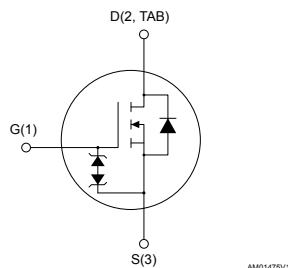
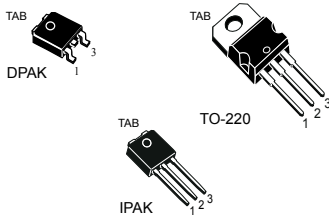


## N-channel 600 V, 0.86 $\Omega$ typ., 5 A, MDmesh™ M2 Power MOSFETs in DPAK, TO-220 and IPAK packages



### Features

| Order codes | $V_{DS} @ T_{Jmax}$ | $R_{DS(on)}$ max. | $I_D$ |
|-------------|---------------------|-------------------|-------|
| STD7N60M2   | 650 V               | 0.95 $\Omega$     | 5 A   |
| STP7N60M2   |                     |                   |       |
| STU7N60M2   |                     |                   |       |

- 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.

#### Product status link

[STD7N60M2](#)

[STP7N60M2](#)

[STU7N60M2](#)

#### Product summary

|            |               |
|------------|---------------|
| Order code | STD7N60M2     |
| Marking    | 7N60M2        |
| Package    | DPAK          |
| Packing    | Tape and reel |
| Order code | STP7N60M2     |
| Marking    | 7N60M2        |
| Package    | TO-220        |
| Packing    | Tube          |
| Order code | STU7N60M2     |
| Marking    | 7N60M2        |
| Package    | IPAK          |
| Packing    | Tube          |

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol         | Parameter  | Value      | Unit             |
|----------------|--|------------|------------------|
| $V_{GS}$       | Gate-source voltage  | $\pm 25$   | V                |
| $I_D^{(1)}$    | Drain current (continuous) at $T_{case} = 25\text{ }^\circ\text{C}$  | 5          | A                |
|                | Drain current (continuous) at $T_{case} = 100\text{ }^\circ\text{C}$ | 3.5        |                  |
| $I_{DM}^{(2)}$ | Drain current (pulsed)   | 20         | A                |
| $P_{TOT}$      | Total dissipation at $T_{case} = 25\text{ }^\circ\text{C}$           | 60         | W                |
| $dv/dt^{(3)}$  | Peak diode recovery voltage slope                                    | 15         | V/ns             |
| $dv/dt^{(4)}$  | MOSFET $dv/dt$ ruggedness  | 50         |                  |
| $T_{stg}$      | Storage temperature range  | -55 to 150 | $^\circ\text{C}$ |
| $T_j$          | Operating junction temperature range                                 |            |                  |

1. Limited by maximum junction temperature.
2. Pulse width limited by safe operating area.
3.  $I_{SD} \leq 5\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ;  $V_{DS\ peak} < V_{(BR)DSS}$ ,  $V_{DD}=400\text{ V}$
4.  $V_{DS} \leq 480\text{ V}$

**Table 2. Thermal data**

| Symbol              | Parameter                           | Value |        |      | Unit                      |
|---------------------|-------------------------------------|-------|--------|------|---------------------------|
|                     |                                     | DPAK  | TO-220 | IPAK |                           |
| $R_{thj-case}$      | Thermal resistance junction-case    | 2.08  |        |      | $^\circ\text{C}/\text{W}$ |
| $R_{thj-pcb}^{(1)}$ | Thermal resistance junction-pcb     | 50    |        |      | $^\circ\text{C}/\text{W}$ |
| $R_{thj-amb}$       | Thermal resistance junction-ambient |       | 62.5   | 100  | $^\circ\text{C}/\text{W}$ |

1. When mounted on 1 inch<sup>2</sup> FR-4, 2 Oz copper board

**Table 3. Avalanche characteristics**

| Symbol   | Parameter   | Value | Unit |
|----------|---|-------|------|
| $I_{AR}$ | Avalanche current, repetitive or non-repetitive (pulse width limited by $T_{Jmax}$ )                                    | 1.5   | A    |
| $E_{AS}$ | Single pulse avalanche energy<br>(starting $T_j = 25\text{ }^\circ\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ ) | 99    | mJ   |

## 2 Electrical characteristics

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

**Table 4. 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             |
| $I_{\text{DSS}}$            | Zero gate voltage drain current   | $V_{\text{GS}} = 0\text{ V}$ , $V_{\text{DS}} = 600\text{ V}$   |      |      | 1        | $\mu\text{A}$ |
|                             |                                   | $V_{\text{GS}} = 0\text{ V}$ , $V_{\text{DS}} = 600\text{ V}$ ,<br>$T_{\text{case}} = 125\text{ }^{\circ}\text{C}$ <sup>(1)</sup> |      |      | 100      |               |
| $I_{\text{GSS}}$            | Gate-body leakage current         | $V_{\text{DS}} = 0\text{ V}$ , $V_{\text{GS}} = \pm 25\text{ V}$  |      |      | $\pm 10$ | $\mu\text{A}$ |
| $V_{\text{GS(th)}}$         | 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 | $V_{\text{GS}} = 10\text{ V}$ , $I_{\text{D}} = 2.5\text{ A}$   |      | 0.86 | 0.95     | $\Omega$      |

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

**Table 5. Dynamic**

| Symbol                     | Parameter                     | Test conditions  | Min. | Typ. | Max. | Unit          |
|----------------------------|-------------------------------|--|------|------|------|---------------|
| $C_{\text{iss}}$           | Input capacitance             | $V_{\text{DS}} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{\text{GS}} = 0\text{ V}$   | -    | 271  | -    | $\mu\text{F}$ |
| $C_{\text{oss}}$           | Output capacitance            |  | -    | 15.7 | -    |               |
| $C_{\text{riss}}$          | Reverse transfer capacitance  |  | -    | 0.68 | -    |               |
| $C_{\text{oss eq.}}^{(1)}$ | Equivalent output capacitance | $V_{\text{DS}} = 0\text{ to }480\text{ V}$ , $V_{\text{GS}} = 0\text{ V}$  | -    | 75.5 | -    | $\mu\text{F}$ |
| $R_{\text{G}}$             | Intrinsic gate resistance     | $f = 1\text{ MHz}$ , $I_{\text{D}} = 0\text{ A}$   | -    | 7.2  | -    | $\Omega$      |
| $Q_{\text{g}}$             | Total gate charge             | $V_{\text{DD}} = 480\text{ V}$ , $I_{\text{D}} = 5\text{ A}$ ,<br>$V_{\text{GS}} = 0\text{ to }10\text{ V}$ (see Figure 17. Test circuit for gate charge behavior) | -    | 8.8  | -    | nC            |
| $Q_{\text{gs}}$            | Gate-source charge            |  | -    | 1.8  | -    |               |
| $Q_{\text{gd}}$            | Gate-drain charge             |  | -    | 4.3  | -    |               |

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

**Table 6. Switching times**

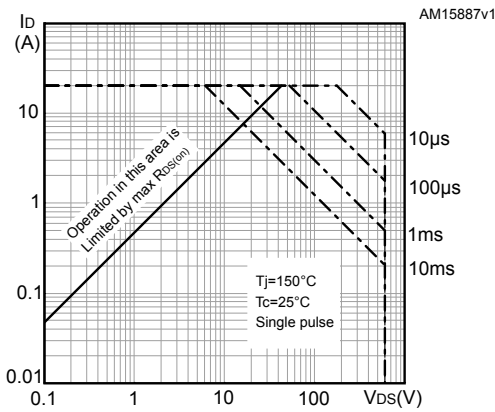
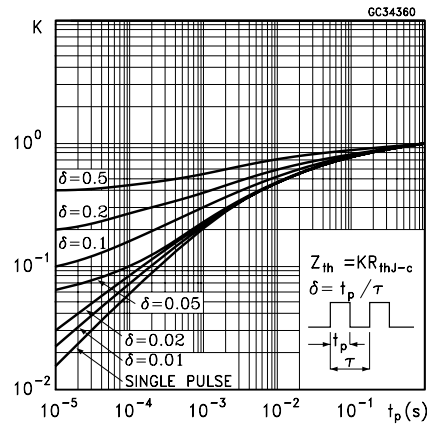
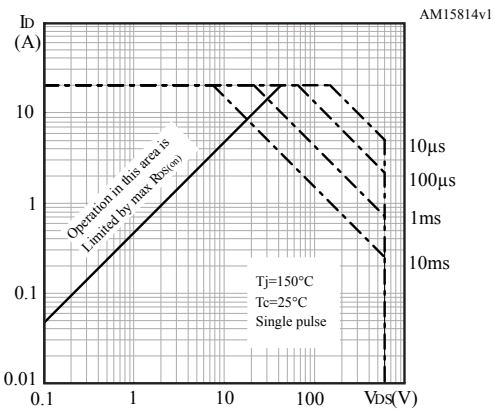
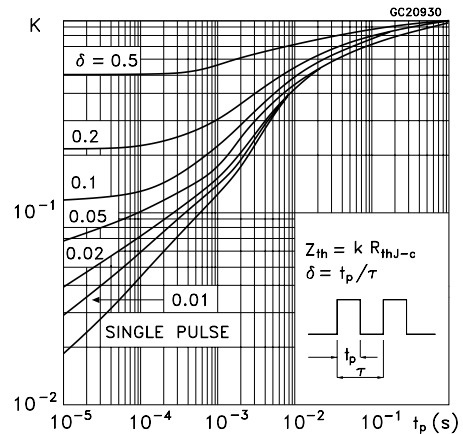
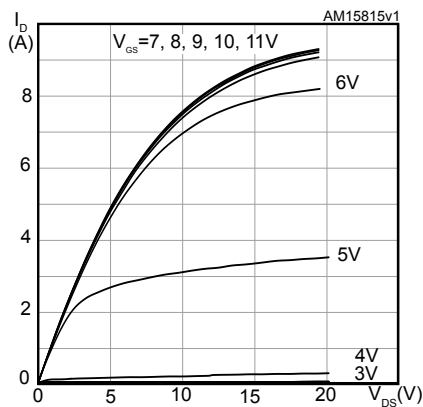
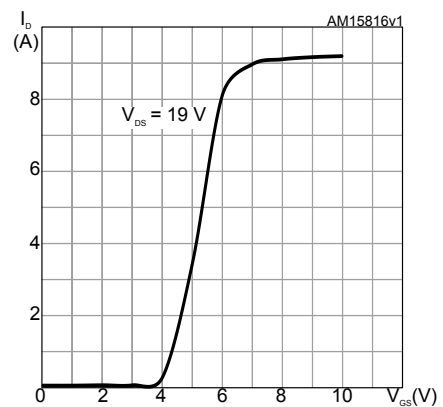
| Symbol              | Parameter           | Test conditions   | Min. | Typ. | Max. | Unit |
|---------------------|---------------------|---|------|------|------|------|
| $t_{\text{d(on)}}$  | Turn-on delay time  | $V_{\text{DD}} = 300\text{ V}$ , $I_{\text{D}} = 2.5\text{ A}$ , $R_{\text{G}} = 4.7\text{ }\Omega$ ,<br>$V_{\text{GS}} = 10\text{ V}$<br>(see Figure 16. Test circuit for resistive load switching times and Figure 21. Switching time waveform) | -    | 7.6  | -    | ns   |
| $t_{\text{r}}$      | Rise time           |   | -    | 7.2  | -    |      |
| $t_{\text{d(off)}}$ | Turn-off delay time |   | -    | 19.3 | -    |      |
| $t_{\text{f}}$      | Fall time           |   | -    | 15.9 | -    |      |

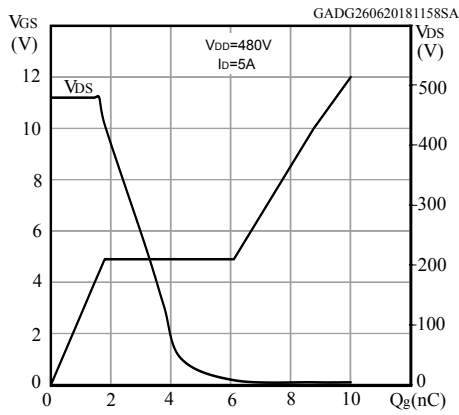
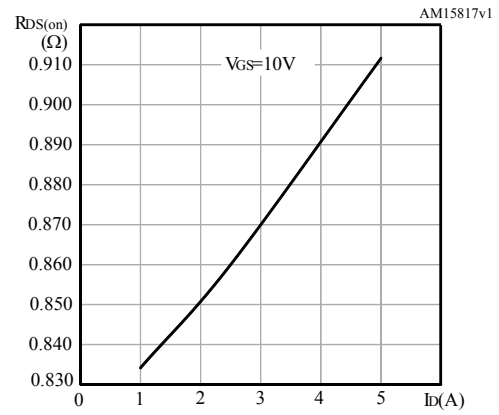
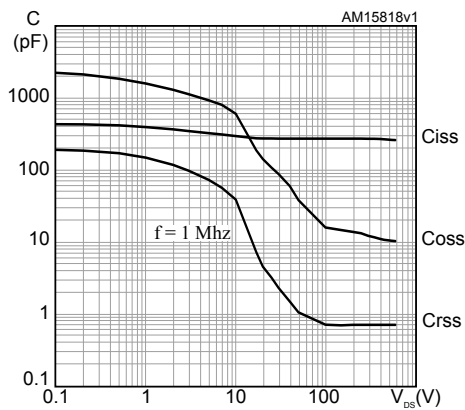
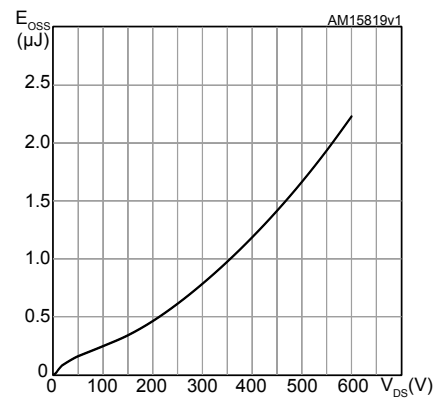
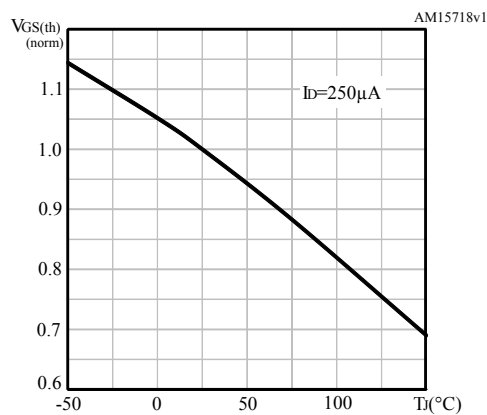
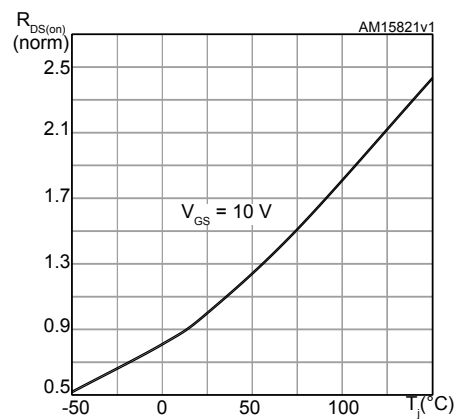
**Table 7. Source-drain diode**

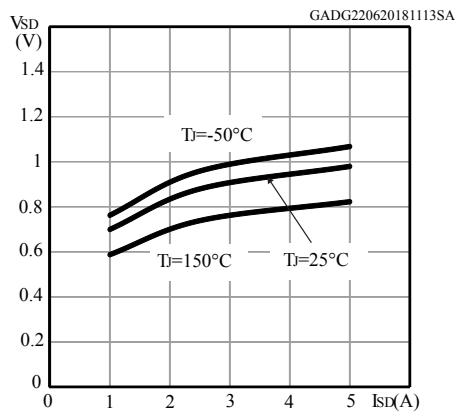
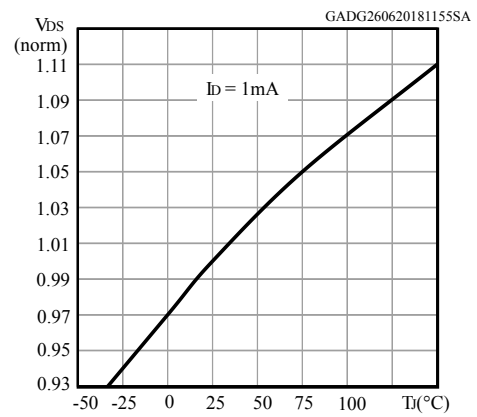
| Symbol          | Parameter                     | Test conditions   | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|---|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |   | -    |      | 5    | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |   | -    |      | 20   | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $V_{GS} = 0\text{ V}$ , $I_{SD} = 5\text{ A}$   | -    |      | 1.6  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60\text{ V}$ (see Figure 18. Test circuit for inductive load switching and diode recovery times )                                     | -    | 275  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |   | -    | 1.55 |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |   | -    | 11   |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$ (see Figure 18. Test circuit for inductive load switching and diode recovery times ) | -    | 376  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |   | -    | 2.1  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |   | -    | 11   |      | A             |

1. Pulse width is limited by safe operating area.

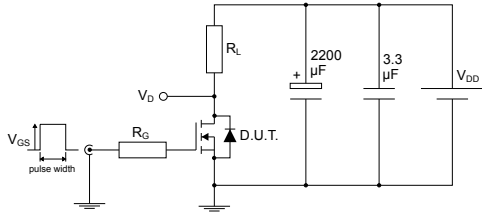
2. Pulse test: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

**2.1 Electrical characteristics (curves)**
**Figure 2. Safe operating area for DPAK and IPAK**

**Figure 3. Thermal impedance for DPAK and IPAK**

**Figure 4. Safe operating area for TO-220**

**Figure 5. Thermal impedance for TO-220**

**Figure 6. Output characteristics**

**Figure 7. Transfer characteristics**


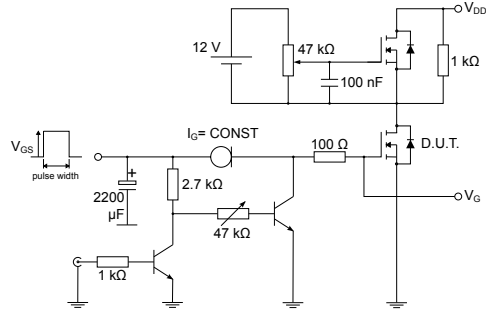
**Figure 8. Gate charge vs gate-source voltage**

**Figure 9. Static drain-source on-resistance**

**Figure 10. Capacitance variations**

**Figure 11. Output capacitance stored energy**

**Figure 12. Normalized gate threshold voltage vs temperature**

**Figure 13. Normalized on-resistance vs temperature**


**Figure 14. Source-drain diode forward characteristics**

**Figure 15. Normalized  $V_{(BR)DSS}$  vs temperature**


### 3 Test circuits

**Figure 16. Test circuit for resistive load switching times**


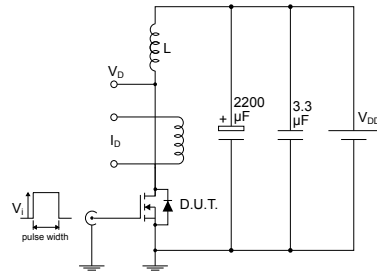
AM01468v1

**Figure 17. Test circuit for gate charge behavior**


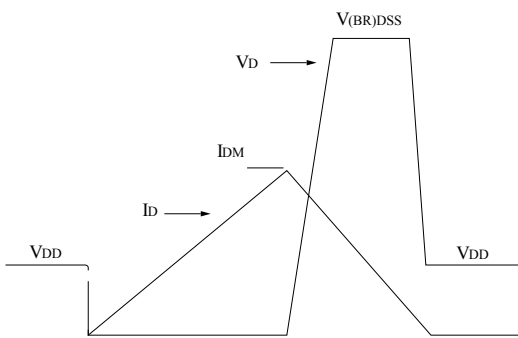
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**Figure 18. Test circuit for inductive load switching and diode recovery times**

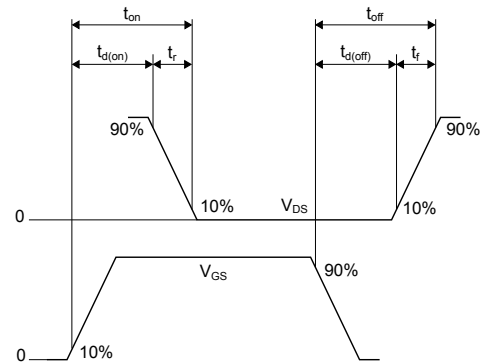

AM01470v1

**Figure 19. Unclamped inductive load test circuit**


AM01471v1

**Figure 20. Unclamped inductive waveform**


AM01472v1

**Figure 21. Switching time waveform**


AM01473v1



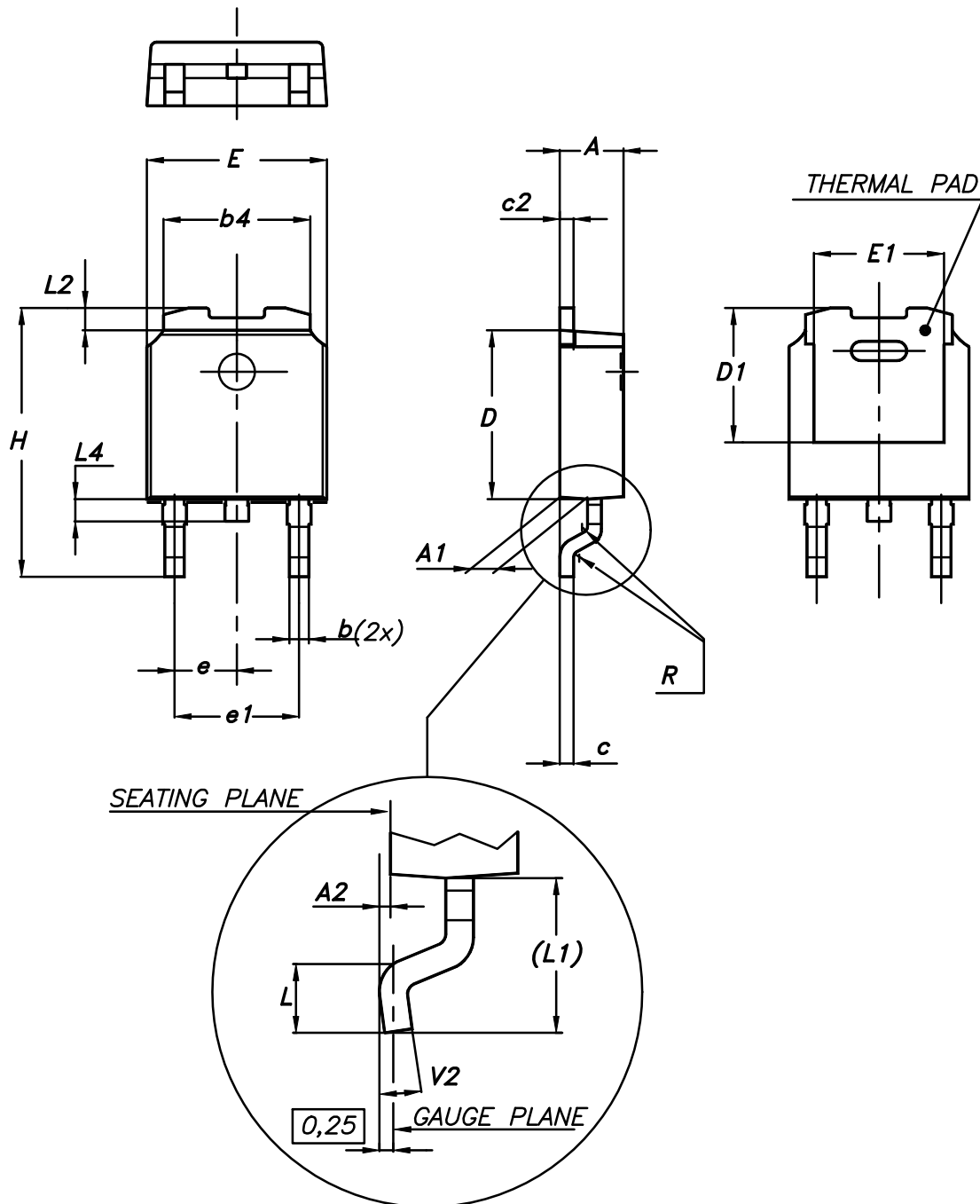
## 4 Package information

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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 DPAK (TO-252) type A package information

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



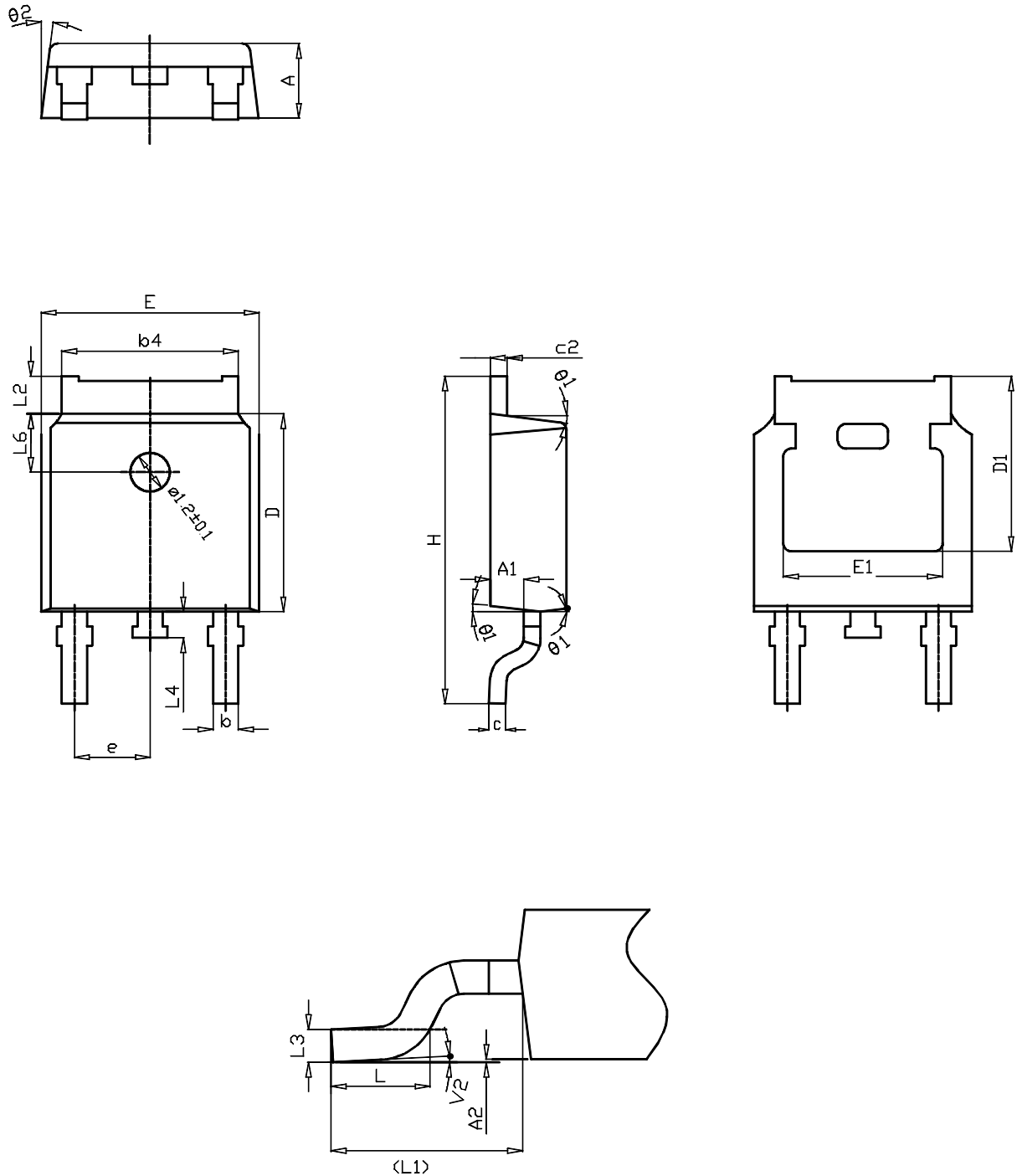
0068772\_A\_25

**Table 8. 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

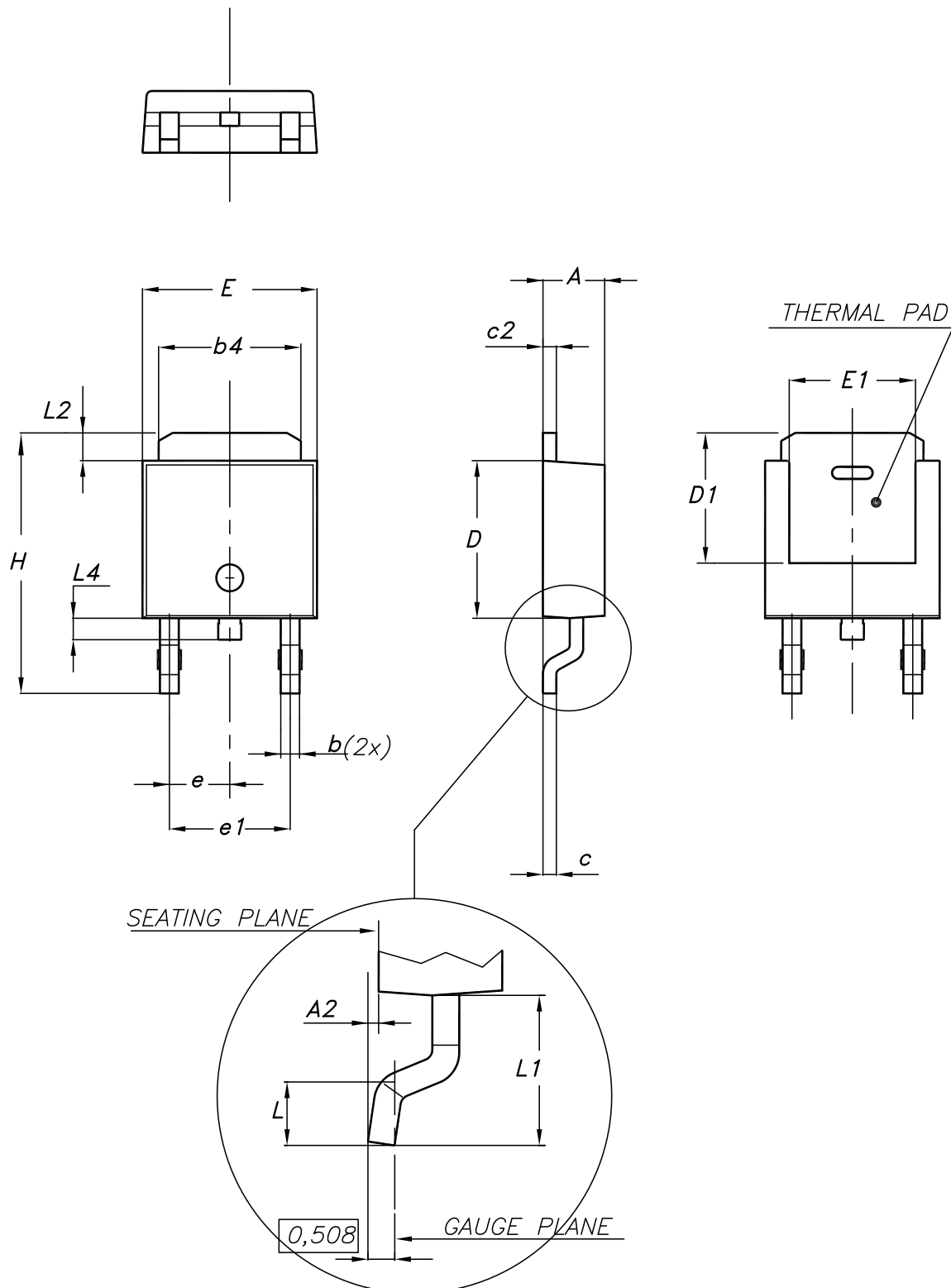
Figure 23. DPAK (TO-252) type C package outline



0068772\_C\_25

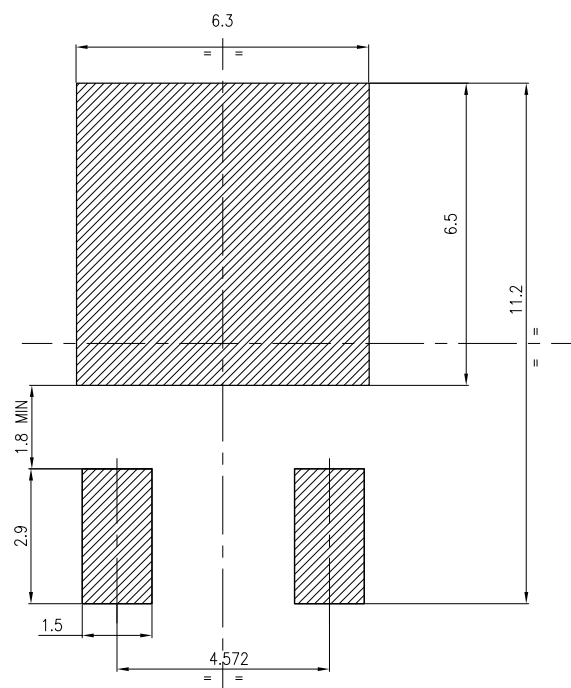
**Table 9. DPAK (TO-252) type C mechanical data**

| 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 24. DPAK (TO-252) type E package outline**


**Table 10. 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 25. DPAK (TO-252) recommended footprint (dimensions are in mm)**


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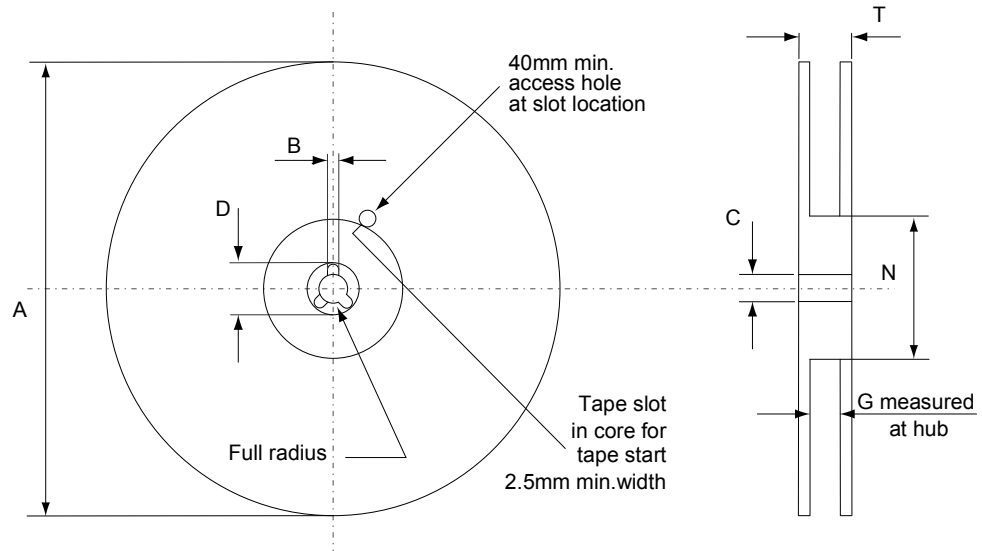
#### 4.4 DPAK (TO-252) packing information

Figure 26. DPAK (TO-252) tape outline



AM08852v1

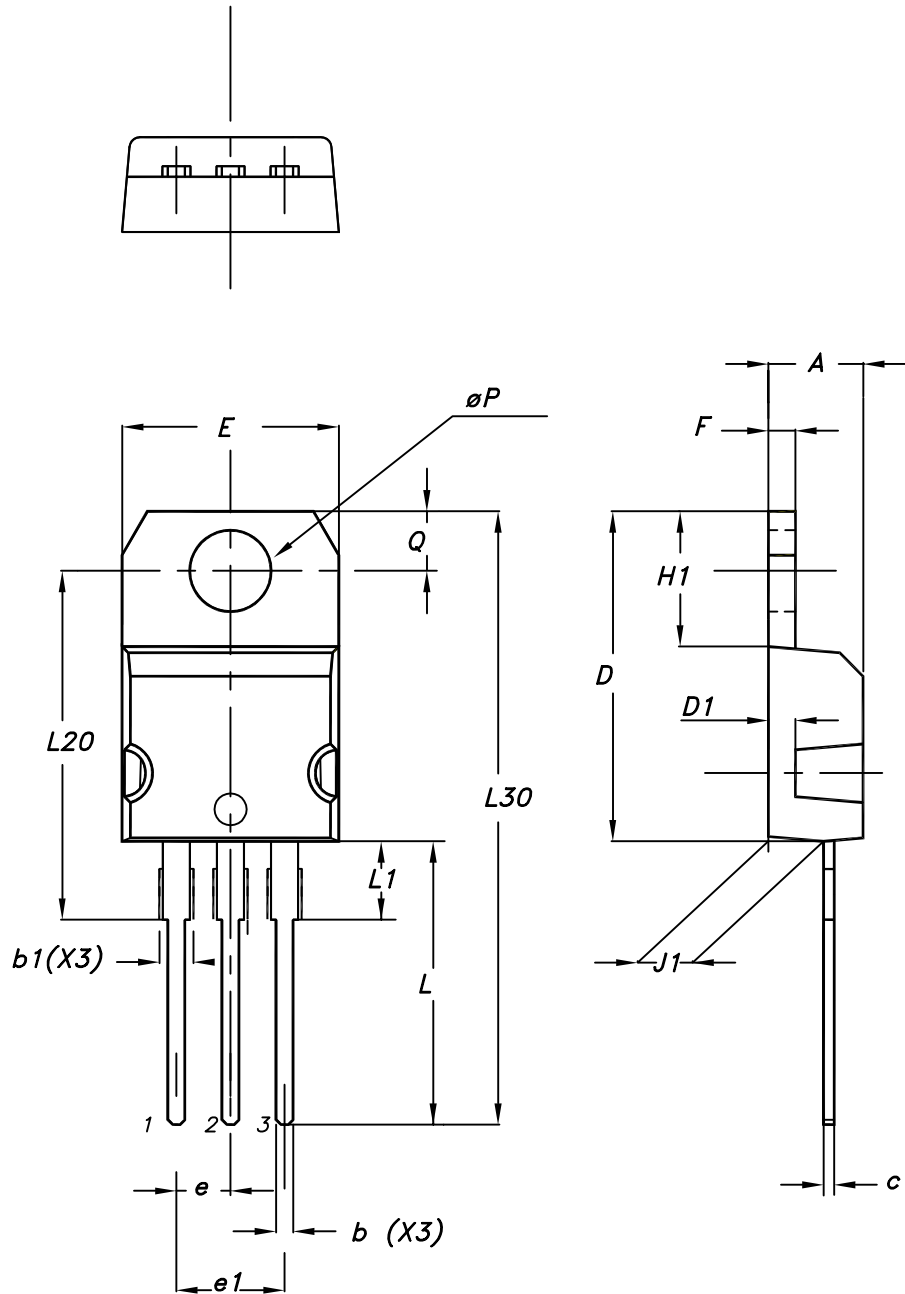


**Figure 27. DPAK (TO-252) reel outline**


AM06038v1

**Table 11. DPAK (TO-252) tape and reel mechanical data**

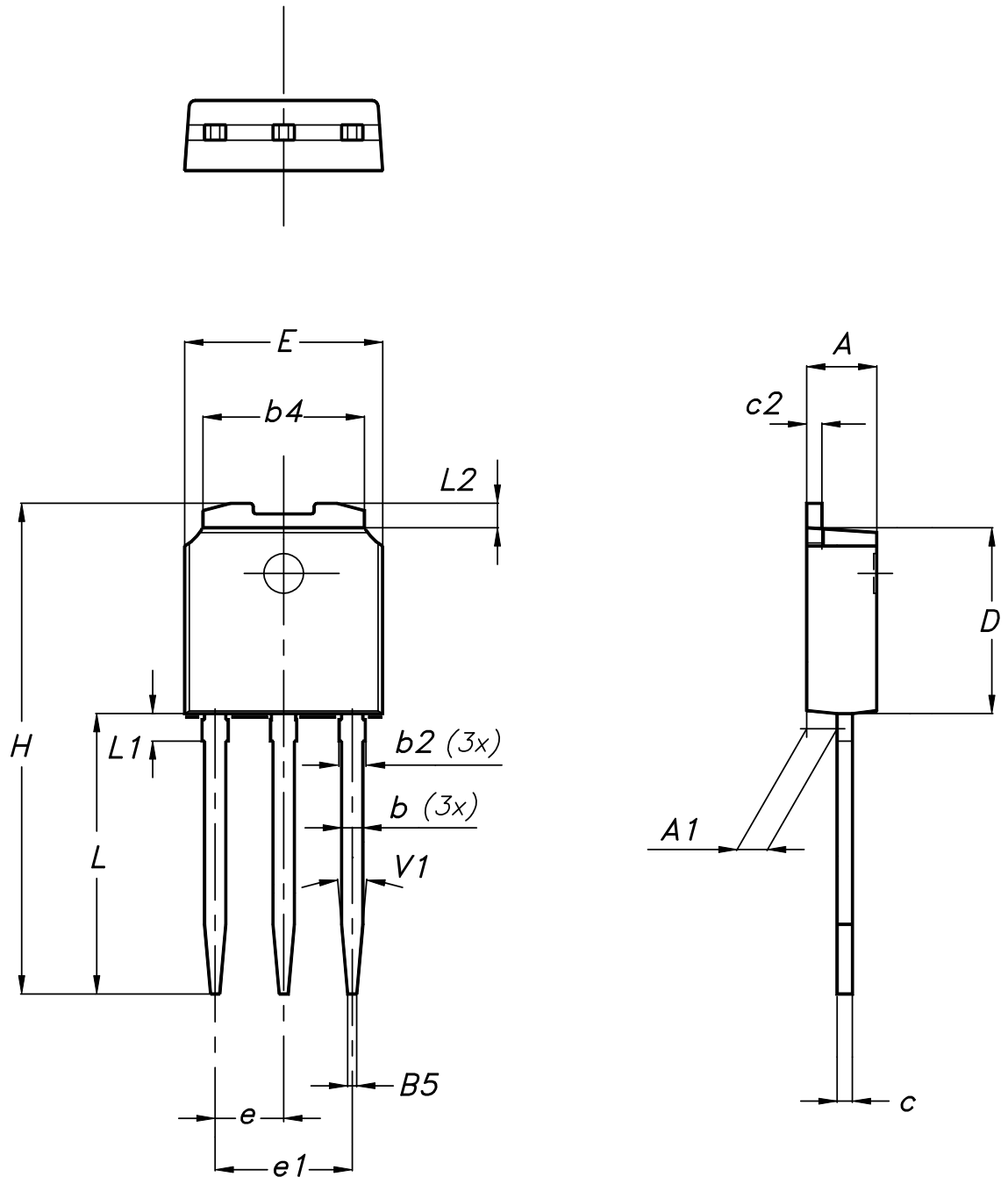
| Tape |      |      | Reel      |      |      |
|------|------|------|-----------|------|------|
| Dim. | mm   |      | Dim.      | mm   |      |
|      | Min. | Max. |           | Min. | Max. |
| A0   | 6.8  | 7    | A         |      | 330  |
| B0   | 10.4 | 10.6 | B         | 1.5  |      |
| B1   |      | 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 28. TO-220 type A package outline**


0015988\_typeA\_Rev\_21

**Table 12. 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 29. IPAK (TO-251) type A package outline**


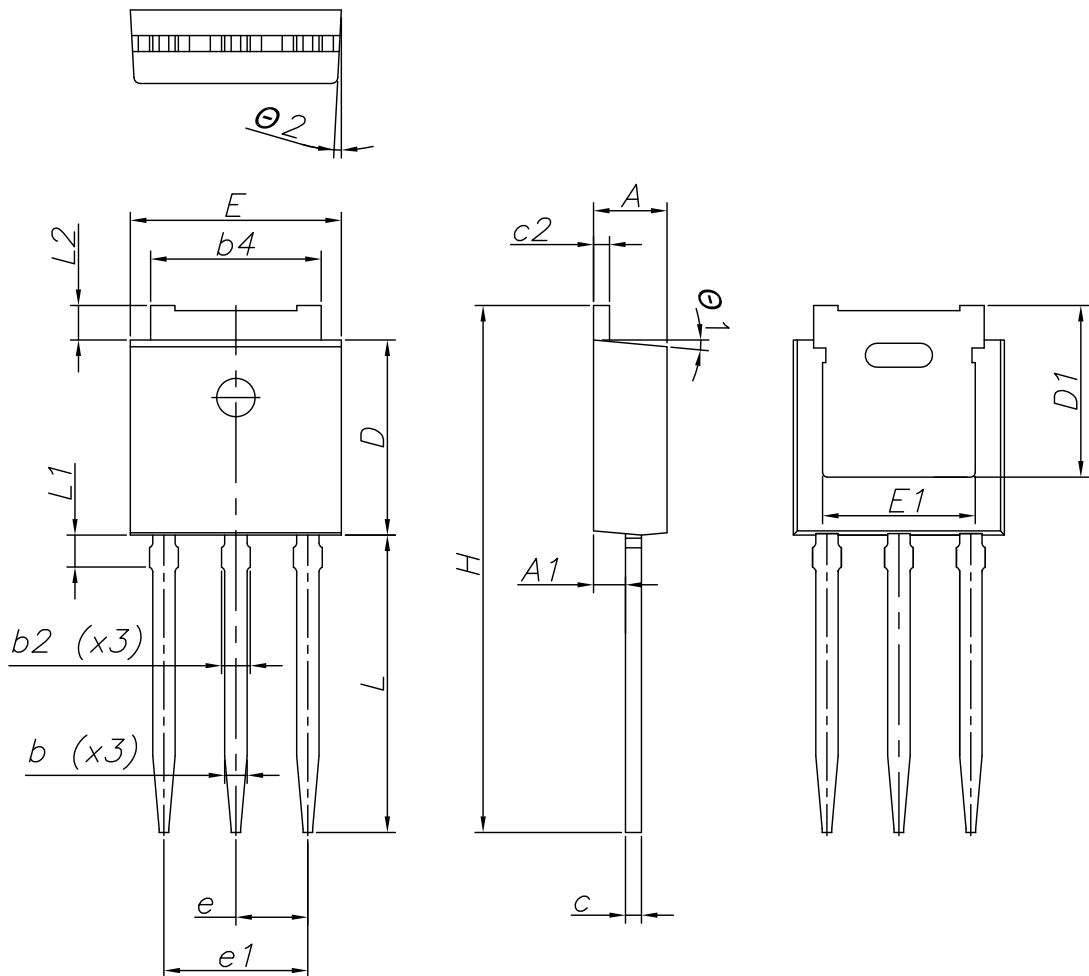
0068771\_IK\_typeA\_rev14

**Table 13. 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 14. 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°    |

## Revision history

**Table 15. Document revision history**

| Date        | Revision | Changes   |
|-------------|----------|---|
| 06-Jun-2013 | 1        | First release.  |
| 12-Jul-2018 | 2        | Removed maturity status indication from cover page. The document status is production data.<br>Added <a href="#">Section 4.2 DPAK (TO-252) type C package information</a> and <a href="#">Section 4.3 DPAK (TO-252) type E package information</a> .<br>Minor text changes. |



## Contents

|            |  |           |
|------------|--|-----------|
| <b>1</b>   | <b>Electrical ratings</b> .....                | <b>2</b>  |
| <b>2</b>   | <b>Electrical characteristics</b> .....        | <b>3</b>  |
| <b>2.1</b> | Electrical characteristics (curves) .....      | 5         |
| <b>3</b>   | <b>Test circuits</b> .....                     | <b>8</b>  |
| <b>4</b>   | <b>Package information</b> .....               | <b>9</b>  |
| <b>4.1</b> | DPAK (TO-252) type A package information ..... | 9         |
| <b>4.2</b> | DPAK (TO-252) type C package information ..... | 11        |
| <b>4.3</b> | DPAK (TO-252) type E package information ..... | 13        |
| <b>4.4</b> | DPAK (TO-252) packing information .....        | 15        |
| <b>4.5</b> | TO-220 type A package information .....        | 17        |
| <b>4.6</b> | IPAK (TO-251) type A package information ..... | 19        |
| <b>4.7</b> | IPAK (TO-251) type C package information ..... | 21        |
|            | <b>Revision history</b> .....                  | <b>24</b> |

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