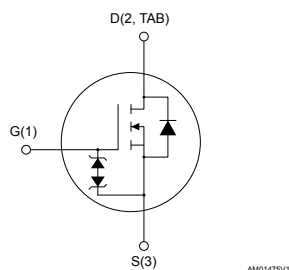
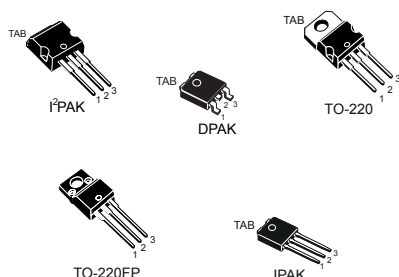


N-channel 500 V, 1.22  $\Omega$  typ., 4.4 A SuperMESH™ Power MOSFETs in I<sup>2</sup>PAK, DPAK, TO-220, TO-220FP and IPAK packages



AM01475V1

## Features

| Order codes | V <sub>DS</sub> | R <sub>DS(on)</sub> max. | I <sub>D</sub> | Package            |
|-------------|-----------------|--------------------------|----------------|--------------------|
| STB5NK50Z-1 | 500 V           | 1.5 $\Omega$             | 4.4 A          | I <sup>2</sup> PAK |
| STD5NK50ZT4 |                 |                          |                | DPAK               |
| STP5NK50Z   |                 |                          |                | TO-220             |
| STP5NK50ZFP |                 |                          |                | TO-220FP           |
| STU5NK50Z   |                 |                          |                | IPAK               |

- 100% avalanche tested
- Gate charge minimized
- Very low intrinsic capacitance
- 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.

### Product status link

[STB5NK50Z-1](#)
[STD5NK50ZT4](#)
[STP5NK50Z](#)
[STP5NK50ZFP](#)
[STU5NK50Z](#)

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol                         | Parameter                                                                                                             | Value                                     |                     | Unit |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------------|-------------------------------------------|---------------------|------|
|                                |                                                                                                                       | I <sup>2</sup> PAK, DPAK,<br>TO-220, IPAK | TO-220FP            |      |
| V <sub>DS</sub>                | Drain-source voltage                                                                                                  | 500                                       |                     | V    |
| V <sub>GS</sub>                | Gate-source voltage                                                                                                   | ±30                                       |                     | V    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 25 °C                                                                  | 4.4                                       | 4.4 <sup>(1)</sup>  | A    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 100 °C                                                                 | 2.7                                       | 2.7 <sup>(1)</sup>  | A    |
| I <sub>DM</sub> <sup>(2)</sup> | Drain current (pulsed)                                                                                                | 17.6                                      | 17.6 <sup>(1)</sup> | A    |
| P <sub>TOT</sub>               | Total dissipation at T <sub>C</sub> = 25 °C                                                                           | 70                                        | 25                  | W    |
| ESD                            | Gate-source human body model<br>(R = 1.5 kΩ, C = 100 pF)                                                              | 3                                         |                     | kV   |
| V <sub>ISO</sub>               | Insulation withstand voltage (RMS)<br>from all three leads to external heat-sink<br>(t = 1 s, T <sub>C</sub> = 25 °C) |                                           | 2.5                 | kV   |
| dv/dt <sup>(3)</sup>           | Peak diode recovery voltage slope                                                                                     | 4.5                                       |                     | V/ns |
| T <sub>J</sub>                 | Operating junction temperature range                                                                                  | -55 to 150                                |                     | °C   |
| T <sub>stg</sub>               | Storage temperature range                                                                                             |                                           |                     |      |

1. Limited by maximum junction temperature.
2. Pulse width limited by safe operating area.
3. I<sub>SD</sub> ≤ 4.4 A, di/dt ≤ 200 A/μs, V<sub>DD</sub> ≤ V<sub>(BR)DSS</sub>.

**Table 2. Thermal data**

| Symbol                              | Parameter                           | Value                         |          |      |      | Unit |
|-------------------------------------|-------------------------------------|-------------------------------|----------|------|------|------|
|                                     |                                     | I <sup>2</sup> PAK,<br>TO-220 | TO-220FP | DPAK | IPAK |      |
| R <sub>thj-case</sub>               | Thermal resistance junction-case    | 1.78                          | 5        | 1.78 |      | °C/W |
| R <sub>thj-amb</sub>                | Thermal resistance junction-ambient | 62.5                          |          |      | 100  | °C/W |
| R <sub>thj-pcb</sub> <sup>(1)</sup> | Thermal resistance junction-pcb     |                               |          | 50   |      | °C/W |

1. When mounted on an 1-inch<sup>2</sup> FR-4, 2oz Cu board.

**Table 3. Avalanche characteristics**

| Symbol          | Parameter                                                                                                                     | Value | Unit |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------|-------|------|
| I <sub>AR</sub> | Avalanche current, repetitive or not-repetitive<br>(pulse width limited by T <sub>J</sub> Max)                                | 4.4   | A    |
| E <sub>AS</sub> | Single pulse avalanche energy<br>(starting T <sub>J</sub> = 25 °C, I <sub>D</sub> = I <sub>AR</sub> , V <sub>DD</sub> = 50 V) | 130   | mJ   |

## 2 Electrical characteristics

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

**Table 4. On/off states**

| Symbol        | Parameter                         | Test conditions                                                                                      | Min. | Typ. | Max.     | Unit          |
|---------------|-----------------------------------|------------------------------------------------------------------------------------------------------|------|------|----------|---------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage    | $I_D = 1\text{ mA}$ , $V_{GS} = 0\text{ V}$                                                          | 500  |      |          | V             |
| $I_{DSS}$     | Zero gate voltage drain current   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 500\text{ V}$                                                      |      |      | 1        | $\mu\text{A}$ |
|               |                                   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 500\text{ V}$ , $T_C = 125\text{ }^{\circ}\text{C}$ <sup>(1)</sup> |      |      | 50       | $\mu\text{A}$ |
| $I_{GSS}$     | Gate body leakage current         | $V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 20\text{ V}$                                                   |      |      | $\pm 10$ | $\mu\text{A}$ |
| $V_{GS(th)}$  | 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 | $V_{GS} = 10\text{ V}$ , $I_D = 2.2\text{ A}$                                                        |      | 1.22 | 1.5      | $\Omega$      |

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

**Table 5. Dynamic**

| Symbol                     | Parameter                     | Test conditions                                                                                                                               | Min. | Typ. | Max. | Unit          |
|----------------------------|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $C_{iss}$                  | Input capacitance             | $V_{DS} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$                                                                           | -    | 535  |      | $\mu\text{F}$ |
| $C_{oss}$                  | Output capacitance            |                                                                                                                                               |      | 75   |      |               |
| $C_{rss}$                  | Reverse transfer capacitance  |                                                                                                                                               |      | 17   |      |               |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{DS} = 0\text{ to }400\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                   | -    | 45   |      | $\mu\text{F}$ |
| $Q_g$                      | Total gate charge             | $V_{DD} = 400\text{ V}$ , $I_D = 4.4\text{ A}$ , $V_{GS} = 0\text{ to }10\text{ V}$<br>(see Figure 16. Test circuit for gate charge behavior) | -    | 20   | 28   | nC            |
| $Q_{gs}$                   | Gate-source charge            |                                                                                                                                               |      | 4    |      |               |
| $Q_{gd}$                   | Gate-drain charge             |                                                                                                                                               |      | 10   |      |               |

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 6. Switching times**

| Symbol       | Parameter           | Test conditions                                                                                                                                                                                                   | Min. | Typ. | Max. | Unit |
|--------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 250\text{ V}$ , $I_D = 2.2\text{ A}$ ,<br>$R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$<br>(see Figure 15. Test circuit for resistive load switching times and Figure 20. Switching time waveform) | -    | 15   | -    | ns   |
| $t_r$        | Rise time           |                                                                                                                                                                                                                   |      | 10   |      |      |
| $t_{d(off)}$ | Turn-off delay time |                                                                                                                                                                                                                   |      | 32   |      |      |
| $t_f$        | Fall time           |                                                                                                                                                                                                                   |      | 15   |      |      |

**Table 7. Source drain diode**

| Symbol                          | Parameter                     | Test conditions                                                                                                                                                                                      | Min. | Typ.  | Max. | Unit |
|---------------------------------|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------|------|------|
| I <sub>SD</sub>                 | Source-drain current          |                                                                                                                                                                                                      | -    |       | 4.4  | A    |
| I <sub>SDM</sub> <sup>(1)</sup> | Source-drain current (pulsed) |                                                                                                                                                                                                      |      |       | 17.6 |      |
| V <sub>SD</sub> <sup>(2)</sup>  | Forward on voltage            | I <sub>SD</sub> = 4.4 A, V <sub>GS</sub> = 0 V                                                                                                                                                       | -    |       | 1.6  | V    |
| t <sub>rr</sub>                 | Reverse recovery time         | I <sub>SD</sub> = 4.4 A, di/dt = 100 A/μs<br><br>V <sub>DD</sub> = 30 V, T <sub>j</sub> = 150°C (see <a href="#">Figure 17. Test circuit for inductive load switching and diode recovery times</a> ) | -    | 310   |      | ns   |
| Q <sub>rr</sub>                 | Reverse recovery charge       |                                                                                                                                                                                                      |      | 1.425 |      | μC   |
| I <sub>RRM</sub>                | Reverse recovery current      |                                                                                                                                                                                                      |      | 9.2   |      | A    |

1. Pulse width limited by safe operating area.
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

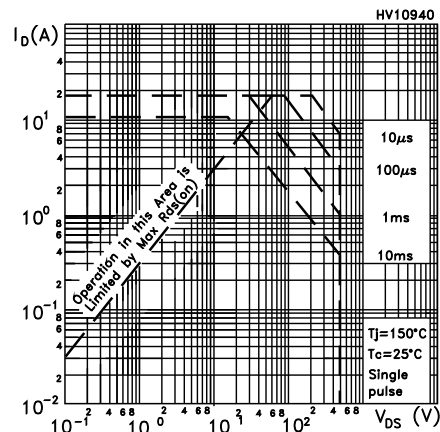
**Table 8. Gate-source Zener diode**

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

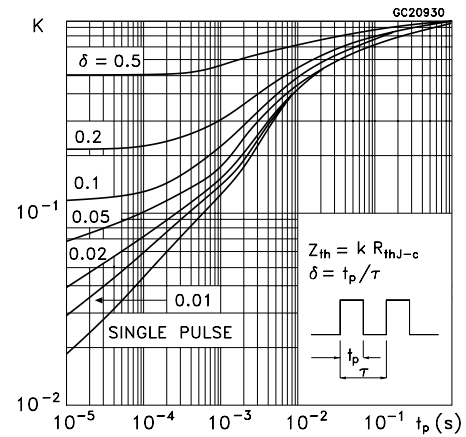
The built-in back-to-back Zener diodes are specifically designed to enhance the ESD performance of the device. The Zener voltage facilitates efficient and cost-effective device integrity protection, thus eliminating the need for additional external componentry.

## 2.1 Electrical characteristics curves

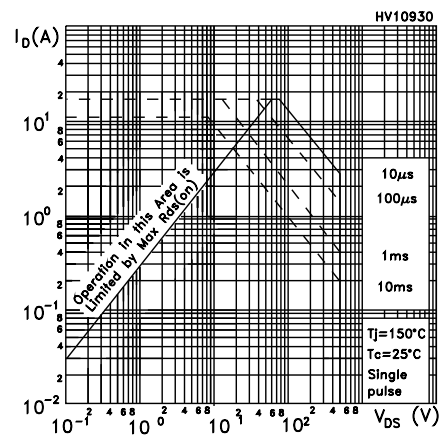
**Figure 1. Safe operating area for I<sup>2</sup>PAK, DPAK, TO-220, IPAK**



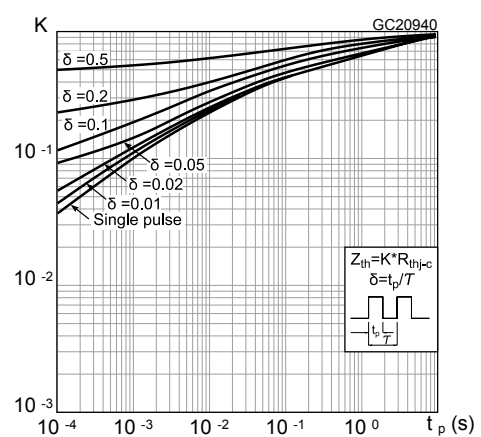
**Figure 2. Thermal impedance for I<sup>2</sup>PAK, DPAK, TO-220, IPAK**

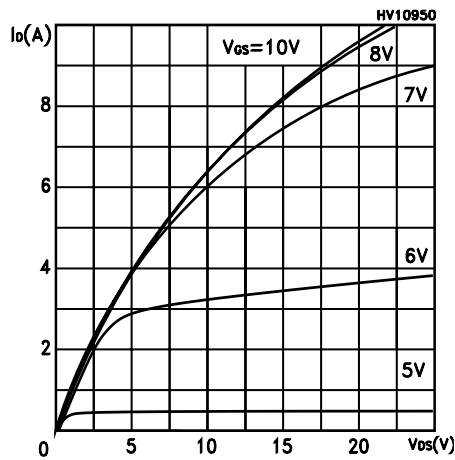
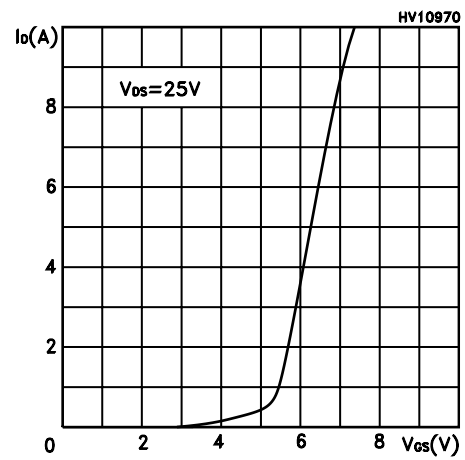
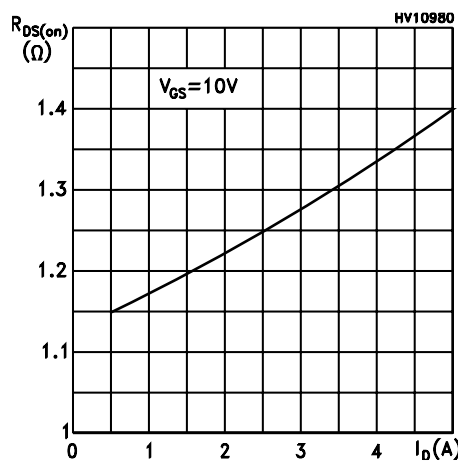
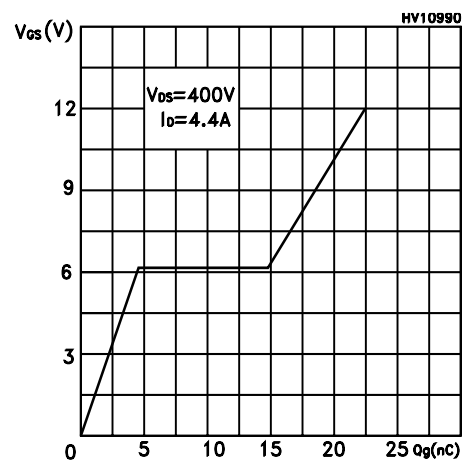
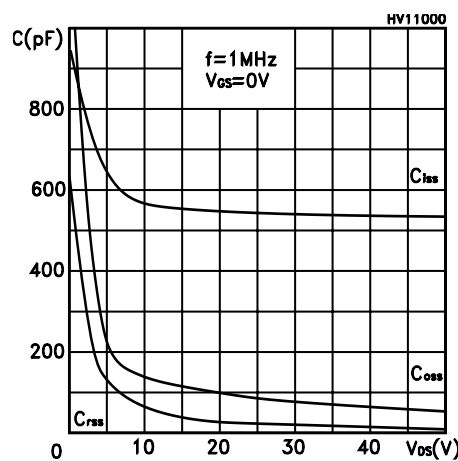
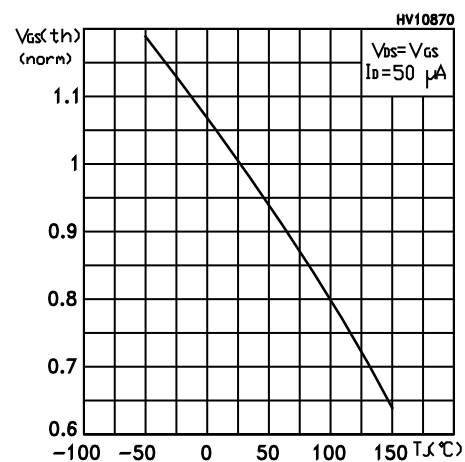


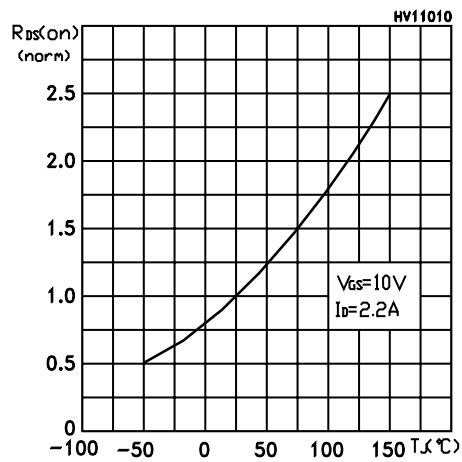
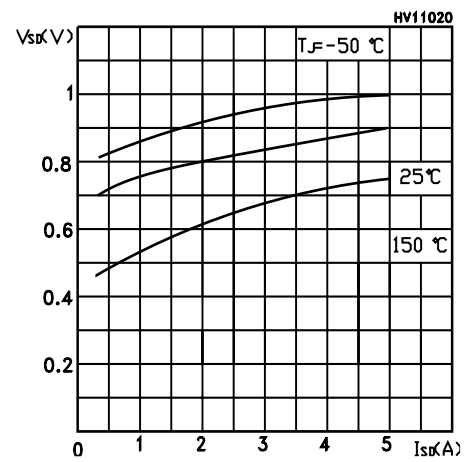
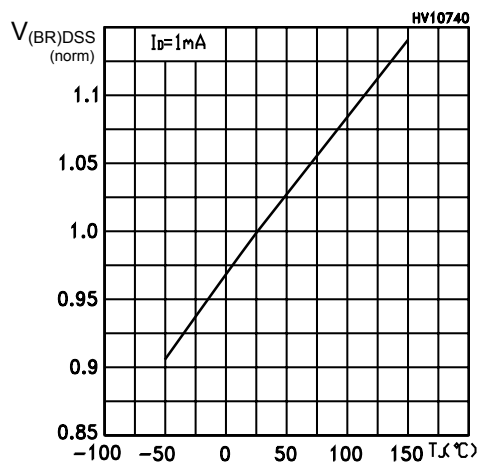
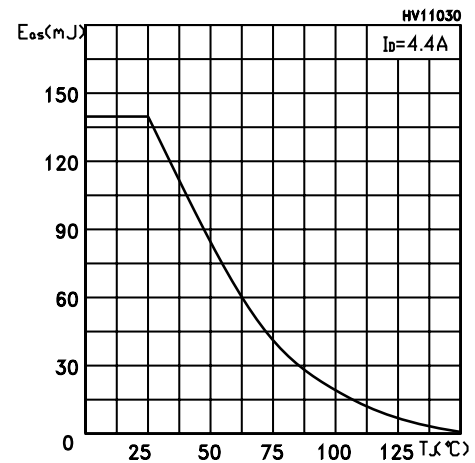
**Figure 3. Safe operating area for TO-220FP**



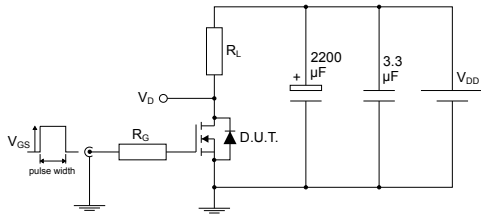
**Figure 4. Thermal impedance for TO-220FP**



**Figure 5. Output characteristics**

**Figure 6. Transfer characteristics**

**Figure 7. Static drain-source on resistance**

**Figure 8. Gate charge vs gate-source voltage**

**Figure 9. Capacitance variations**

**Figure 10. Normalized gate threshold voltage vs temperature**


**Figure 11. Normalized on resistance vs temperature**

**Figure 12. Source-drain diode forward characteristic**

**Figure 13. Normalized  $V_{(BR)DSS}$  vs temperature**

**Figure 14. Maximum avalanche energy vs temperature**


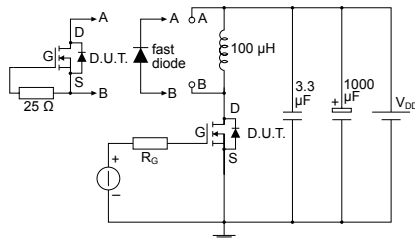
### 3 Test circuits

**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



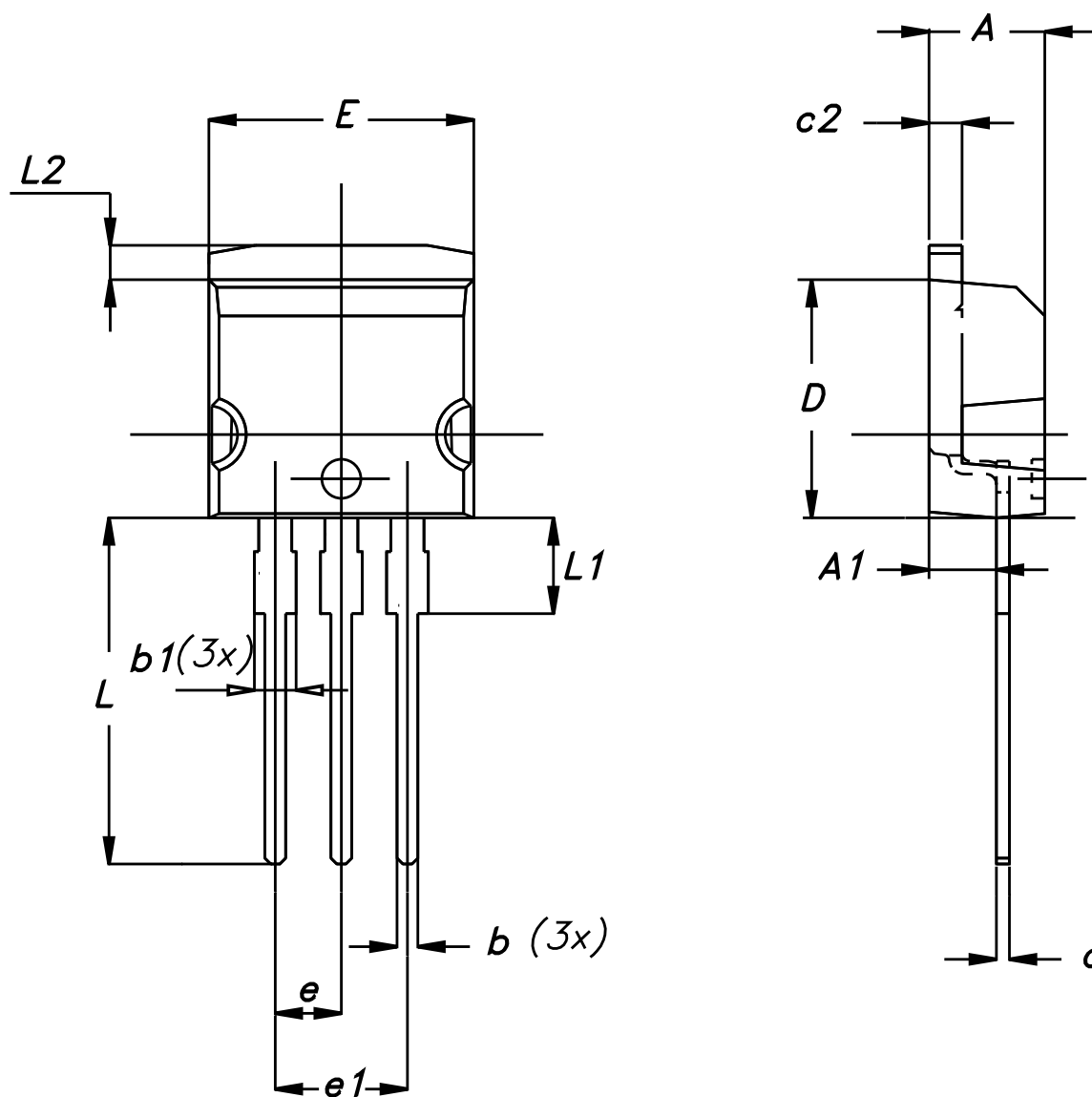
## 4 Package information

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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](http://www.st.com). ECOPACK® is an ST trademark.

## 4.1 I<sup>2</sup>PAK package information

Figure 21. I<sup>2</sup>PAK package outline



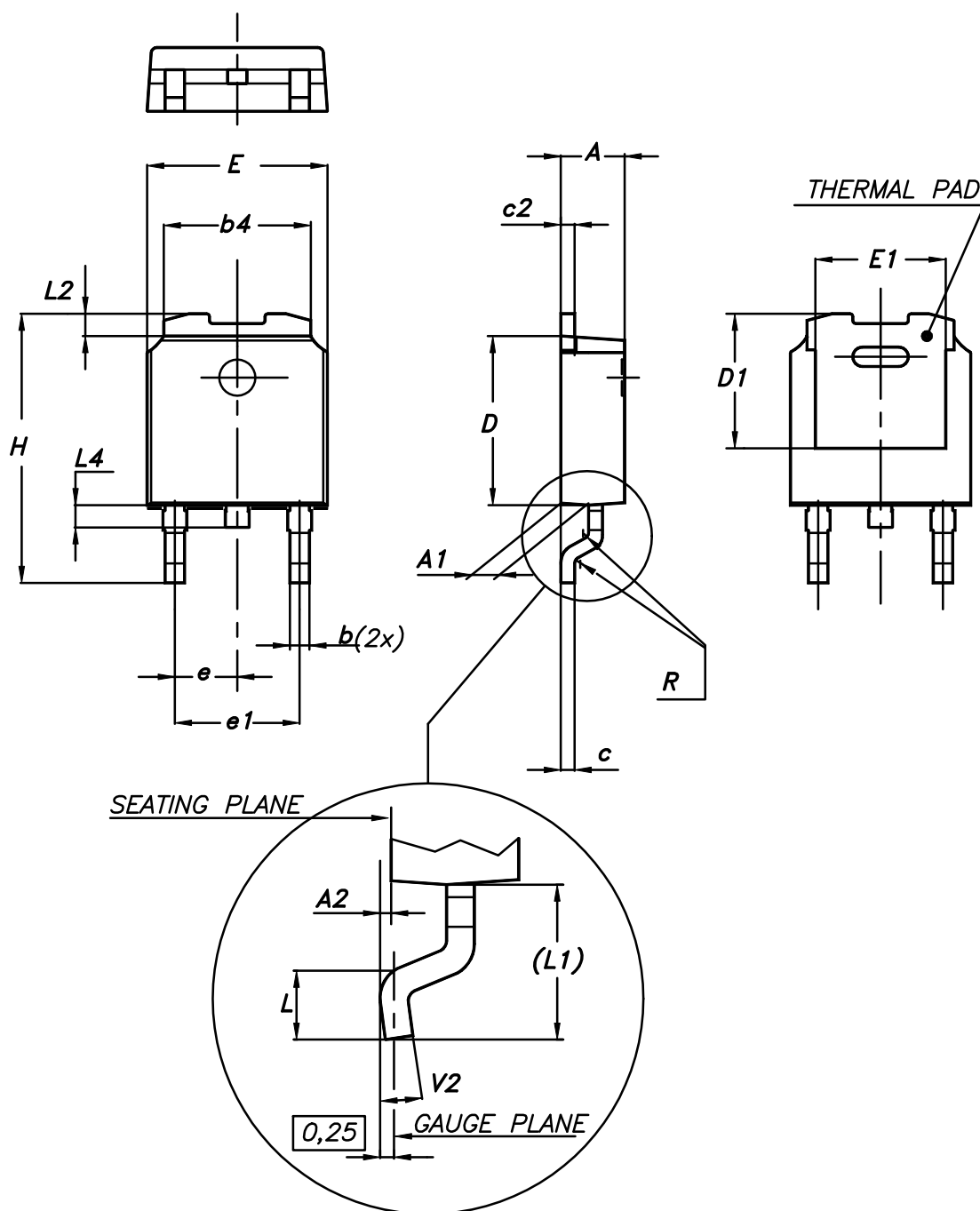
0004982\_Rev\_H

**Table 9. I<sup>2</sup>PAK package mechanical data**

| Dim. | mm   |      |       |
|------|------|------|-------|
|      | Min. | Typ. | Max.  |
| A    | 4.40 | -    | 4.60  |
| A1   | 2.40 | -    | 2.72  |
| b    | 0.61 | -    | 0.88  |
| b1   | 1.14 | -    | 1.70  |
| c    | 0.49 | -    | 0.70  |
| c2   | 1.23 | -    | 1.32  |
| D    | 8.95 | -    | 9.35  |
| e    | 2.40 | -    | 2.70  |
| e1   | 4.95 | -    | 5.15  |
| E    | 10   | -    | 10.40 |
| L    | 13   | -    | 14    |
| L1   | 3.50 | -    | 3.93  |
| L2   | 1.27 | -    | 1.40  |

## 4.2 DPAK (TO-252) type A package information

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



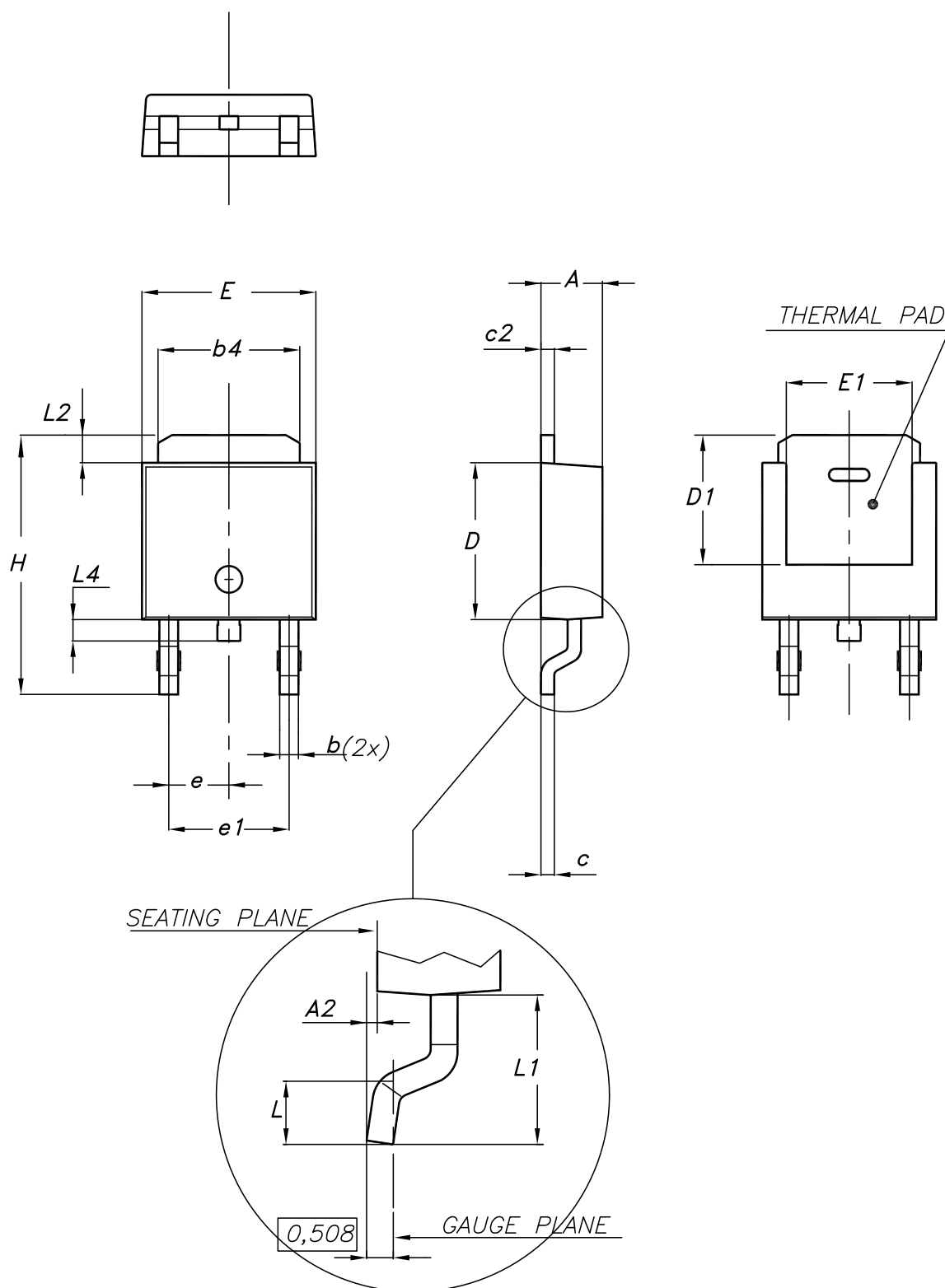
0068772\_A\_25

**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    | 2.159 | 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°    |

### 4.3 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**

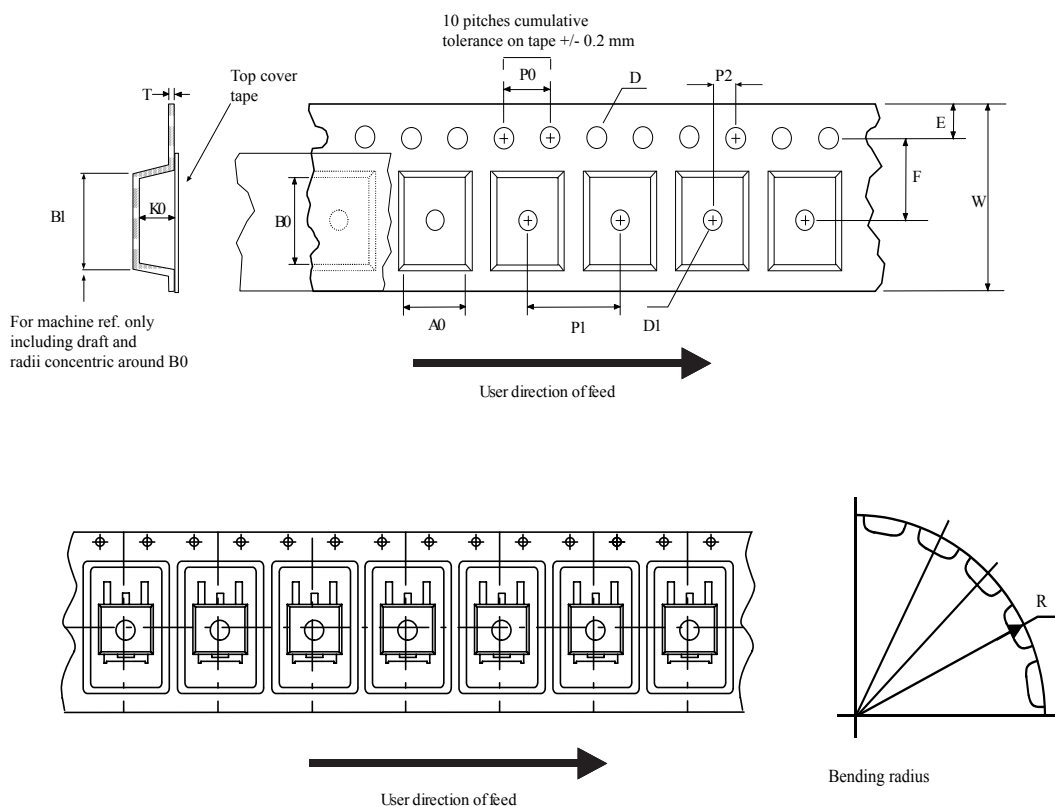
| Dim. | mm   |       |       |
|------|------|-------|-------|
|      | Min. | Typ.  | Max.  |
| A    | 2.18 |       | 2.39  |
| A2   |      |       | 0.13  |
| b    | 0.65 |       | 0.884 |
| b4   | 4.95 |       | 5.46  |
| c    | 0.46 |       | 0.61  |
| c2   | 0.46 |       | 0.60  |
| D    | 5.97 |       | 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)**

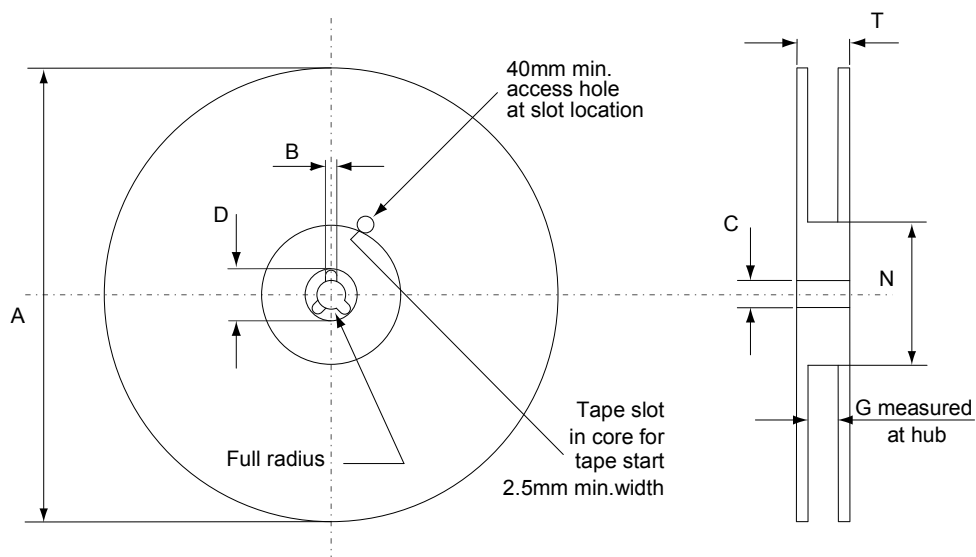

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## 4.4 DPAK (TO-252) packing information

**Figure 25. DPAK (TO-252) tape outline**



AM08852v1

**Figure 26. DPAK (TO-252) reel outline**


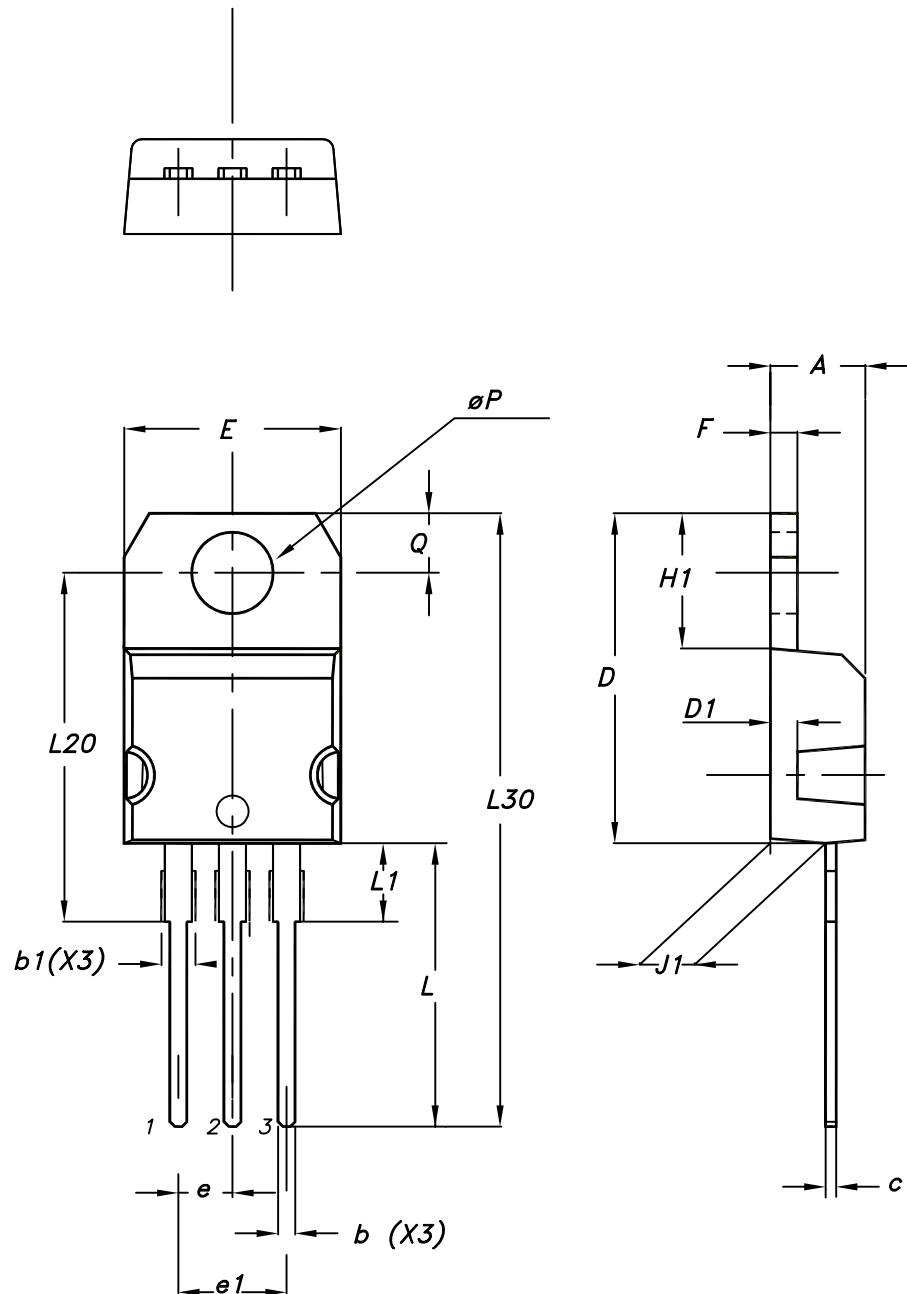
AM06038v1

**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



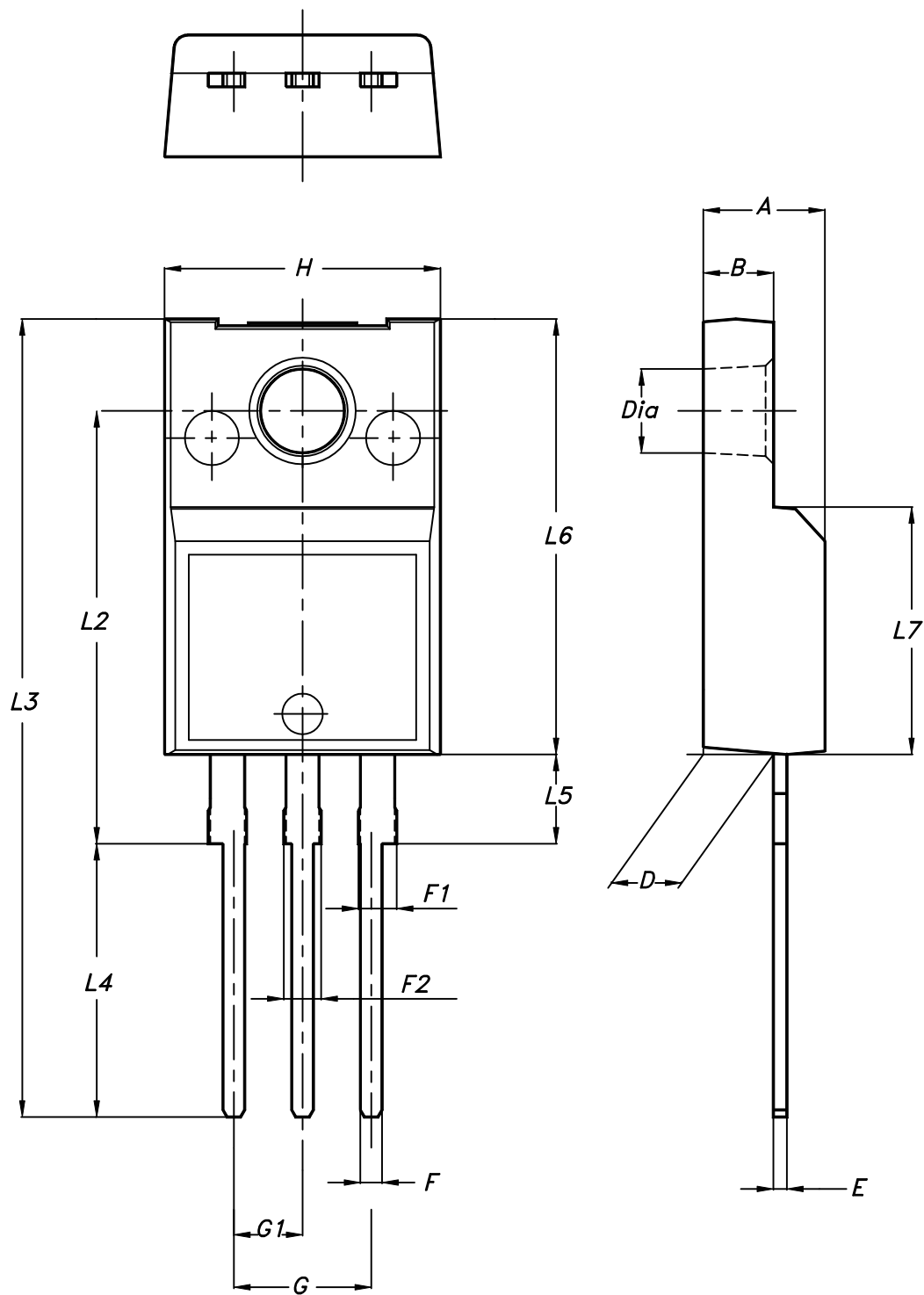
0015988\_typeA\_Rev\_21

**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 TO-220FP package information

Figure 28. TO-220FP package outline



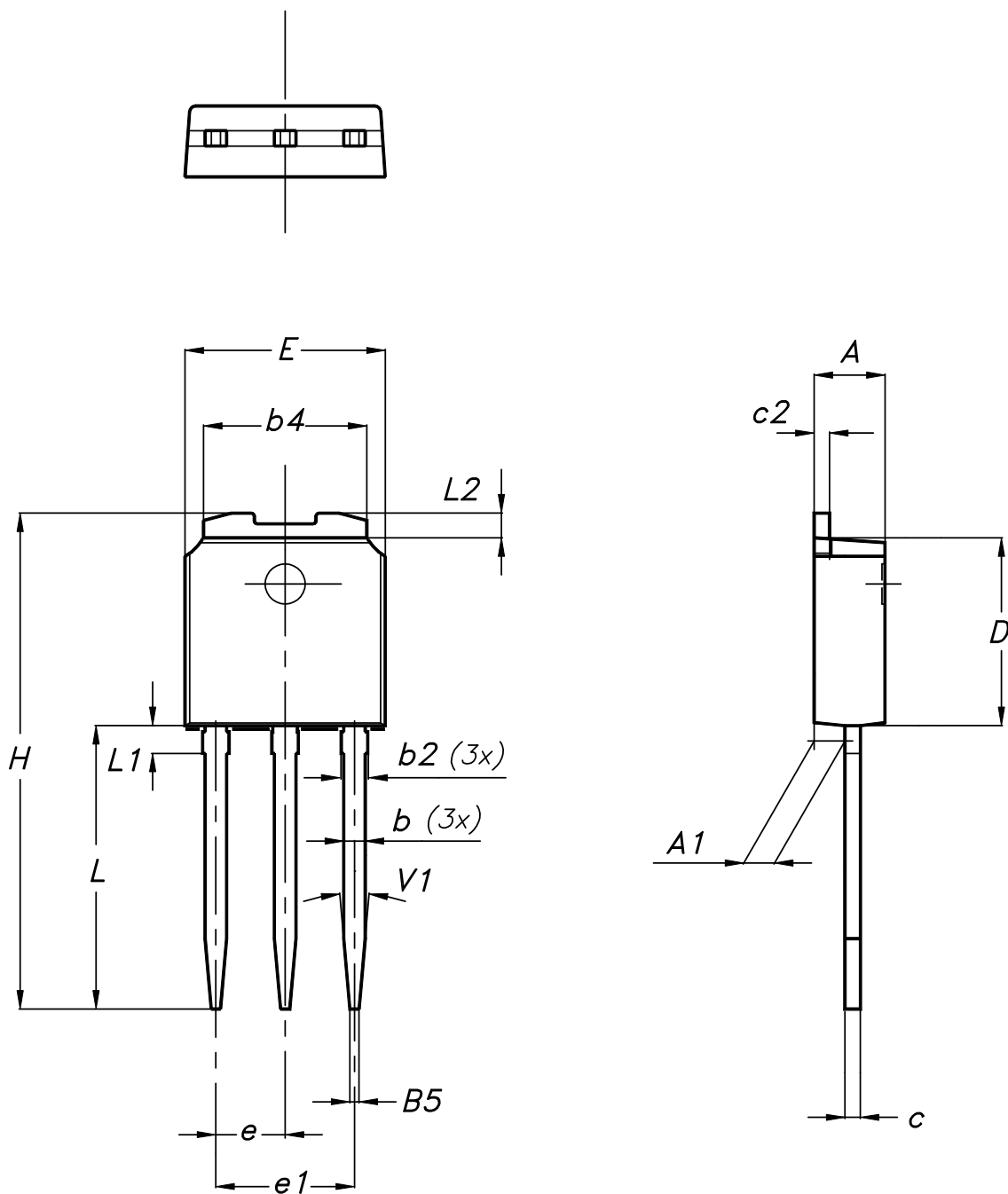
7012510\_Rev\_12\_B

**Table 14. 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  |

#### 4.7 IPAK (TO-251) type A package information

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



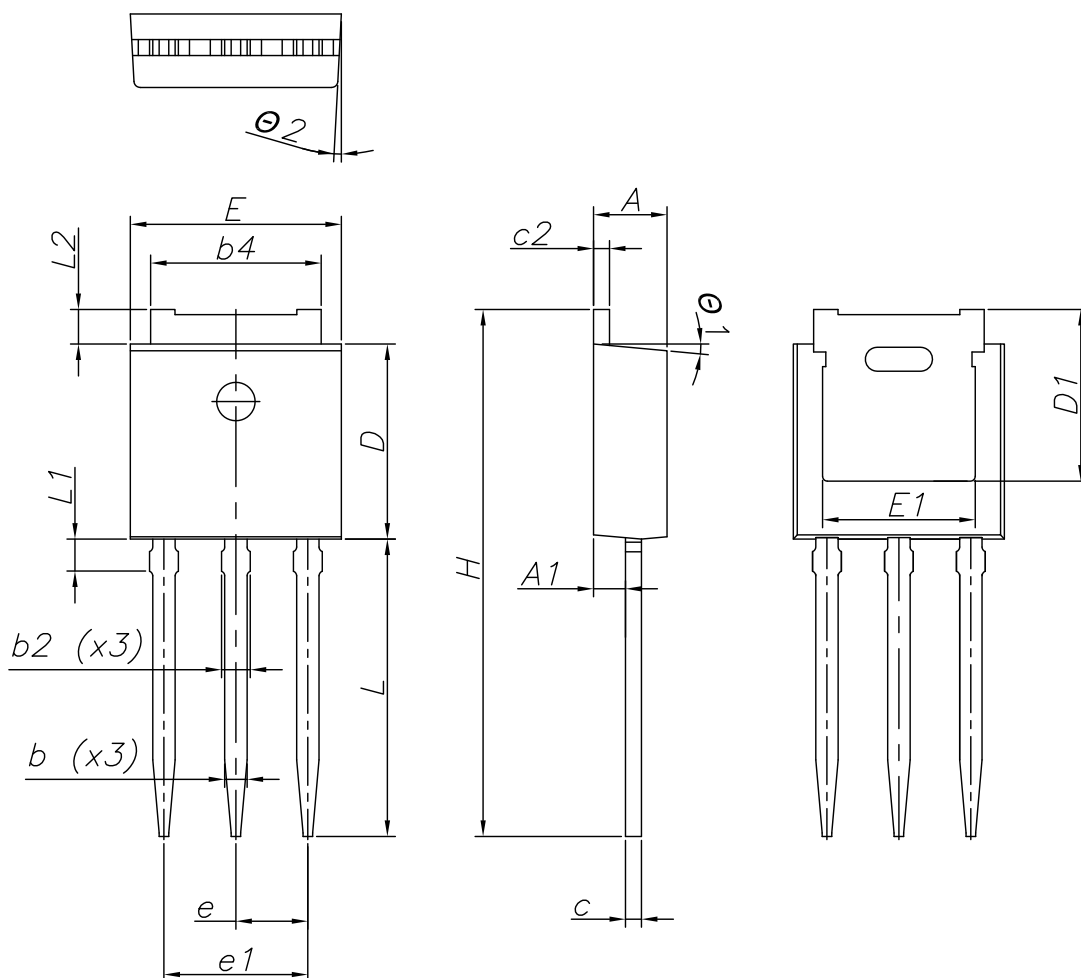
0068771\_IK\_typeA\_rev14

**Table 15. 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°   |      |

## 4.8 IPAK (TO-251) type C package information

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



0068771\_IK\_typeC\_rev14

**Table 16. 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 17. Order codes**

| Order code  | Marking   | Package            | Packing       |
|-------------|-----------|--------------------|---------------|
| STB5NK50Z-1 | B5NK50Z   | I <sup>2</sup> PAK | Tube          |
| STD5NK50ZT4 | D5NK50Z   | DPAK               | Tape and reel |
| STP5NK50Z   | P5NK50Z   | TO-220             | Tube          |
| STP5NK50ZFP | P5NK50ZFP | TO-220FP           | Tube          |
| STU5NK50Z   | 5NK50Z    | IPAK               | Tube          |

## Revision history

**Table 18. Document revision history**

| Date        | Version | Changes                                                                                                                                                      |
|-------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 16-Jun-2004 | 4       | D <sup>2</sup> PAK Included. New Stylesheet.                                                                                                                 |
| 06-Sep-2005 | 5       | Inserted Ecopack indication                                                                                                                                  |
| 18-Sep-2018 | 6       | The part number STB5NK50Z has been moved to a separate datasheet.<br>Added part number STU5NK50Z.<br>Updated <a href="#">Section 4 Package information</a> . |

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