO-251) type A package mechanical data

| 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° | |

4.2 DPAK package information

4.2.1 DPAK (TO-252) type A package information

Figure 23: DPAK (TO-252) type A package outline

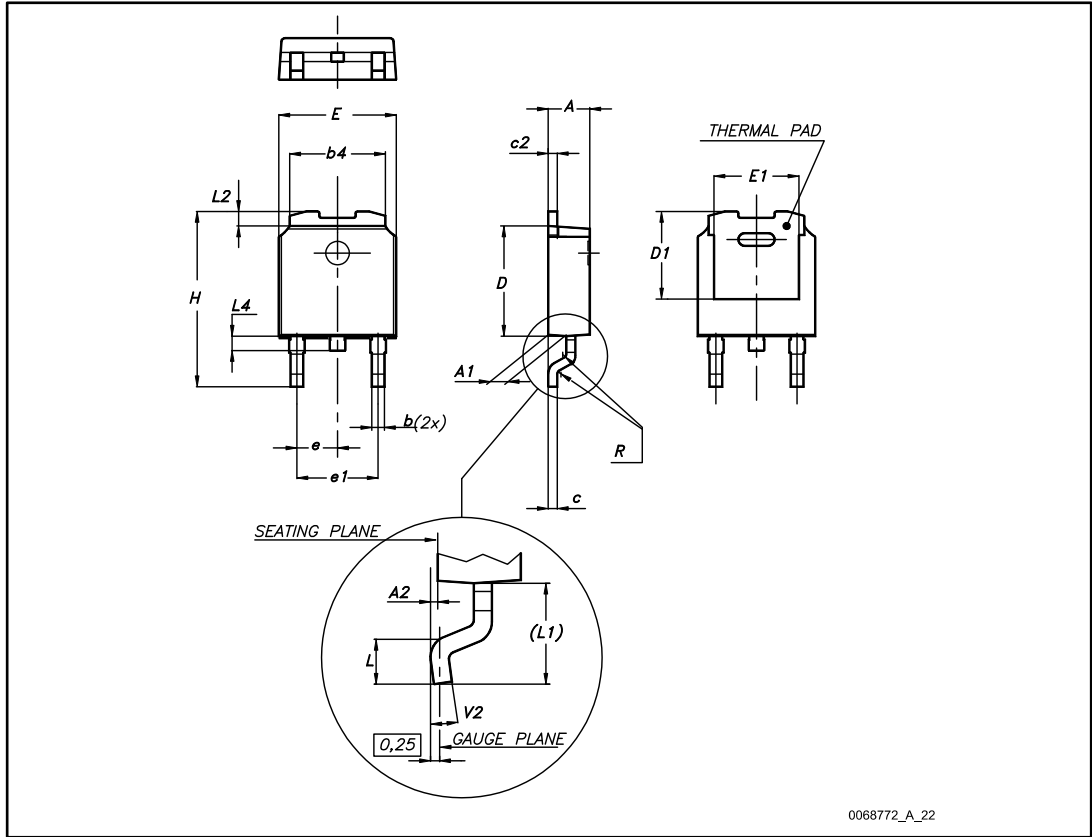
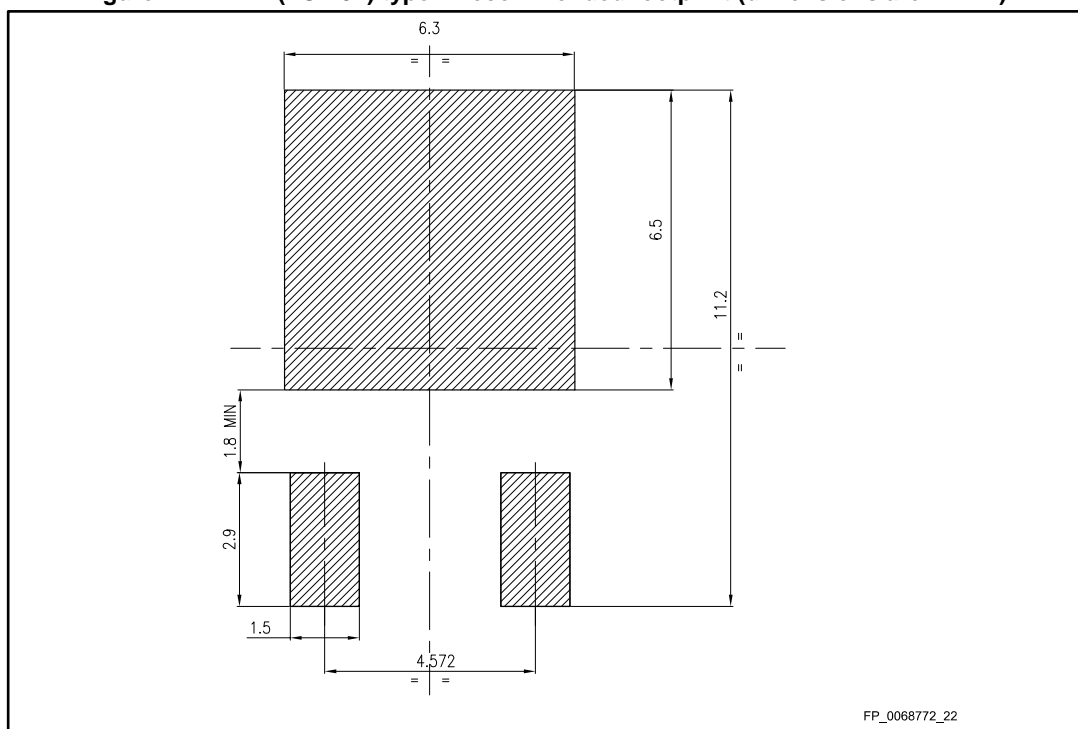


Table 11: DPAK (TO-252) type A mechanical data

| 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° |

Figure 24: DPAK (TO-252) type A recommended footprint (dimensions are in mm)



4.2.2 DPAK (TO-252) type C2 package information

Figure 25: DPAK (TO-252) type C2 package outline

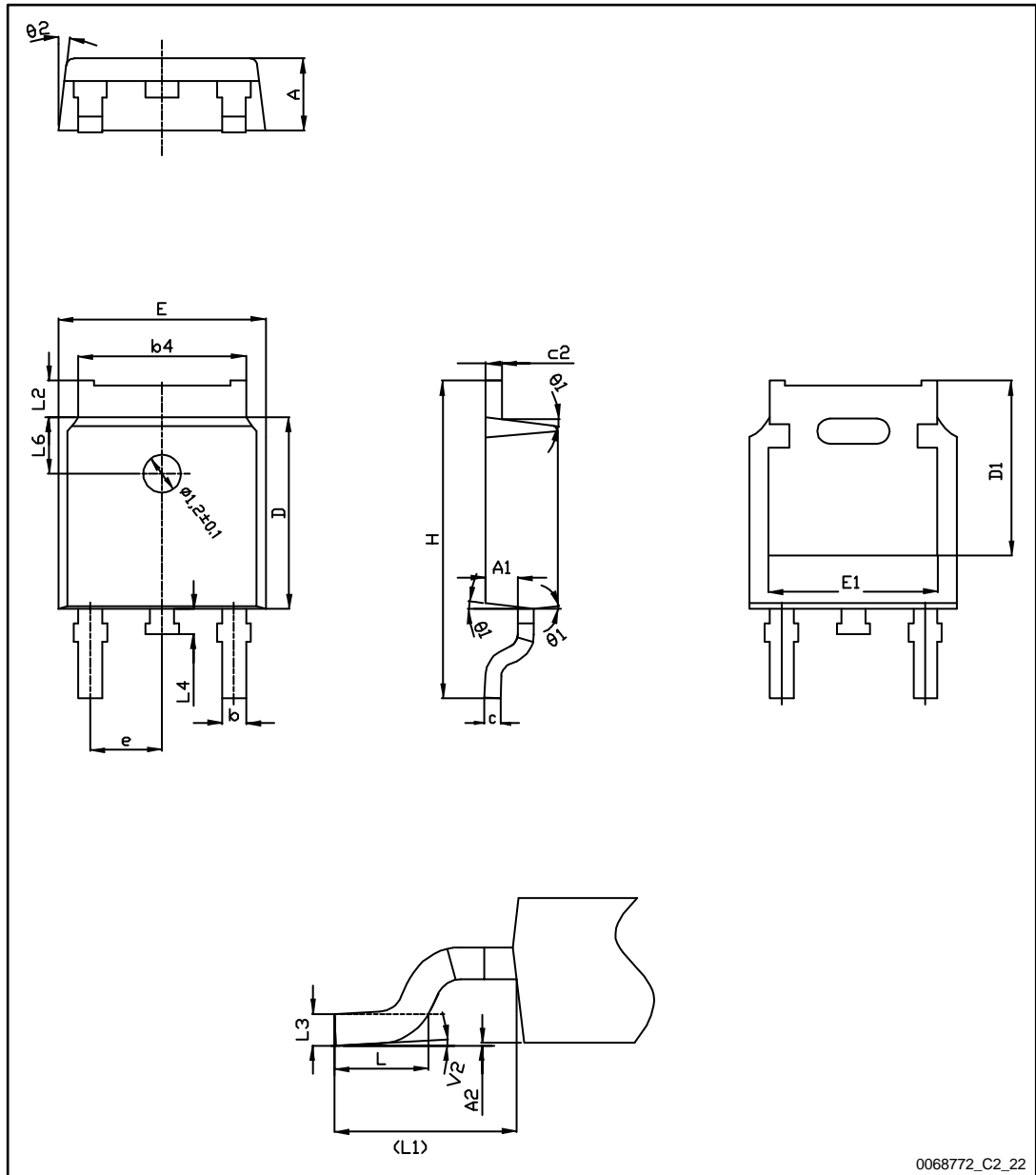
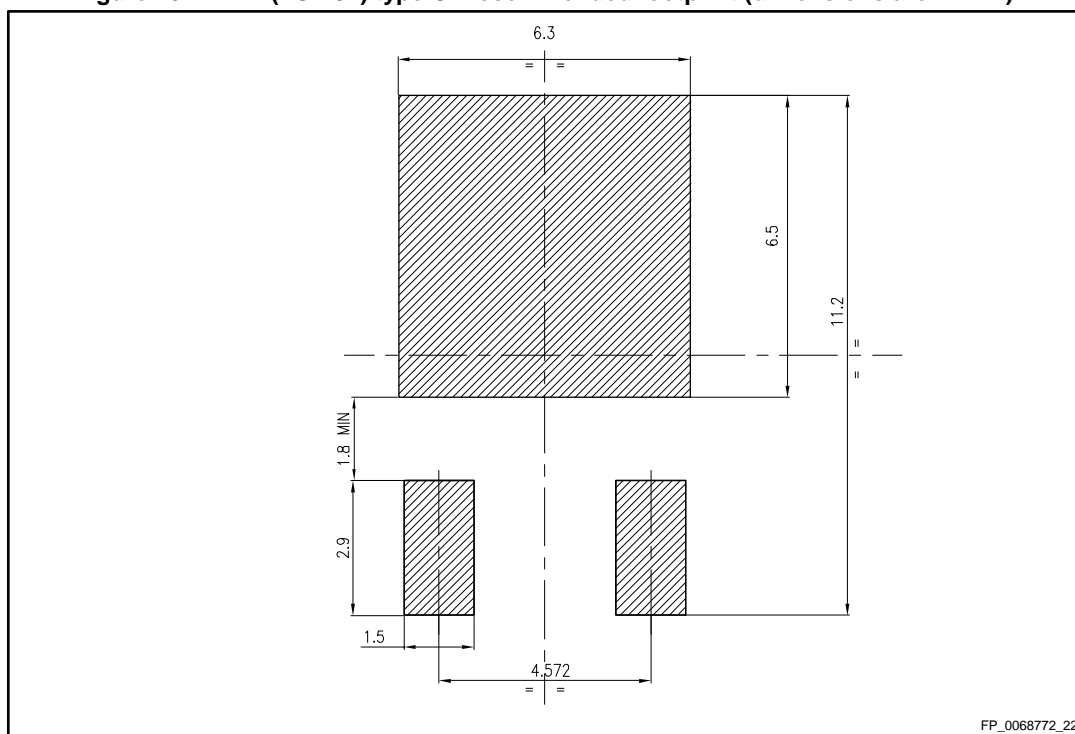


Table 12: DPAK (TO-252) type C2 mechanical data

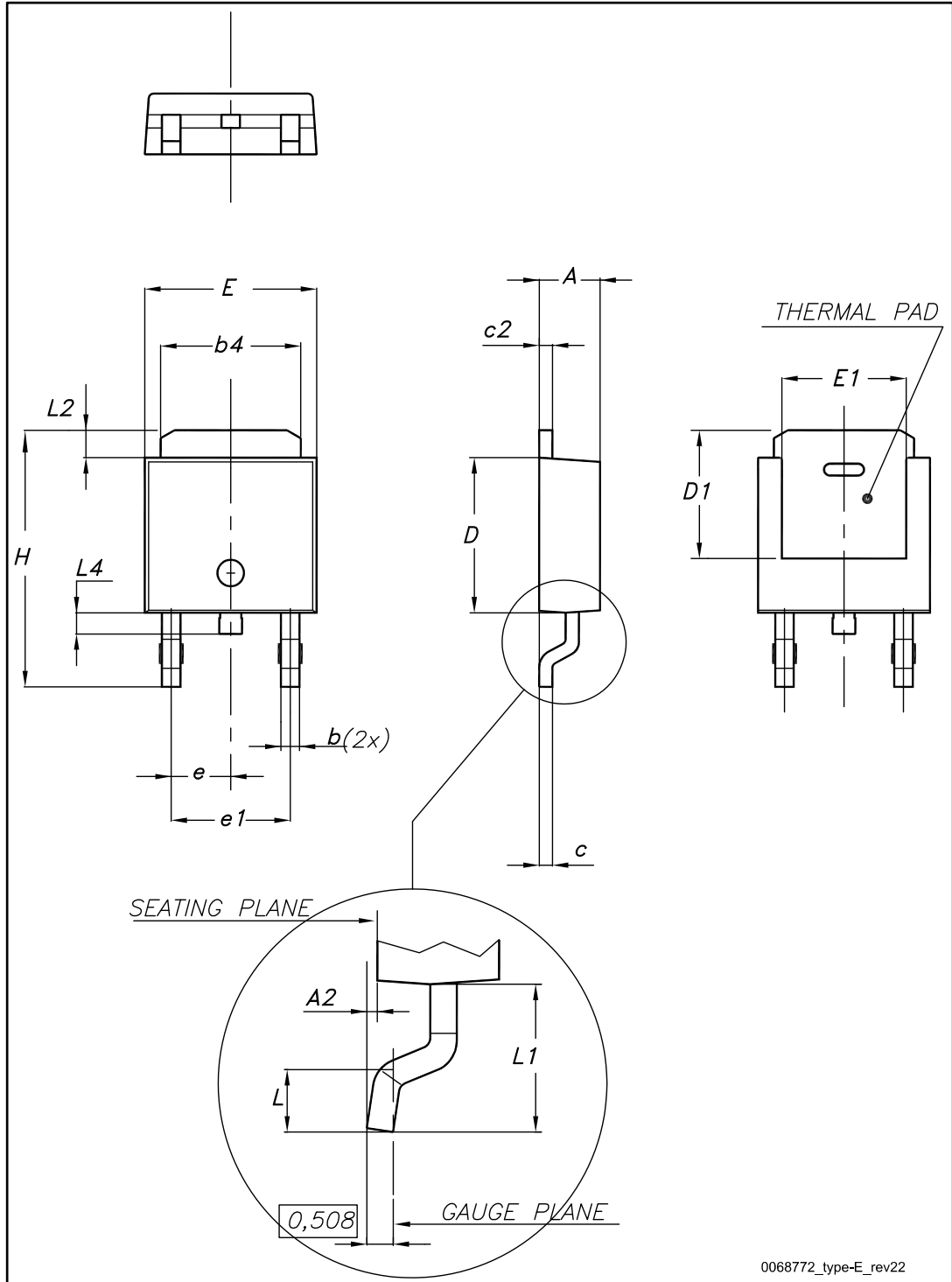
| Dim. | mm | | |
|------|----------|-------|-------|
| | Min. | Typ. | Max. |
| A | 2.20 | 2.30 | 2.38 |
| A1 | 0.90 | 1.01 | 1.10 |
| A2 | 0.00 | | 0.10 |
| b | 0.72 | | 0.85 |
| b4 | 5.13 | 5.33 | 5.46 |
| c | 0.47 | | 0.60 |
| c2 | 0.47 | | 0.60 |
| D | 6.00 | 6.10 | 6.20 |
| D1 | 5.10 | | 5.60 |
| E | 6.50 | 6.60 | 6.70 |
| E1 | 5.20 | | 5.50 |
| 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° |

Figure 26: DPAK (TO-252) type C2 recommended footprint (dimensions are in mm)



4.2.3 DPAK (TO-252) type E package information

Figure 27: DPAK (TO-252) type E package outline

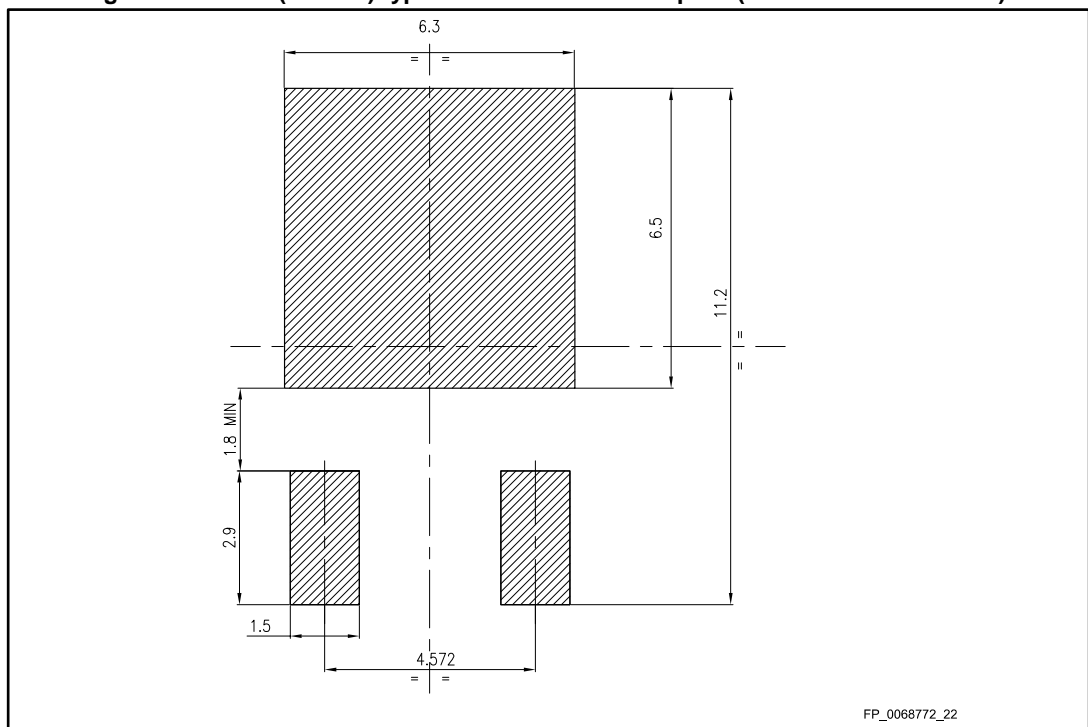


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Table 13: DPAK (TO-252) type E mechanical data

| 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 28: DPAK (TO-252) type E recommended footprint (dimensions are in mm)



4.2.4 DPAK (TO-252) packing information

Figure 29: DPAK (TO-252) tape outline

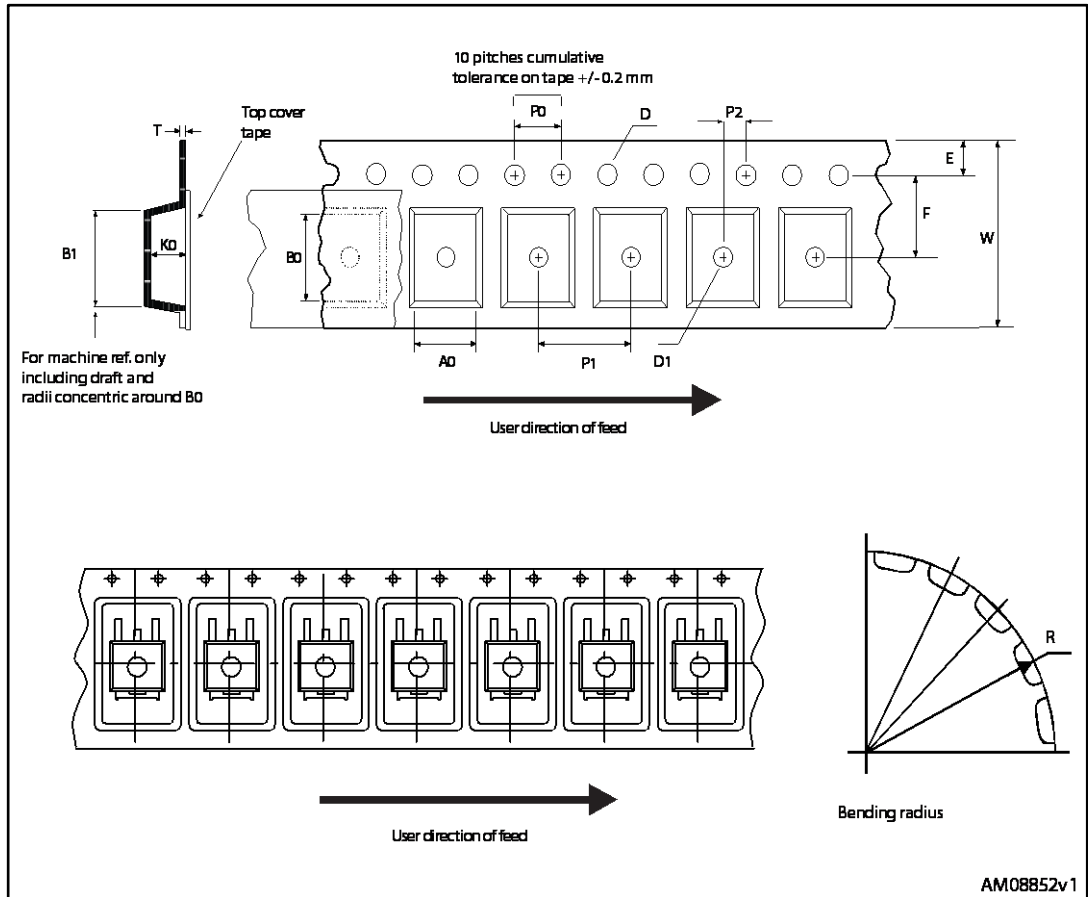
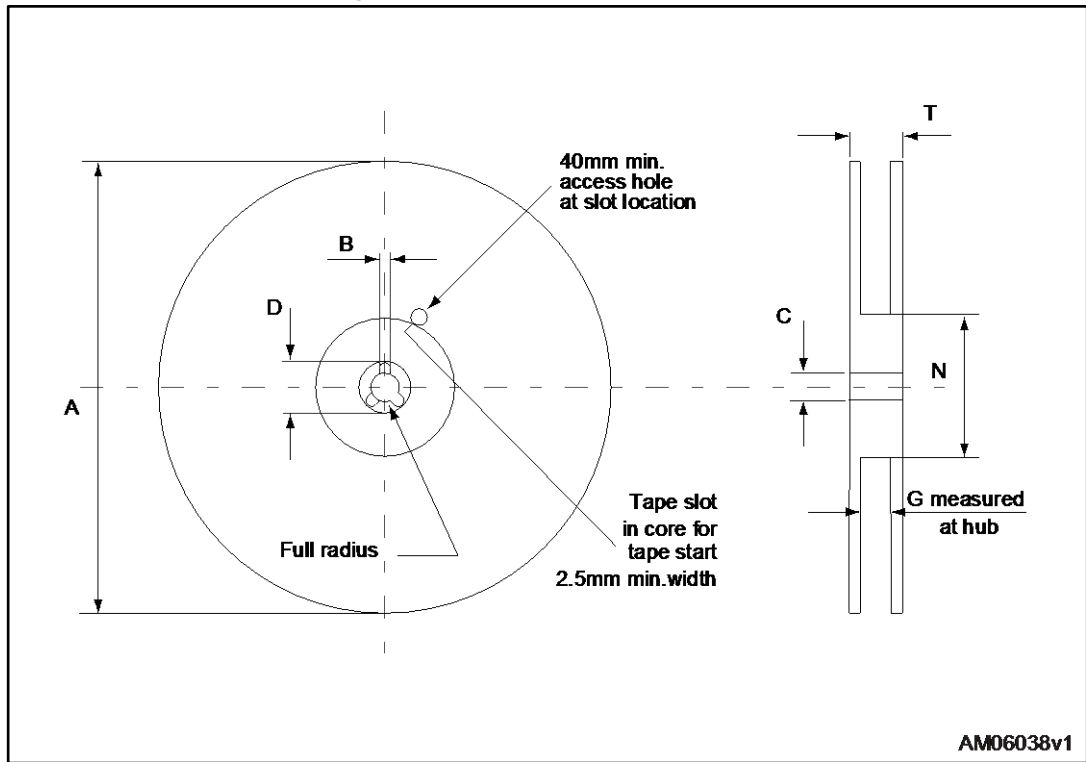


Figure 30: DPAK (TO-252) reel outline



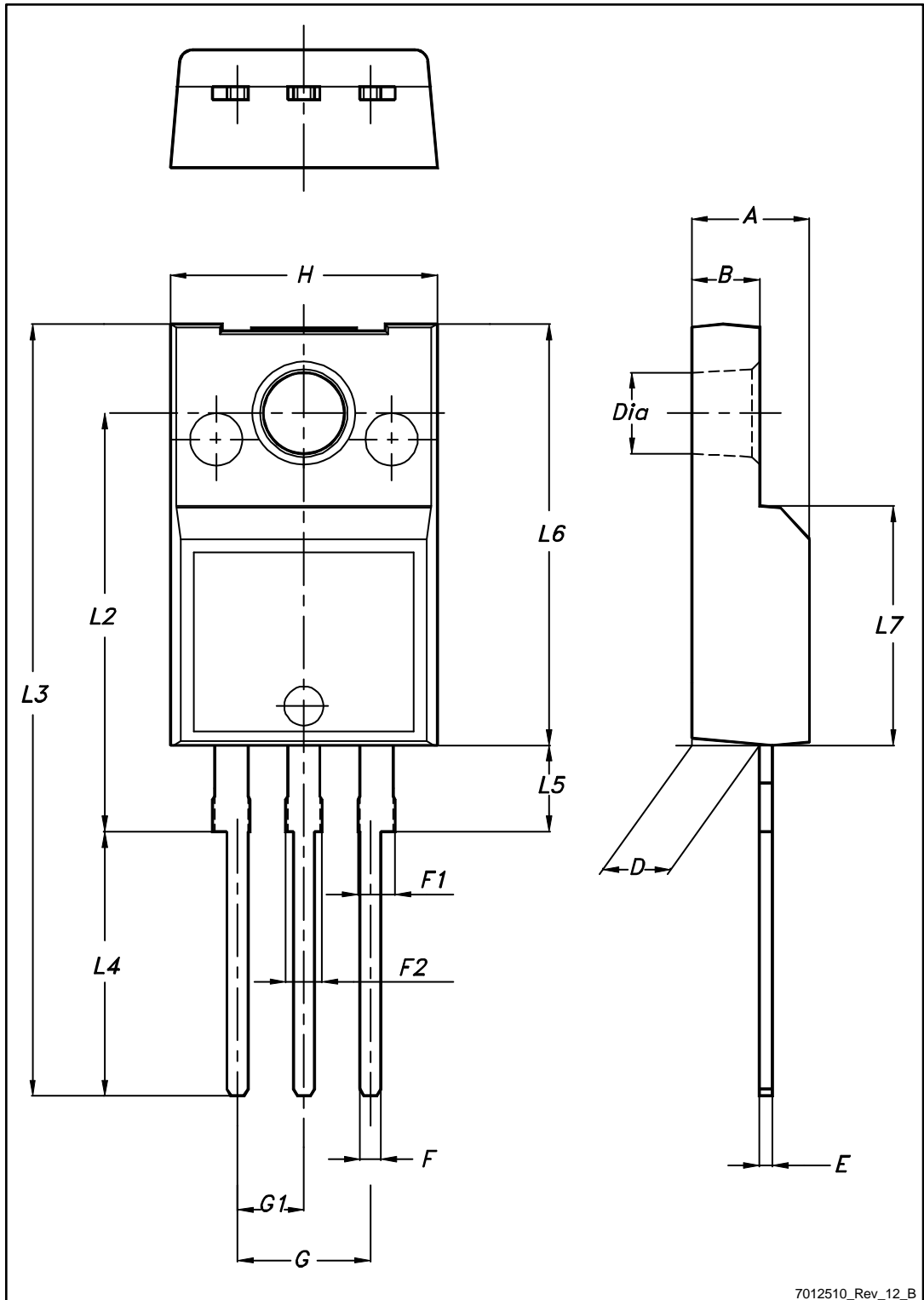
AM06038v1

Table 14: 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 | | | |

4.3 TO-220FP package information

Figure 31: TO-220FP package outline



7012510_Rev_12_B

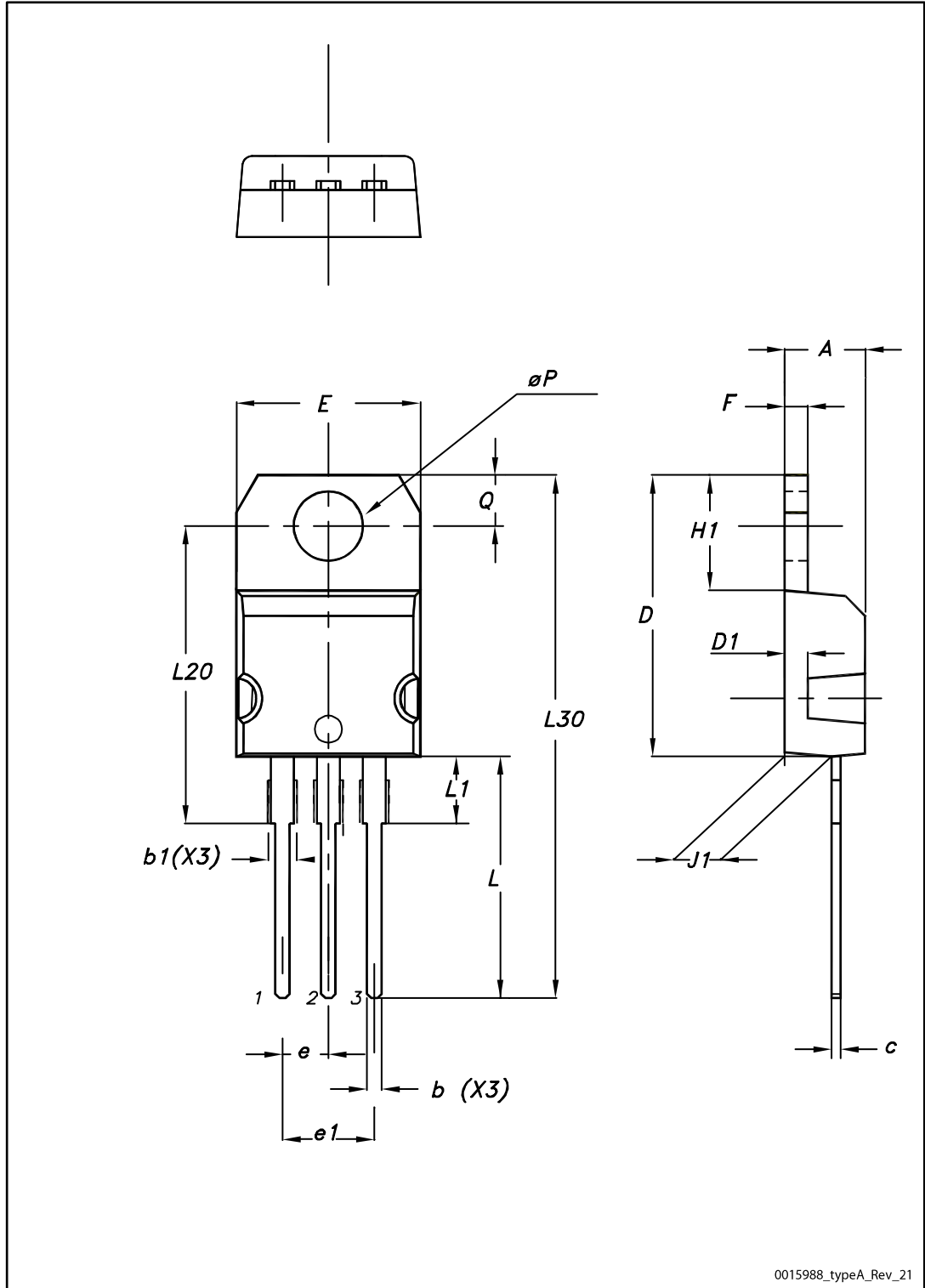
Table 15: TO-220FP package mechanical data

| 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 |

4.4 TO-220 package information

4.4.1 TO-220 type A package information

Figure 32: TO-220 type A package outline



0015988_typeA_Rev_21

Table 16: 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 |

4.4.2 TO-220 type H package information

Figure 33: TO-220 type H package outline

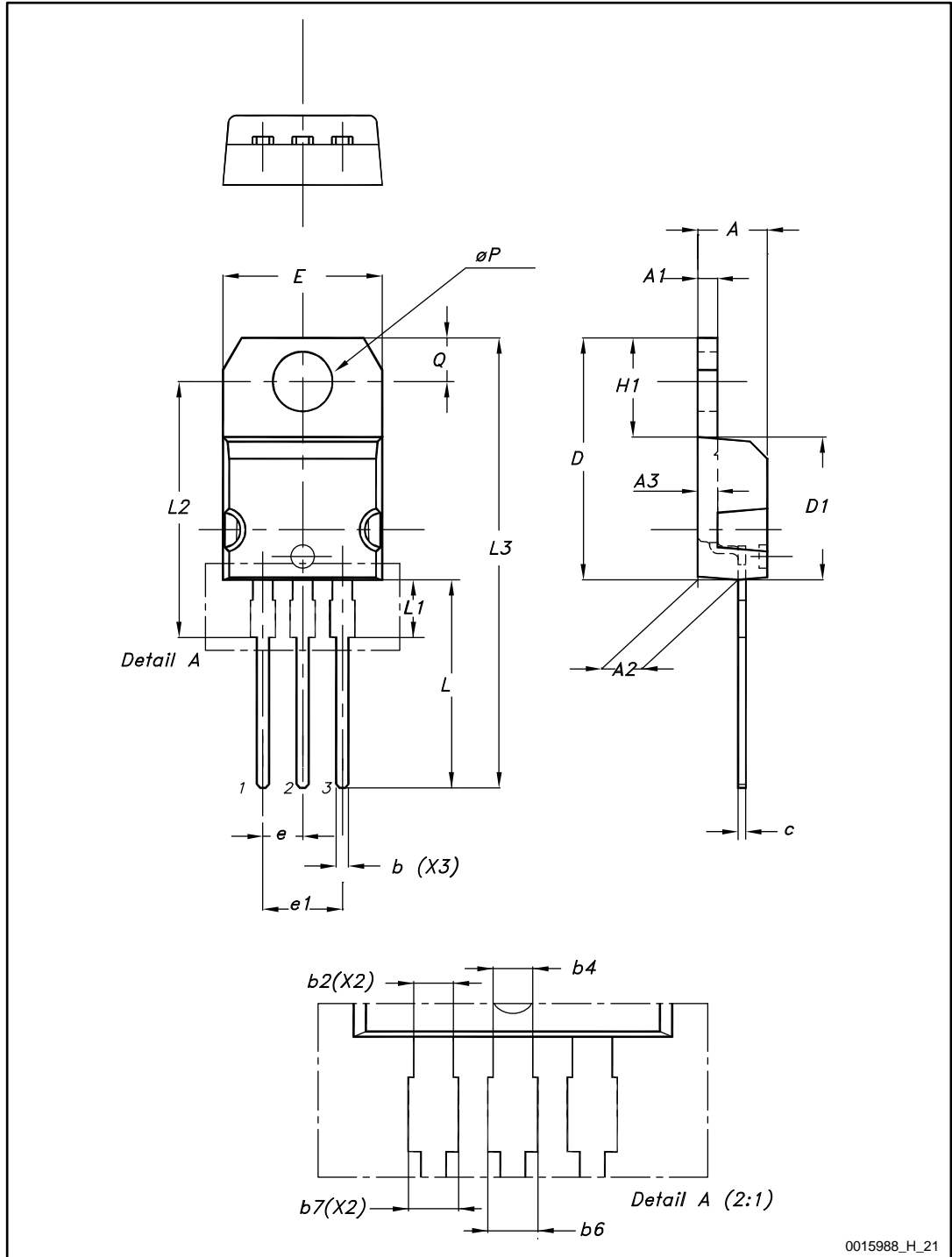


Table 17: TO-220 type H package mechanical data

| Dim. | mm | | |
|------|-------|-------|-------|
| | Min. | Typ. | Max. |
| A | 4.40 | 4.45 | 4.50 |
| A1 | 1.22 | | 1.32 |
| A2 | 2.49 | 2.59 | 2.69 |
| A3 | 1.17 | 1.27 | 1.37 |
| b | 0.78 | | 0.87 |
| b2 | 1.25 | | 1.34 |
| b4 | 1.20 | | 1.29 |
| b6 | | | 1.50 |
| b7 | | | 1.45 |
| c | 0.49 | | 0.56 |
| D | 15.40 | 15.50 | 15.60 |
| D1 | 9.05 | 9.15 | 9.25 |
| E | 10.08 | 10.18 | 10.28 |
| e | 2.44 | 2.54 | 2.64 |
| e1 | 4.98 | 5.08 | 5.18 |
| H1 | 6.25 | 6.35 | 6.45 |
| L | 13.20 | 13.40 | 13.60 |
| L1 | 3.50 | 3.70 | 3.90 |
| L2 | 16.30 | 16.40 | 16.50 |
| L3 | 28.70 | 28.90 | 29.10 |
| øP | 3.75 | 3.80 | 3.85 |
| Q | 2.70 | 2.80 | 2.90 |

5 Revision history

Table 18: Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 09-Sep-2004 | 3 | Complete document |
| 10-Aug-2006 | 4 | New template, no content change |
| 26-Feb-2009 | 5 | Updated mechanical data |
| 07-Sep-2009 | 6 | V _{ESD(G-S)} value has been corrected |
| 06-Apr-2017 | 7 | Updated <i>Section 1: "Electrical ratings"</i> , <i>Section 2: "Electrical characteristics"</i> and <i>Section 4: "Package information"</i> . Minor text changes |

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