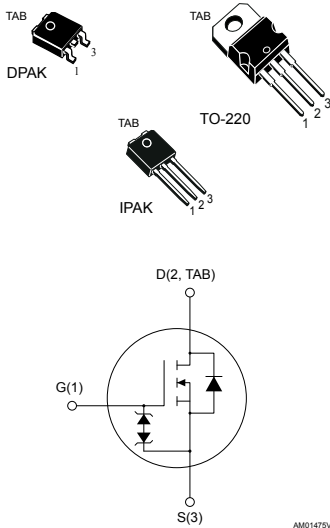


N-channel 525 V, 2.1 Ω typ., 2.5 A MDmesh™ K3 Power MOSFETs in DPAK, TO-220 and IPAK packages



Features

| Order code | V_{DS} | $R_{DS(on)max.}$ | I_D | Package |
|------------|----------|------------------|-------|---------|
| STD4N52K3 | 525 V | 2.6 Ω | 2.5 A | DPAK |
| STP4N52K3 | | | 2.5 A | TO-220 |
| STU4N52K3 | | | 2.5 A | IPAK |

- 100% avalanche tested
- Extremely high dv/dt capability
- Very low intrinsic capacitance
- Improved diode reverse recovery characteristics
- Zener-protected

Applications

- Switching applications

Description

These MDmesh™ K3 Power MOSFETs are the result of improvements applied to STMicroelectronics' MDmesh™ technology, combined with a new optimized vertical structure. These devices boast an extremely low on-resistance, superior dynamic performance and high avalanche capability, rendering them suitable for the most demanding applications.

Product status link

[STD4N52K3](#)
[STP4N52K3](#)
[STU4N52K3](#)

1 Electrical ratings

Table 1. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|----------------|---|------------|------------------|
| V_{DS} | Drain-source voltage | 525 | V |
| V_{GS} | Gate-source voltage | ± 30 | V |
| I_D | Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$ | 2.5 | A |
| I_D | Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$ | 2 | A |
| $I_{DM}^{(1)}$ | Drain current (pulsed) | 10 | A |
| P_{TOT} | Total dissipation at $T_C = 25\text{ }^\circ\text{C}$ | 45 | W |
| $dv/dt^{(2)}$ | Peak diode recovery voltage slope | 12 | V/ns |
| T_j | Operating junction temperature range | -55 to 150 | $^\circ\text{C}$ |
| T_{stg} | Storage temperature range | | |

1. Pulse width limited by safe operating area.
2. $I_{SD} \leq 2.5\text{ A}$, $di/dt \leq 400\text{ A}/\mu\text{s}$, $V_{DSpeak} \leq V_{(BR)DSS}$. $V_{DD} = 80\% V_{(BR)DSS}$.

Table 2. Thermal data

| Symbol | Parameter | Value | | | Unit |
|---------------------|-------------------------------------|-------|--------|------|---------------------------|
| | | DPAK | TO-220 | IPAK | |
| $R_{thj-case}$ | Thermal resistance junction-case | 2.78 | | 2.78 | $^\circ\text{C}/\text{W}$ |
| $R_{thj-amb}$ | Thermal resistance junction-ambient | | 62.5 | 100 | $^\circ\text{C}/\text{W}$ |
| $R_{thj-pcb}^{(1)}$ | Thermal resistance junction-pcb | 50 | | | $^\circ\text{C}/\text{W}$ |

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

Table 3. Avalanche characteristics

| Symbol | Parameter | Value | Unit |
|----------------|---|-------|------|
| $I_{AR}^{(1)}$ | Avalanche current, repetitive or not-repetitive | 1.3 | A |
| $E_{AS}^{(2)}$ | Single pulse avalanche energy | 110 | mJ |

1. Pulse width limited by T_j max.
2. Starting $T_j = 25\text{ }^\circ\text{C}$, $I_D = I_{AR}$, $V_{DD} = 50\text{ V}$.

2 Electrical characteristics

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

Table 4. On/off states

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------|-----------------------------------|--|------|------|----------|---------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $I_D = 1\text{ mA}$, $V_{GS} = 0\text{ V}$ | 525 | | | V |
| I_{DSS} | Zero gate voltage drain current | $V_{GS} = 0\text{ V}$, $V_{DS} = 525\text{ V}$ | | | 1 | μA |
| | | $V_{GS} = 0\text{ V}$, $V_{DS} = 525\text{ V}$, $T_C = 125\text{ °C}$ ⁽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 | $V_{GS} = 10\text{ V}$, $I_D = 1.25\text{ A}$ | | 2.1 | 2.6 | Ω |

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

Table 5. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------------------|-------------------------------|---|------|------|------|---------------|
| C_{iss} | Input capacitance | $V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0\text{ V}$ | - | 334 | - | μF |
| C_{oss} | Output capacitance | | | 28 | | |
| C_{rss} | Reverse transfer capacitance | | | 5 | | |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{DS} = 0\text{ to }420\text{ V}$, $V_{GS} = 0\text{ V}$ | - | 20 | - | μF |
| R_G | Intrinsic gate resistance | $f = 1\text{ MHz}$ open drain | - | 4 | - | Ω |
| Q_g | Total gate charge | $V_{DD} = 420\text{ V}$, $I_D = 2.5\text{ A}$, $V_{GS} = 0\text{ to }10\text{ V}$ (see Figure 16. Test circuit for gate charge behavior) | - | 11 | - | nC |
| Q_{gs} | Gate-source charge | | | 2 | | |
| Q_{gd} | Gate-drain charge | | | 7 | | |

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 420 V.

Table 6. Switching times

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------------|---------------------|--|------|------|------|------|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD} = 260\text{ V}$, $I_D = 1.25\text{ A}$, $R_G = 4.7\text{ }\Omega$, $V_{GS} = 10\text{ V}$ (see Figure 15. Test circuit for resistive load switching times and Figure 20. Switching time waveform) | - | 8 | - | ns |
| t_r | Rise time | | | 7 | | |
| $t_{d(off)}$ | Turn-off delay time | | | 21 | | |
| t_f | Fall time | | | 14 | | |

Table 7. 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 | |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD} = 2.5 \text{ A}$, $V_{GS} = 0 \text{ V}$ | - | | 1.6 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 2.5 \text{ A}$, $di/dt = 100 \text{ A}/\mu\text{s}$ | | 173 | | ns |
| Q_{rr} | Reverse recovery charge | $V_{DD} = 60 \text{ V}$ (see Figure 17. Test circuit for inductive load switching and diode recovery times) | - | 778 | | nC |
| I_{RRM} | Reverse recovery current | | | 9 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 2.5 \text{ A}$, $di/dt = 100 \text{ A}/\mu\text{s}$ | | 196 | | ns |
| Q_{rr} | Reverse recovery charge | $V_{DD} = 60 \text{ V}$, $T_j = 150 \text{ }^\circ\text{C}$ (see Figure 17. Test circuit for inductive load switching and diode recovery times) | - | 941 | | nC |
| I_{RRM} | Reverse recovery current | | | 10 | | 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 | $I_{GS} = \pm 1 \text{ mA}$, $I_D = 0 \text{ A}$ | 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

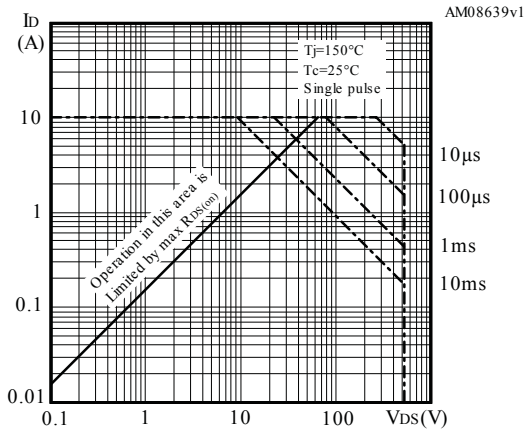
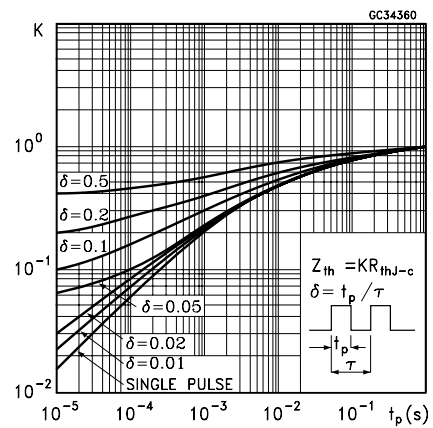
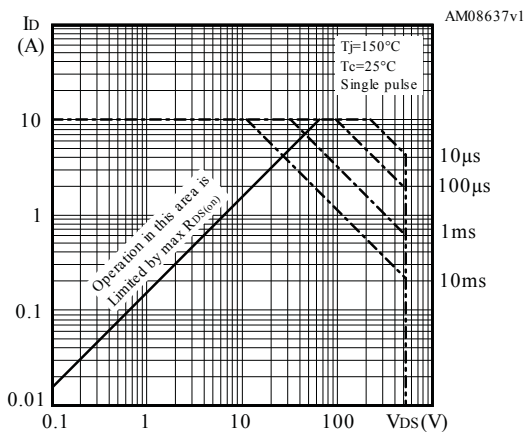
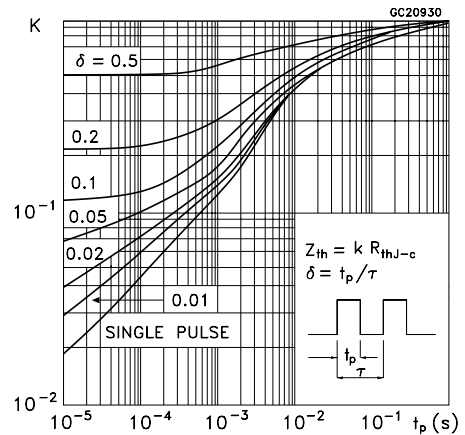
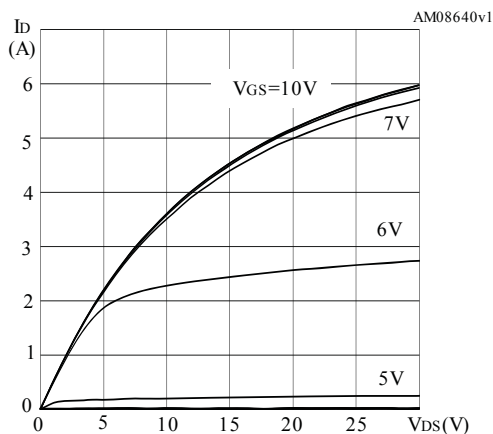
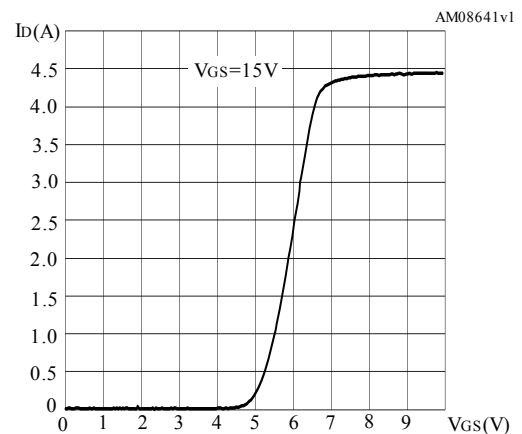
Figure 1. Safe operating area for DPAK/IPAK

Figure 2. Thermal impedance for DPAK/IPAK

Figure 3. Safe operating area for TO-220

Figure 4. Thermal impedance for TO-220

Figure 5. Output characteristics

Figure 6. Transfer characteristics


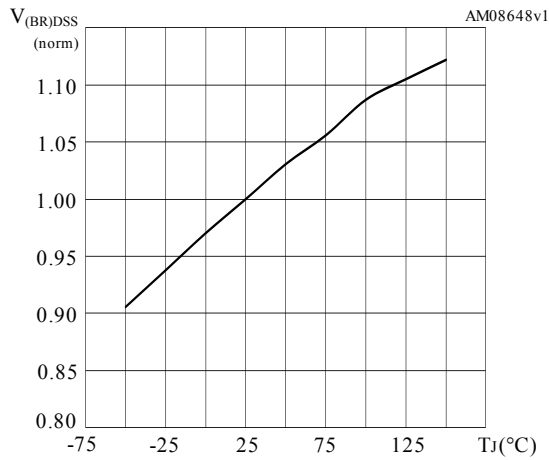
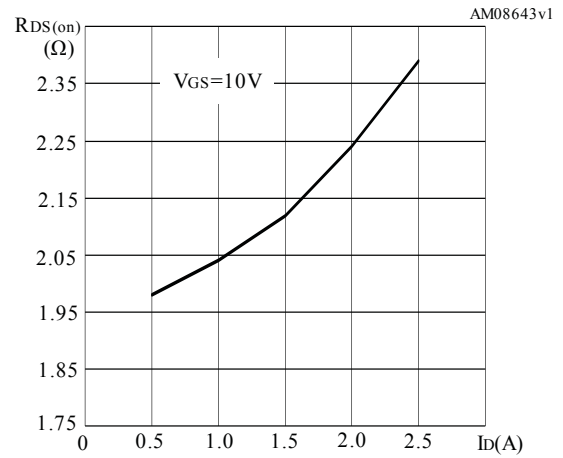
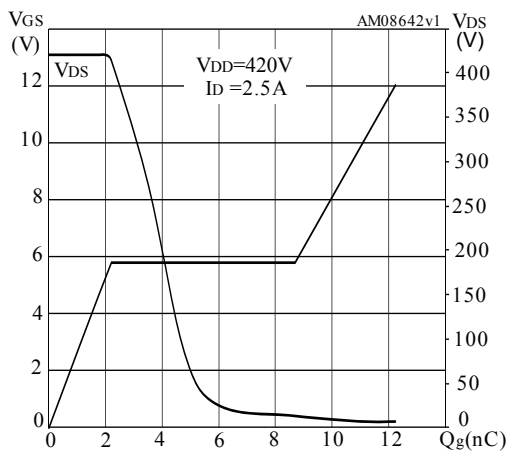
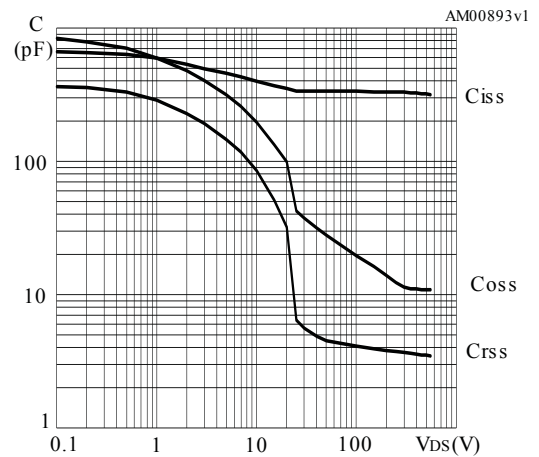
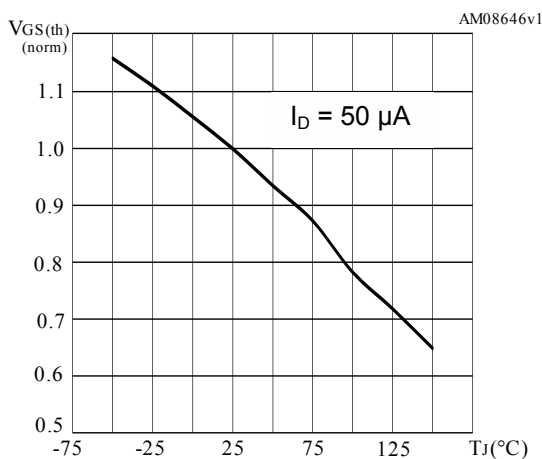
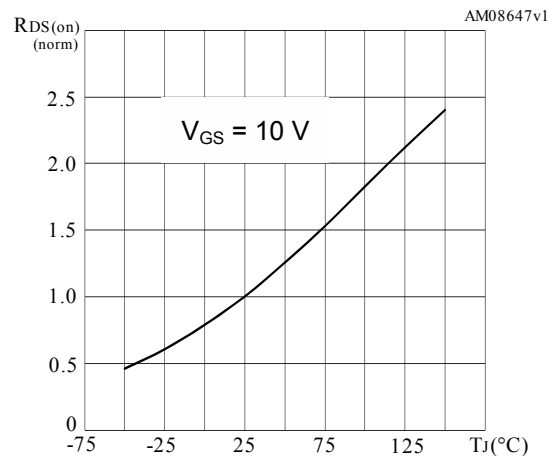
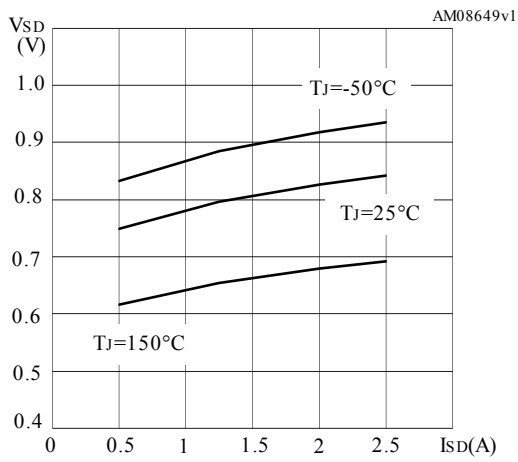
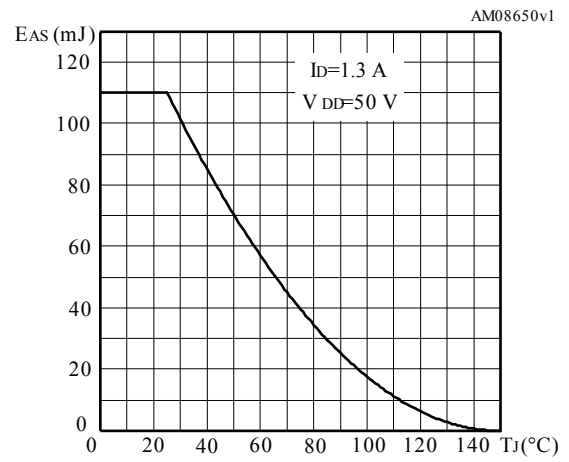
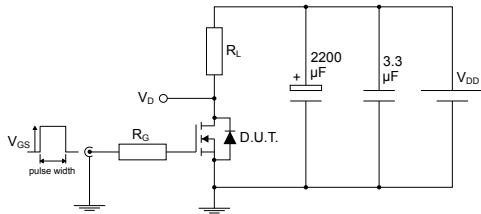
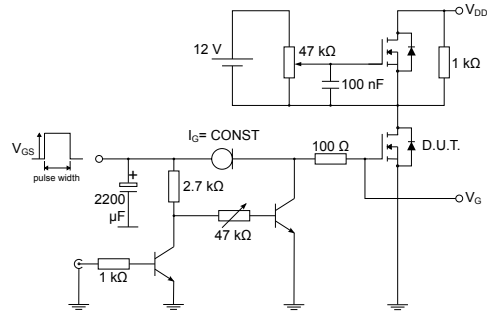
Figure 7. Normalized $V_{(BR)DSS}$ vs temperature

Figure 8. Static drain-source on-resistance

Figure 9. Gate charge vs gate-source voltage

Figure 10. Capacitance variations

Figure 11. Normalized gate threshold voltage vs temperature

Figure 12. Normalized on-resistance vs temperature


Figure 13. Source-drain diode forward characteristics

Figure 14. Maximum avalanche energy vs temperature


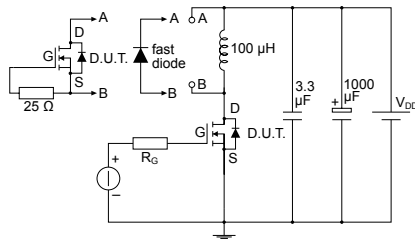
3 Test circuits

Figure 15. Test circuit for resistive load switching times


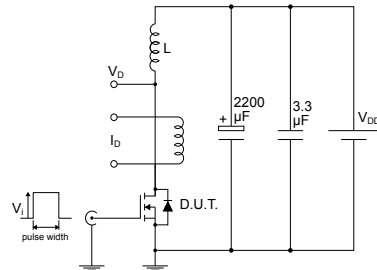
AM01468v1

Figure 16. Test circuit for gate charge behavior


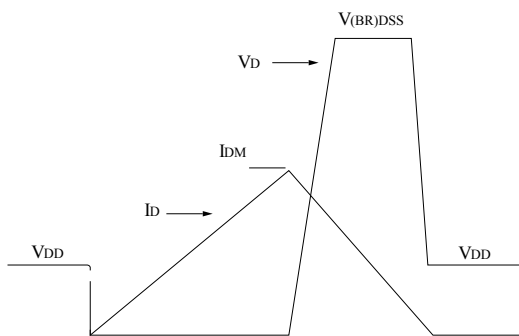
AM01469v1

Figure 17. Test circuit for inductive load switching and diode recovery times


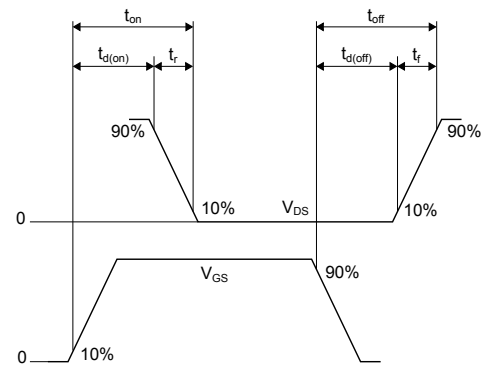
AM01470v1

Figure 18. Unclamped inductive load test circuit


AM01471v1

Figure 19. Unclamped inductive waveform


AM01472v1

Figure 20. Switching time waveform


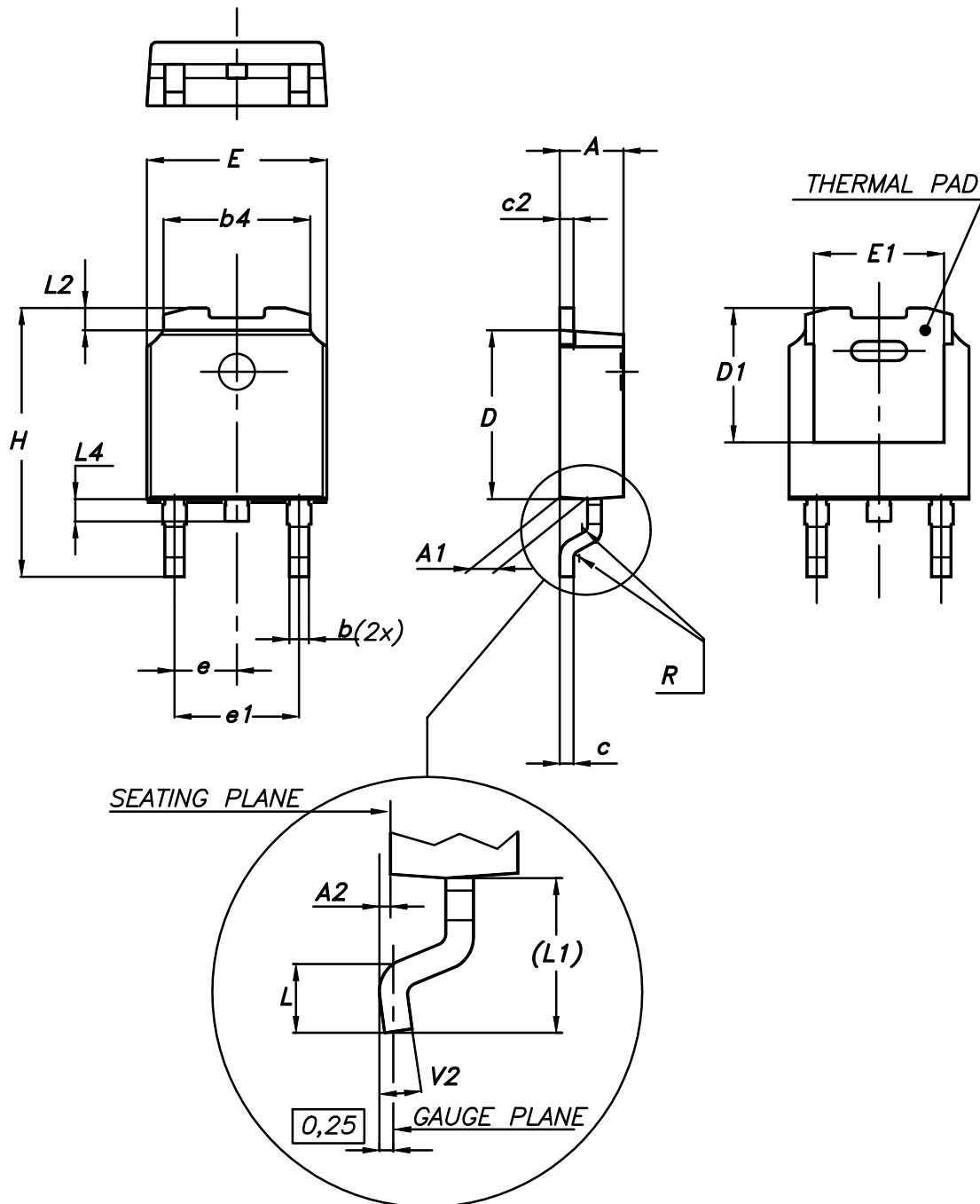
AM01473v1

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) type A package information

Figure 21. DPAK (TO-252) type A package outline



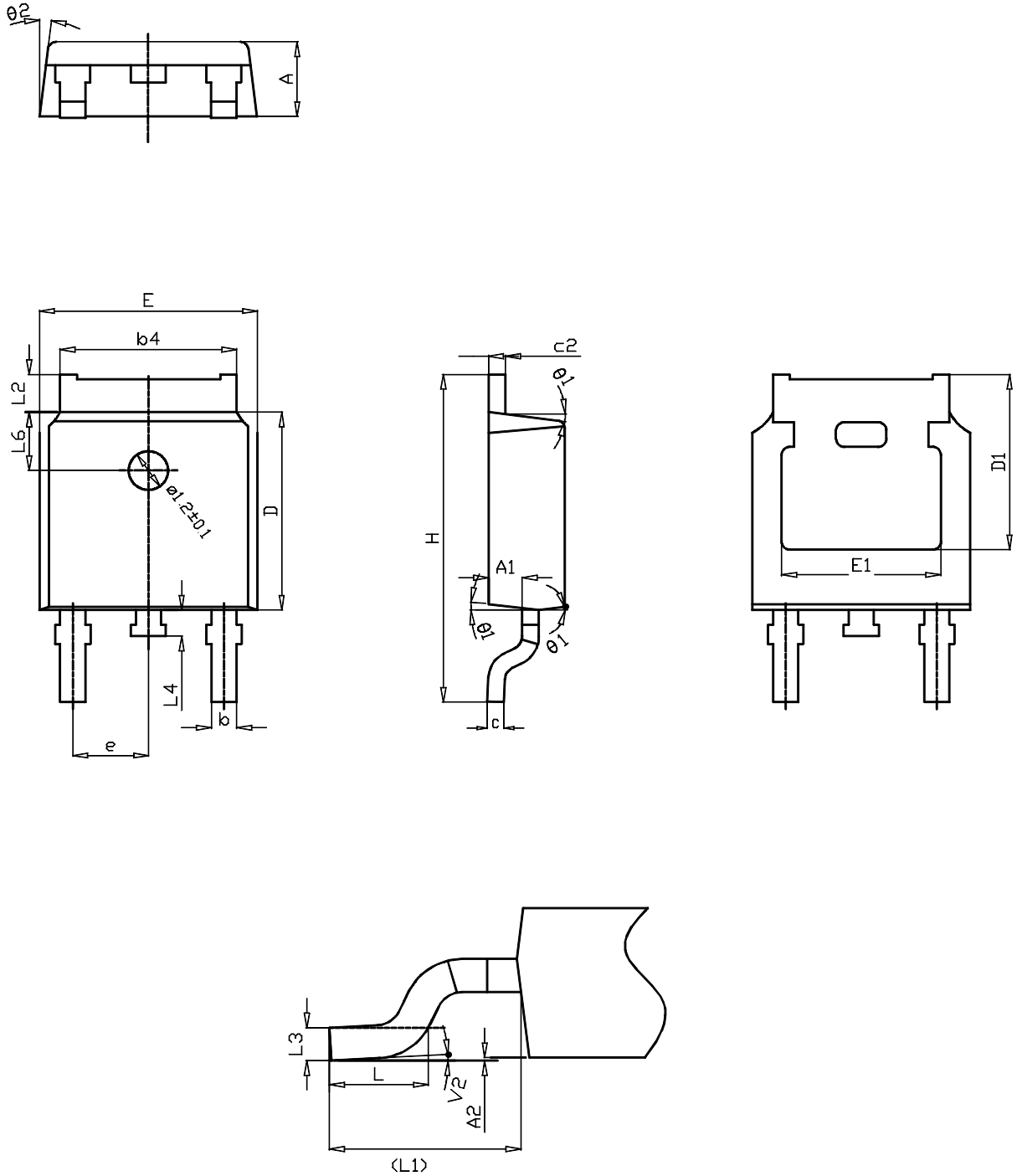
0068772_A_25

Table 9. 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 | 2.159 | 2.286 | 2.413 |
| e1 | 4.445 | 4.572 | 4.699 |
| 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° |

4.2 DPAK (TO-252) type C package information

Figure 22. DPAK (TO-252) type C package outline



0068772_C_25

Table 10. 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° |

4.3 DPAK (TO-252) type E package information

Figure 23. DPAK (TO-252) type E package outline

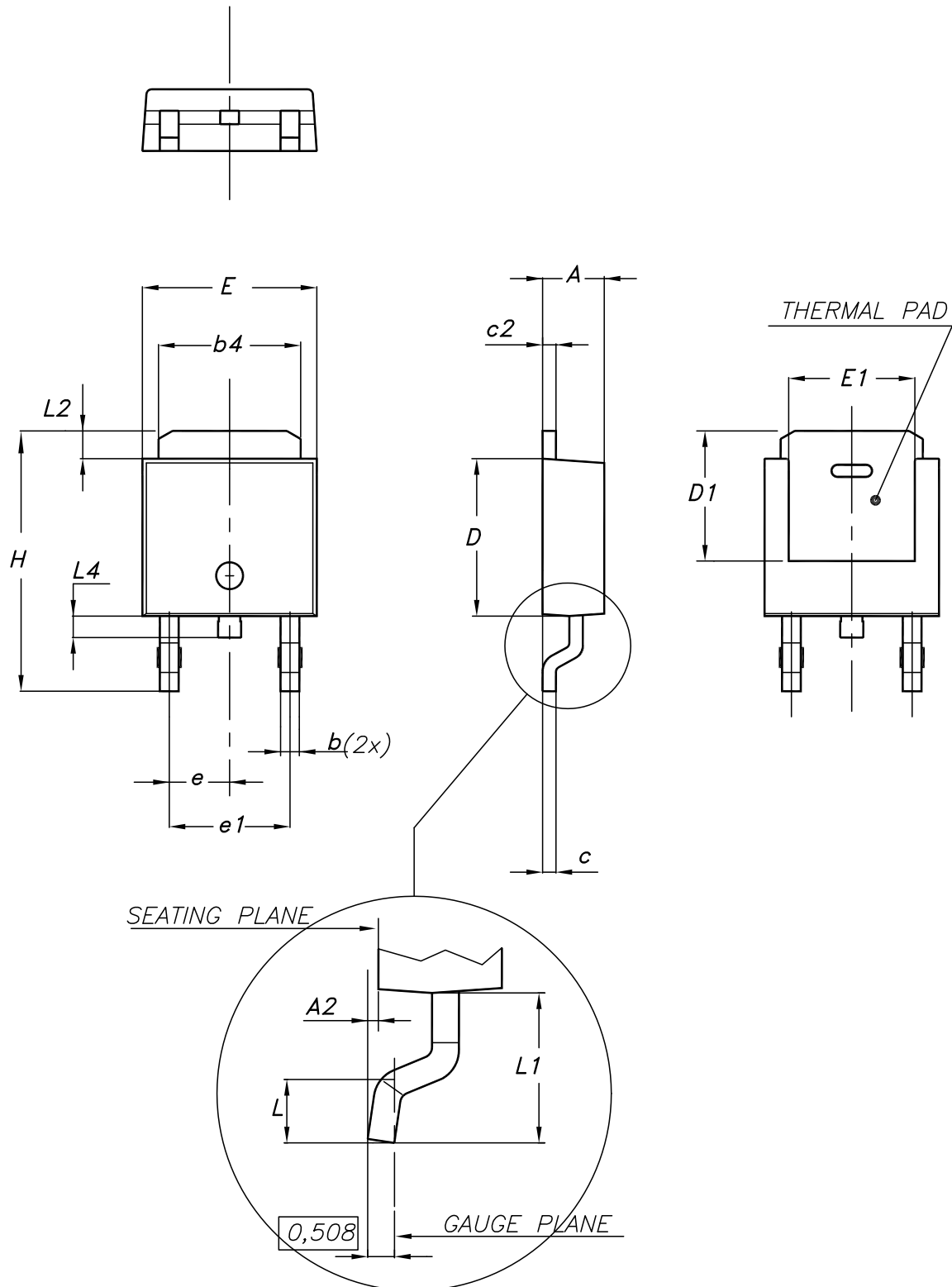
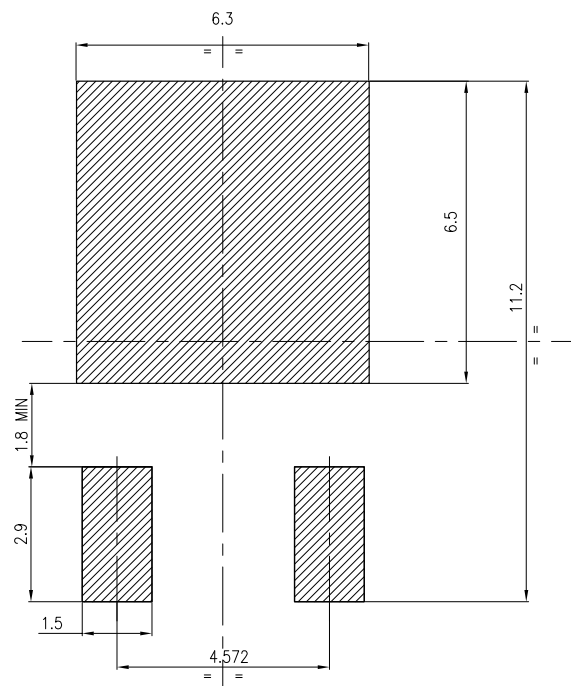


Table 11. DPAK (TO-252) type E mechanical data

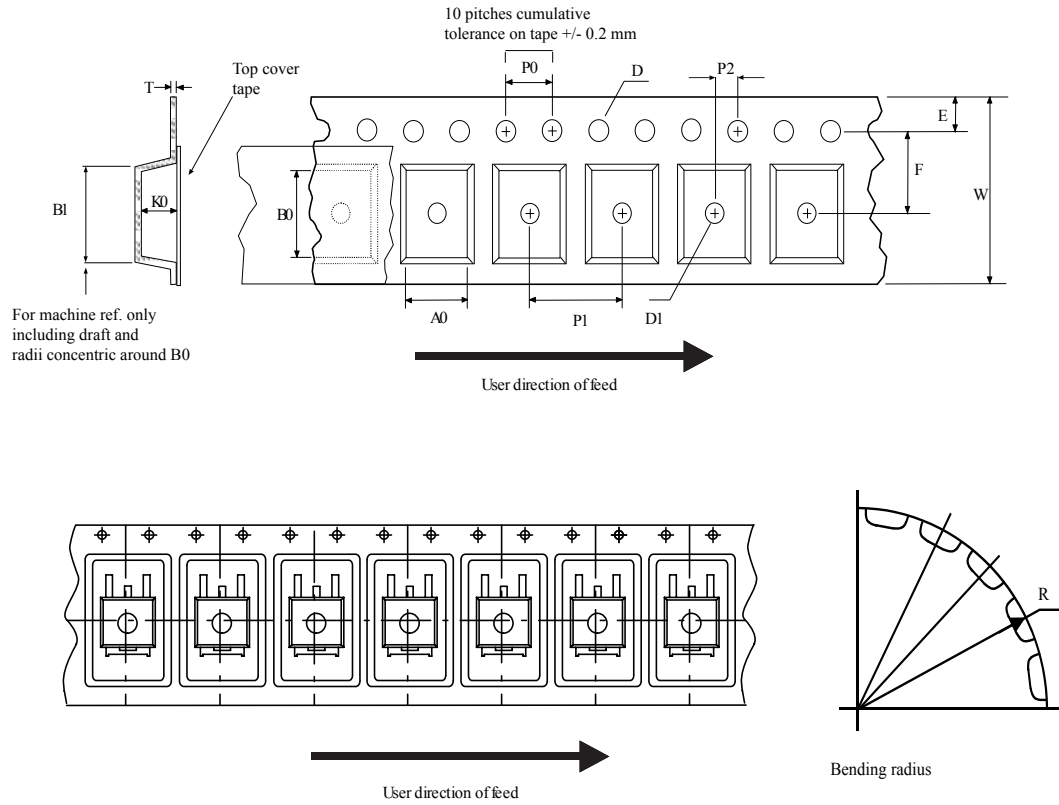
| Dim. | mm | | |
|------|------|-------|-------|
| | Min. | Typ. | Max. |
| A | 2.18 | | 2.39 |
| A2 | | | 0.13 |
| b | 0.65 | | 0.884 |
| b4 | 4.95 | | 5.46 |
| c | 0.46 | | 0.61 |
| c2 | 0.46 | | 0.60 |
| D | 5.97 | | 6.22 |
| D1 | 5.21 | | |
| E | 6.35 | | 6.73 |
| E1 | 4.32 | | |
| e | | 2.286 | |
| 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 24. DPAK (TO-252) recommended footprint (dimensions are in mm)


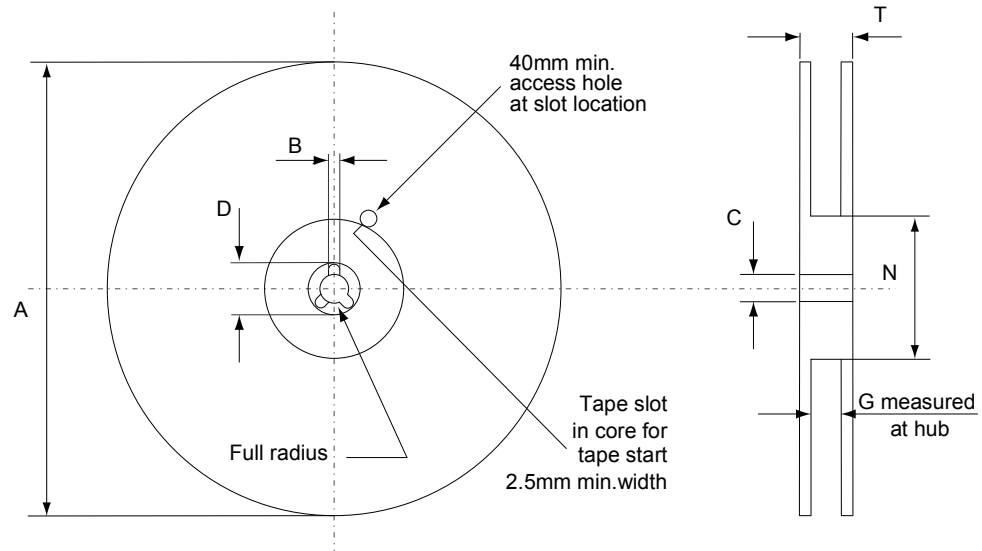
FP_0068772_25

4.4 DPAK (TO-252) packing information

Figure 25. DPAK (TO-252) tape outline



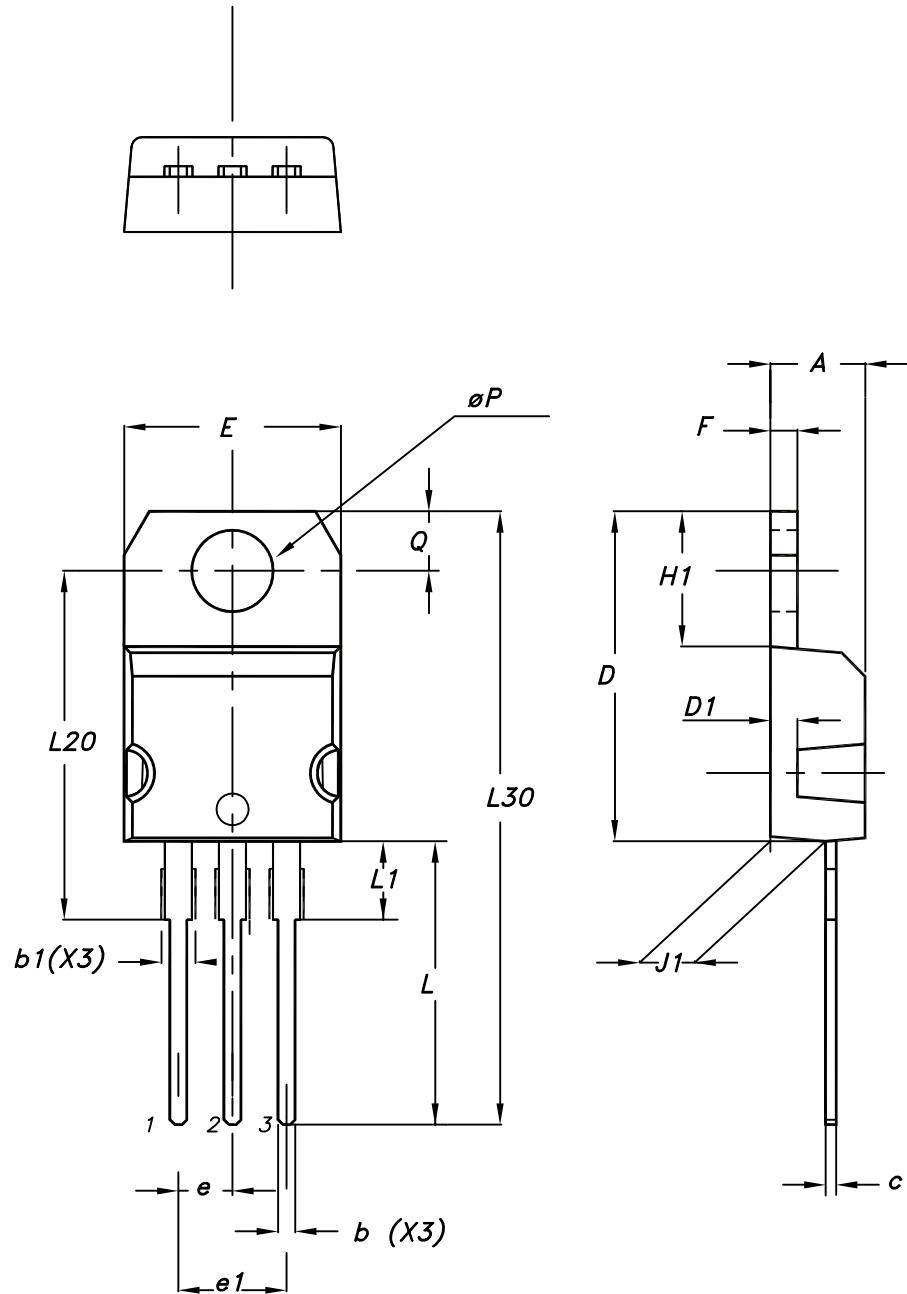
AM08852v1

Figure 26. DPAK (TO-252) reel outline


AM06038v1

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 | | | |

4.5 TO-220 type A package information
Figure 27. TO-220 type A package outline


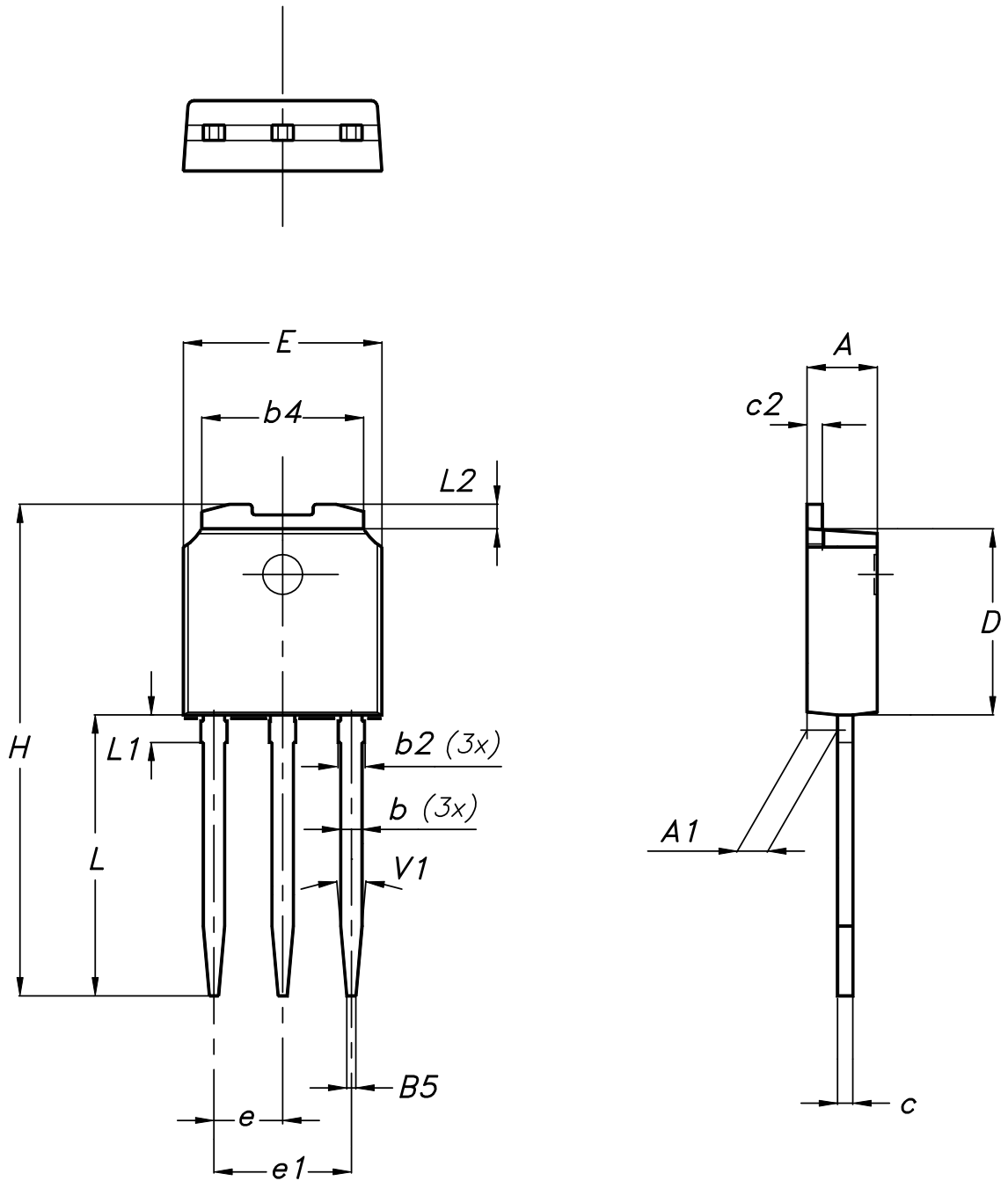
0015988_typeA_Rev_21

Table 13. TO-220 type A package 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 28. IPAk (TO-251) type A package outline



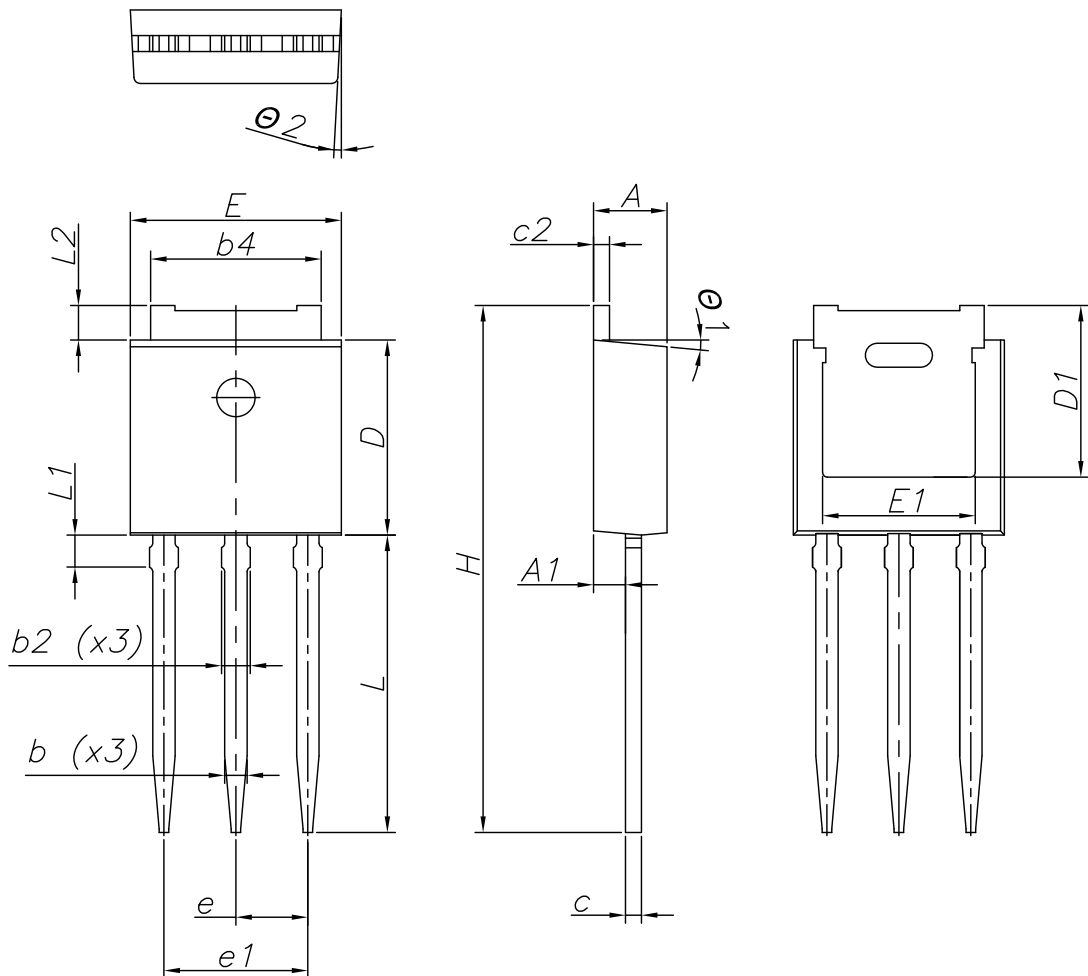
0068771_IK_typeA_rev14

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 29. 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° |

5 Ordering information

Table 16. Order codes

| Order code | Marking | Package | Packing |
|------------|---------|---------|---------------|
| STD4N52K3 | 4N52K3 | DPAK | Tape and reel |
| STP4N52K3 | | TO-220 | Tube |
| STU4N52K3 | | IPAK | Tube |

Revision history

Table 17. Document revision history

| Date | Version | Changes |
|-------------|---------|---|
| 09-Nov-2010 | 1 | First release |
| 19-Feb-2013 | 2 | Updated packages order in Table 1: Device summary. Updated Table 4: Package mechanical data and Table 5: Packaging mechanical data. Minor text changes on the cover page. |
| 20-Aug-2018 | 3 | The part number STF4N52K3 has been moved to a separate datasheet. Removed maturity status indication from cover page. The document status is production data. Updated title and features in cover page. Updated Section 1 Electrical ratings , Section 2 Electrical characteristics and Section 2.1 Electrical characteristics curves . Added Section 5 Ordering information . Minor text changes. |

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