

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol                  | Parameter   | Value      |                   | Unit               |
|-------------------------|---|------------|-------------------|--------------------|
|                         |   | DPAK, IPAK | TO-220FP          |                    |
| $V_{DS}$                | Drain-source voltage  | 600        |                   | V                  |
| $V_{GS}$                | Gate-source voltage   | $\pm 25$   |                   | V                  |
| $I_D$                   | Drain current (continuous) at $T_C = 25\text{ }^{\circ}\text{C}$  | 5          | 5 <sup>(1)</sup>  | A                  |
| $I_D$                   | Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$   | 3          | 3 <sup>(1)</sup>  | A                  |
| $I_{DM}$ <sup>(2)</sup> | Drain current (pulsed)  | 20         | 20 <sup>(1)</sup> | A                  |
| $P_{TOT}$               | Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$   | 45         | 20                | W                  |
| $V_{ISO}$               | Insulation withstand voltage (RMS) from all three leads to external heat-sink ( $t = 1\text{ s}$ , $T_C = 25\text{ }^{\circ}\text{C}$ ) |            | 2.5               | kV                 |
| $dv/dt$ <sup>(3)</sup>  | Peak diode recovery voltage slope   | 15         |                   | V/ns               |
| $T_J$                   | Operating junction temperature range  | -55 to 150 |                   | $^{\circ}\text{C}$ |
| $T_{stg}$               | Storage temperature range   |            |                   |                    |

1. Limited by maximum junction temperature.

2. Pulse width limited by safe operating area.

3.  $I_{SD} \leq 5\text{ A}$ ,  $di/dt \leq 100\text{ A}/\mu\text{s}$ ,  $V_{DSpeak} \leq V_{(BR)DSS}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$ .

**Table 2. Thermal data**

| Symbol                       | Parameter                           | Value |          |      | Unit                        |
|------------------------------|-------------------------------------|-------|----------|------|-----------------------------|
|                              |                                     | DPAK  | TO-220FP | IPAK |                             |
| $R_{thj-case}$               | Thermal resistance junction-case    | 2.78  | 6.25     | 2.78 | $^{\circ}\text{C}/\text{W}$ |
| $R_{thj-amb}$                | Thermal resistance junction-ambient |       | 62.5     | 100  | $^{\circ}\text{C}/\text{W}$ |
| $R_{thj-pcb}$ <sup>(1)</sup> | Thermal resistance junction-pcb     | 50    |          |      | $^{\circ}\text{C}/\text{W}$ |

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

**Table 3. Avalanche characteristics**

| Symbol                  | Parameter                                       | Value | Unit |
|-------------------------|---|-------|------|
| $I_{AS}$ <sup>(1)</sup> | Avalanche current, repetitive or not-repetitive | 2     | A    |
| $E_{AS}$ <sup>(2)</sup> | Single pulse avalanche energy                   | 119   | mJ   |

1. Pulse width limited by  $T_J$  max.

2. Starting  $T_J = 25\text{ }^{\circ}\text{C}$ ,  $I_D = I_{AS}$ ,  $V_{DD} = 50\text{ V}$ .

## 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    | $I_D = 1\text{ mA}$ , $V_{GS} = 0\text{ V}$  | 600  |      |      | V             |
| $I_{DSS}$     | Zero gate voltage drain current   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$  |      |      | 1    | $\mu\text{A}$ |
|               |                                   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$ , $T_C = 125\text{ }^{\circ}\text{C}$ <sup>(1)</sup> |      |      | 100  | $\mu\text{A}$ |
| $I_{GSS}$     | Gate body leakage current         | $V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 20\text{ V}$   |      |      | 100  | nA            |
| $V_{GS(th)}$  | Gate threshold voltage            | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$   | 2    | 3    | 4    | V             |
| $R_{DS(on)}$  | Static drain-source on resistance | $V_{GS} = 10\text{ V}$ , $I_D = 2.5\text{ A}$  |      | 0.8  | 0.9  | $\Omega$      |

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

**Table 5. Dynamic**

| Symbol                     | Parameter                           | Test conditions   | Min. | Typ. | Max. | Unit          |
|----------------------------|-------------------------------------|---|------|------|------|---------------|
| $C_{iss}$                  | Input capacitance                   | $V_{DS} = 50\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$   | -    | 363  | -    | $\mu\text{F}$ |
| $C_{oss}$                  | Output capacitance                  |   |      | 24.6 |      |               |
| $C_{rss}$                  | Reverse transfer capacitance        |   |      | 1.1  |      |               |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent capacitance time related | $V_{DS} = 0\text{ to }480\text{ V}$ , $V_{GS} = 0\text{ V}$   | -    | 130  | -    | $\mu\text{F}$ |
| $R_G$                      | Intrinsic gate resistance           | $f = 1\text{ MHz}$ open drain   | -    | 5.4  | -    | $\Omega$      |
| $Q_g$                      | Total gate charge                   | $V_{DD} = 480\text{ V}$ , $I_D = 5\text{ A}$ , $V_{GS} = 0\text{ to }10\text{ V}$<br>(see Figure 14. Test circuit for gate charge behavior) | -    | 14   | -    | nC            |
| $Q_{gs}$                   | Gate-source charge                  |   |      | 2.7  |      |               |
| $Q_{gd}$                   | Gate-drain charge                   |   |      | 7.7  |      |               |

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 80%  $V_{DSS}$ .

**Table 6. Switching times**

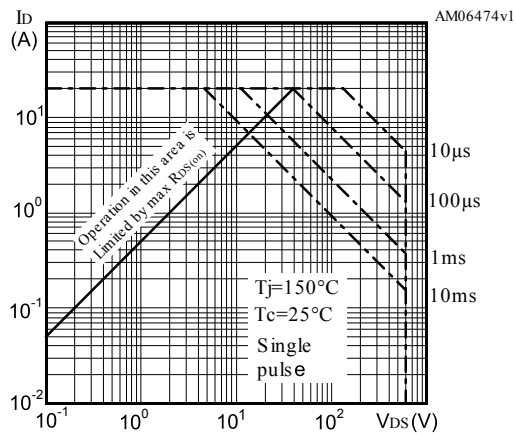
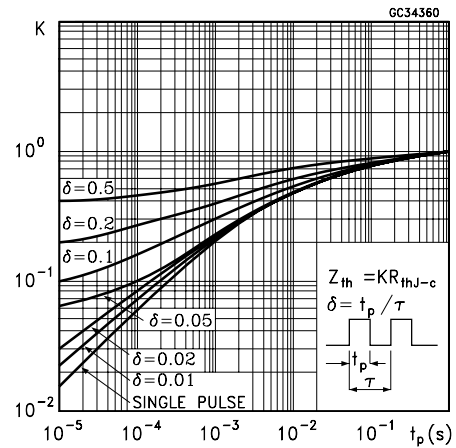
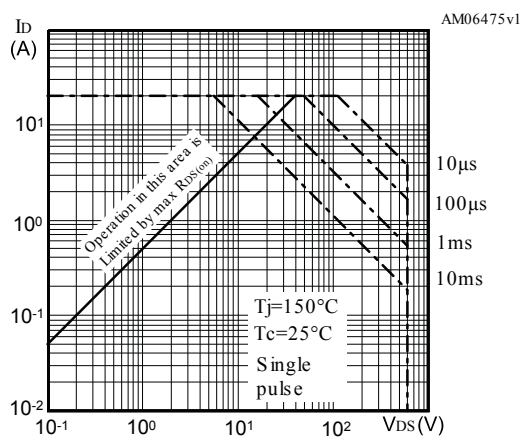
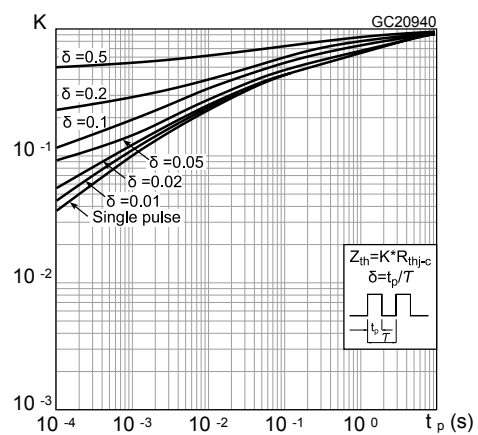
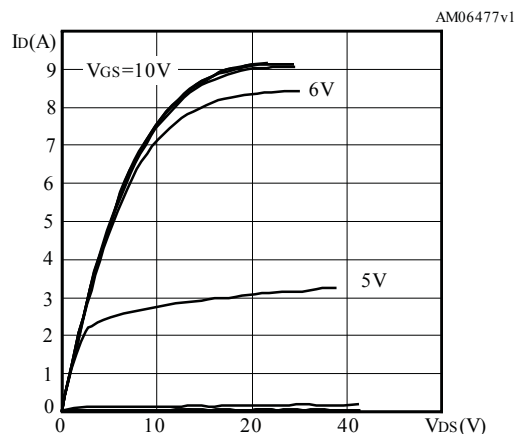
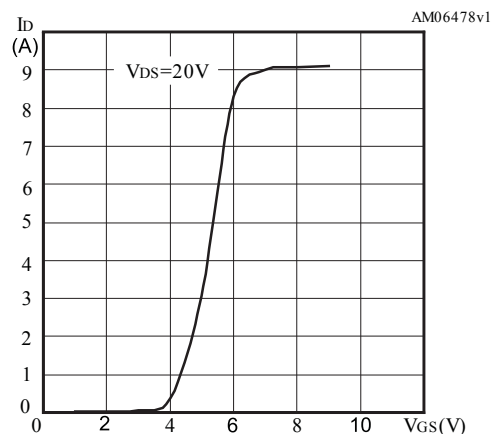
| Symbol       | Parameter           | Test conditions   | Min. | Typ. | Max. | Unit |
|--------------|---------------------|---|------|------|------|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 300\text{ V}$ , $I_D = 2.5\text{ A}$ ,<br>$R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$<br>(see Figure 13. Test circuit for resistive load switching times and Figure 18. Switching time waveform) | -    | 7    | -    | ns   |
| $t_r$        | Rise time           |   |      | 10   |      |      |
| $t_{d(off)}$ | Turn-off delay time |   |      | 26   |      |      |
| $t_f$        | Fall time           |   |      | 12   |      |      |

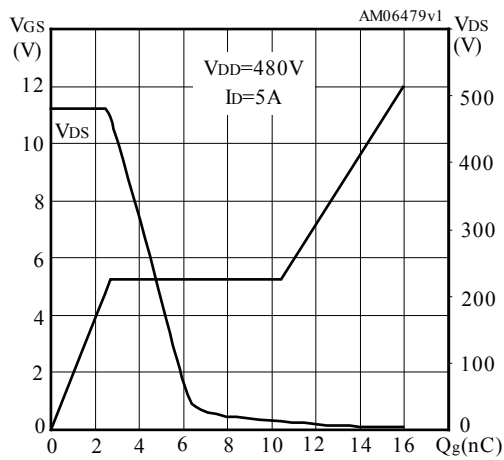
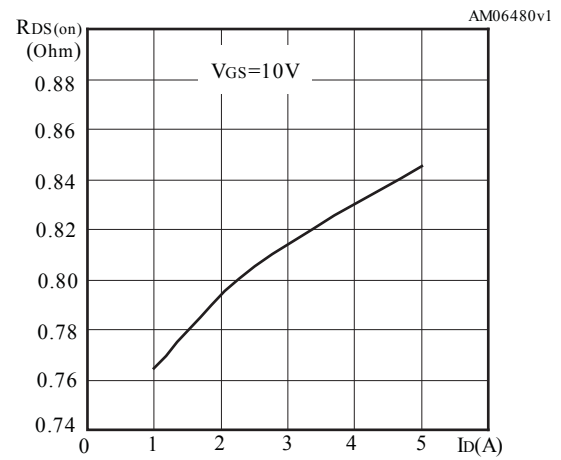
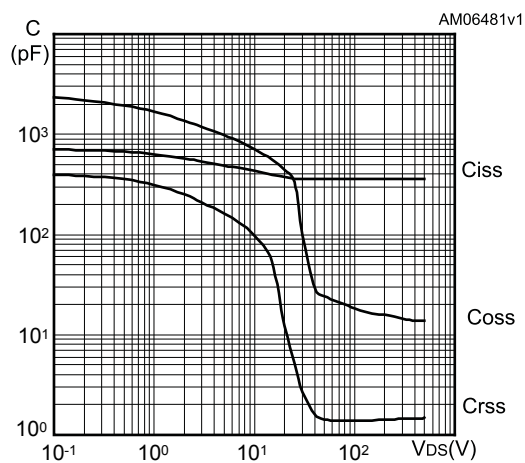
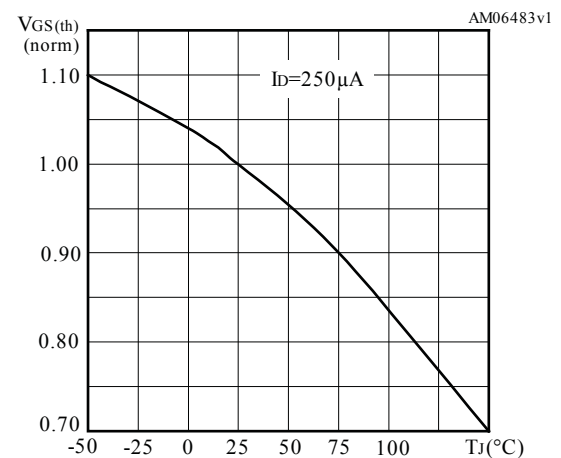
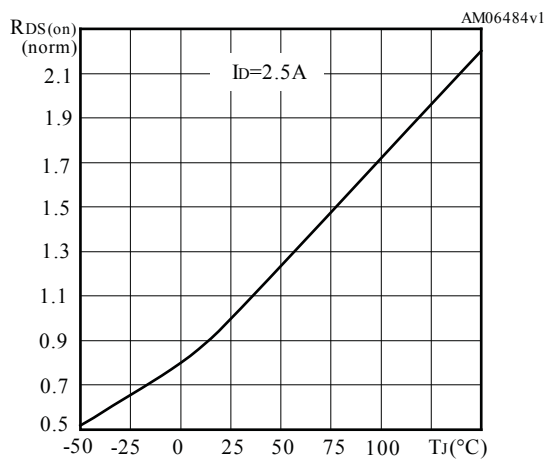
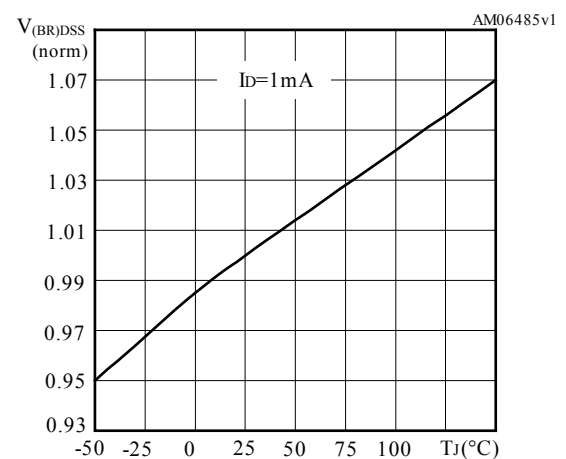
**Table 7. Source drain diode**

| Symbol          | Parameter                     | Test conditions   | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|---|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |   | -    |      | 5    | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |   |      |      | 20   |               |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 5\text{ A}$ , $V_{GS} = 0\text{ V}$   | -    |      | 1.3  | 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 <a href="#">Figure 15. Test circuit for inductive load switching and diode recovery times</a> )                                     | -    | 213  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |   |      | 1.5  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |   |      | 14   |      | 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 <a href="#">Figure 15. Test circuit for inductive load switching and diode recovery times</a> ) | -    | 265  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |   |      | 1.8  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |   |      | 14   |      | A             |

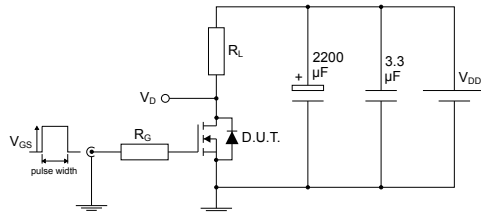
1. Pulse width limited by safe operating area.
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

## 2.1 Electrical characteristics curves

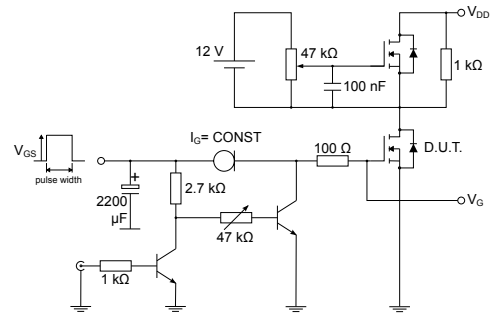
**Figure 1. Safe operating area for DPAK and IPAK**

**Figure 2. Thermal impedance for DPAK and 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. Gate charge vs gate-source voltage**

**Figure 8. Static drain-source on-resistance**

**Figure 9. Capacitance variations**

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

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

**Figure 12. Normalized  $V_{(BR)DSS}$  vs temperature**


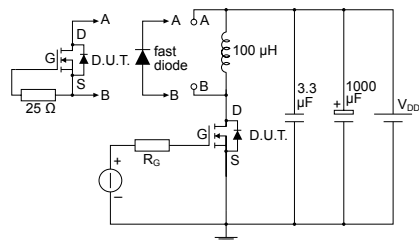
### 3 Test circuits

**Figure 13. Test circuit for resistive load switching times**


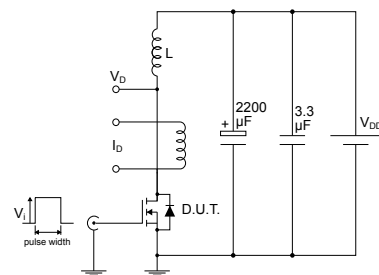
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**Figure 14. Test circuit for gate charge behavior**


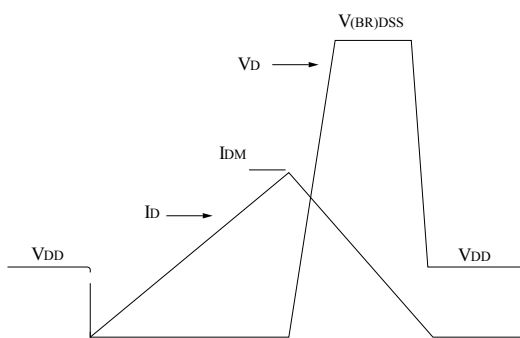
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**Figure 15. Test circuit for inductive load switching and diode recovery times**


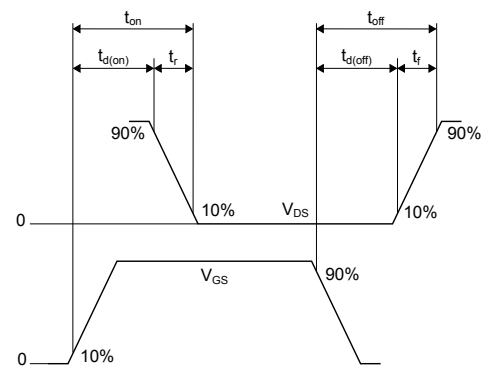
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**Figure 16. Unclamped inductive load test circuit**


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**Figure 17. Unclamped inductive waveform**


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**Figure 18. Switching time waveform**


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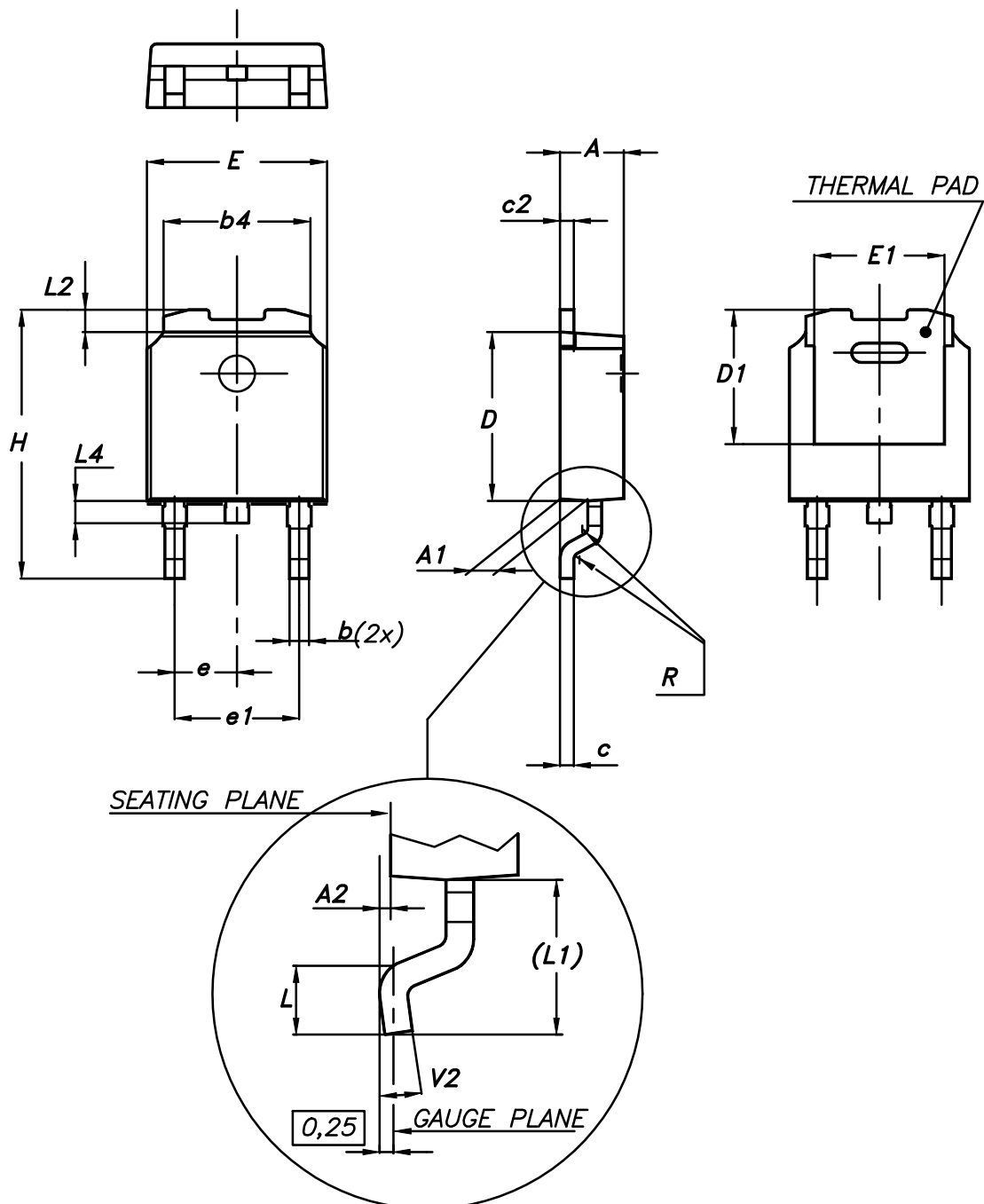
## 4 Package information

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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 19. DPAK (TO-252) type A package outline



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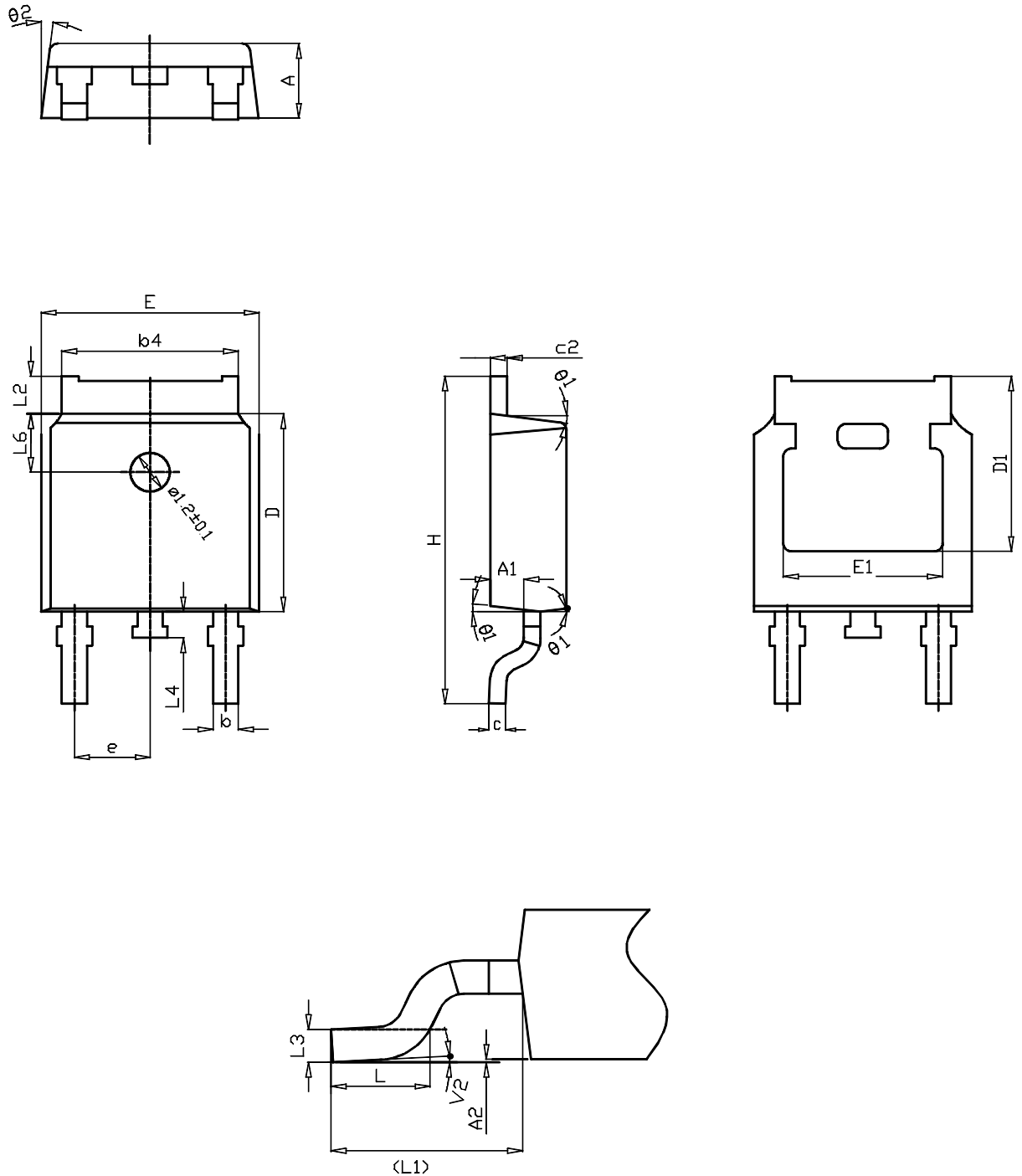


**Table 8. DPAK (TO-252) type A mechanical data**

| 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 20. DPAK (TO-252) type C package outline



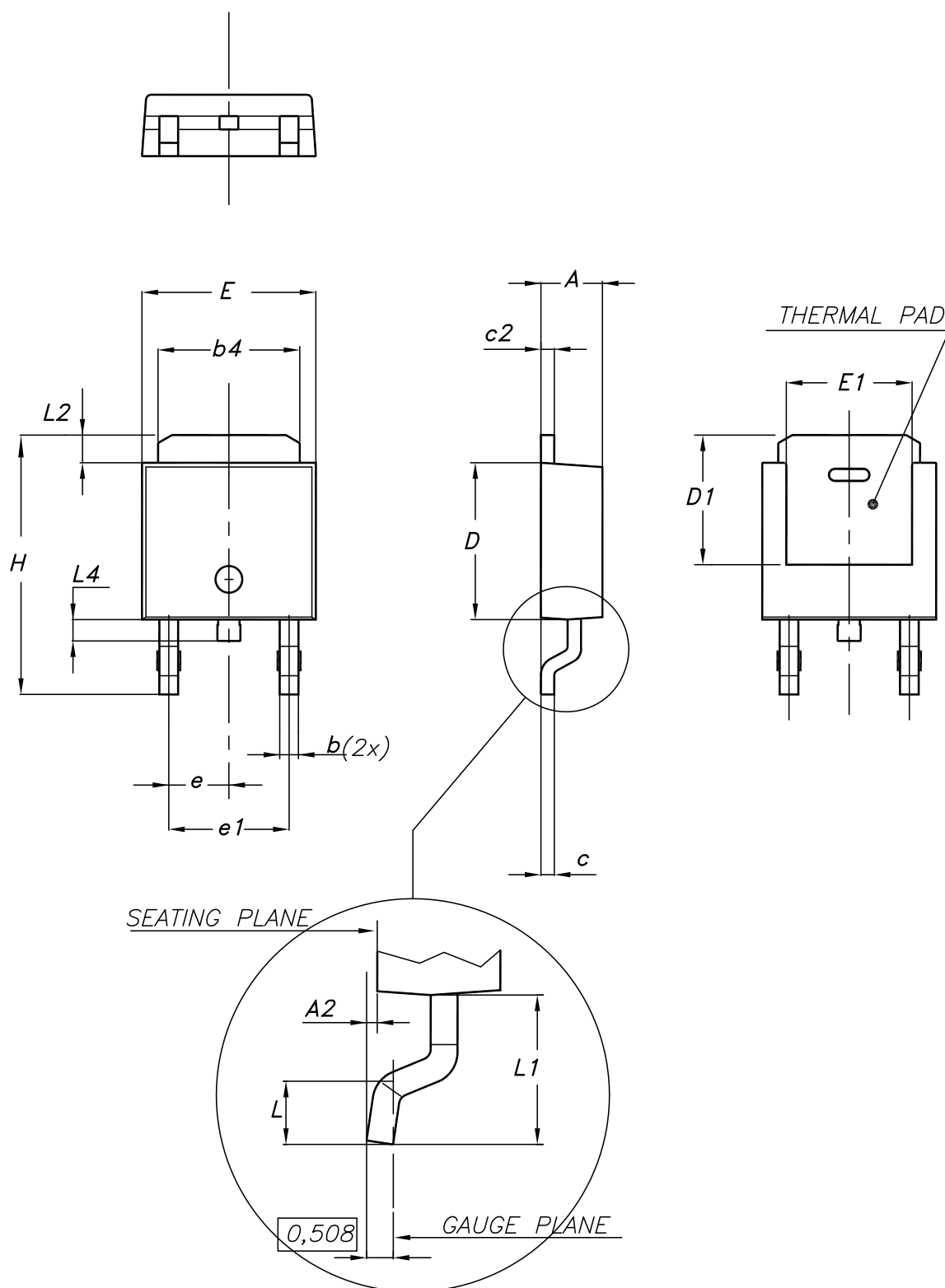
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**Table 9. DPAK (TO-252) type C mechanical data**

| 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

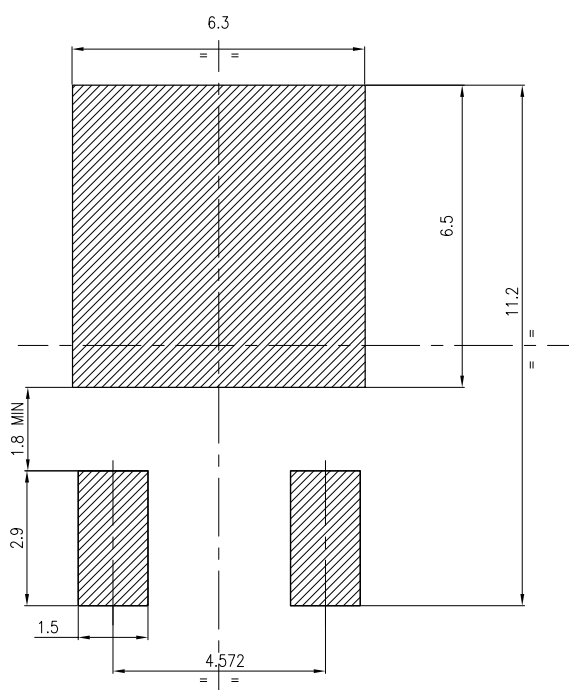
Figure 21. DPAK (TO-252) type E package outline



0068772\_type-E\_rev.25

**Table 10. DPAK (TO-252) type E mechanical data**

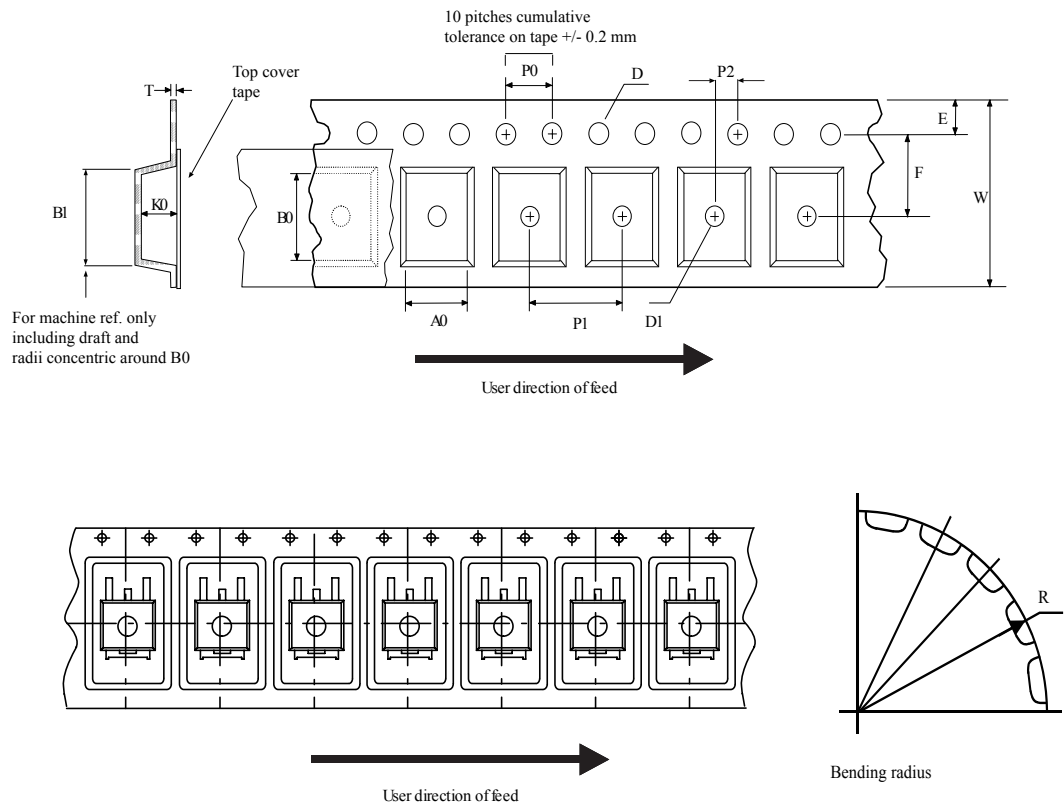
| Dim. | mm   |       |       |
|------|------|-------|-------|
|      | Min. | Typ.  | Max.  |
| A    | 2.18 |       | 2.39  |
| A2   |      |       | 0.13  |
| b    | 0.65 |       | 0.884 |
| b4   | 4.95 |       | 5.46  |
| c    | 0.46 |       | 0.61  |
| c2   | 0.46 |       | 0.60  |
| D    | 5.97 |       | 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 22. DPAK (TO-252) recommended footprint (dimensions are in mm)**


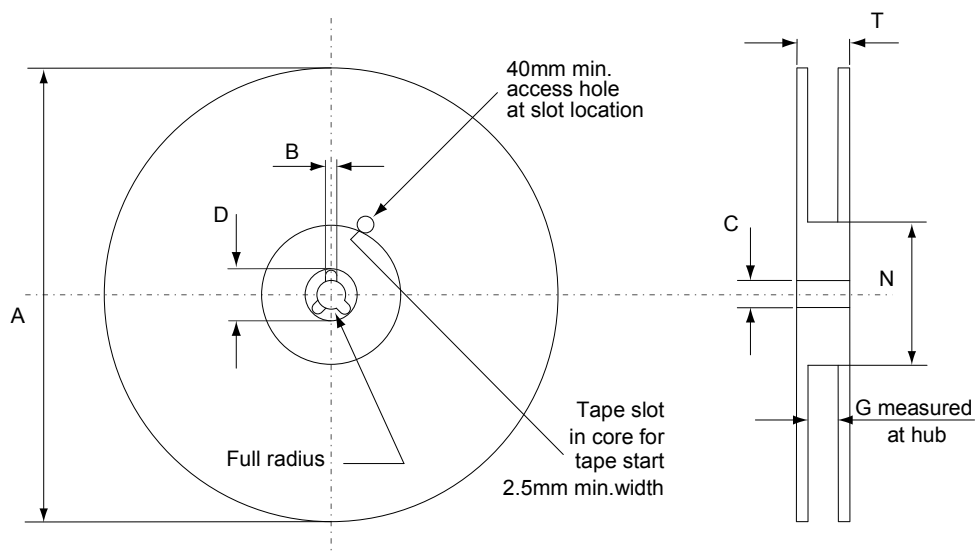
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## 4.4 DPAK (TO-252) packing information

**Figure 23. DPAK (TO-252) tape outline**



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**Figure 24. DPAK (TO-252) reel outline**


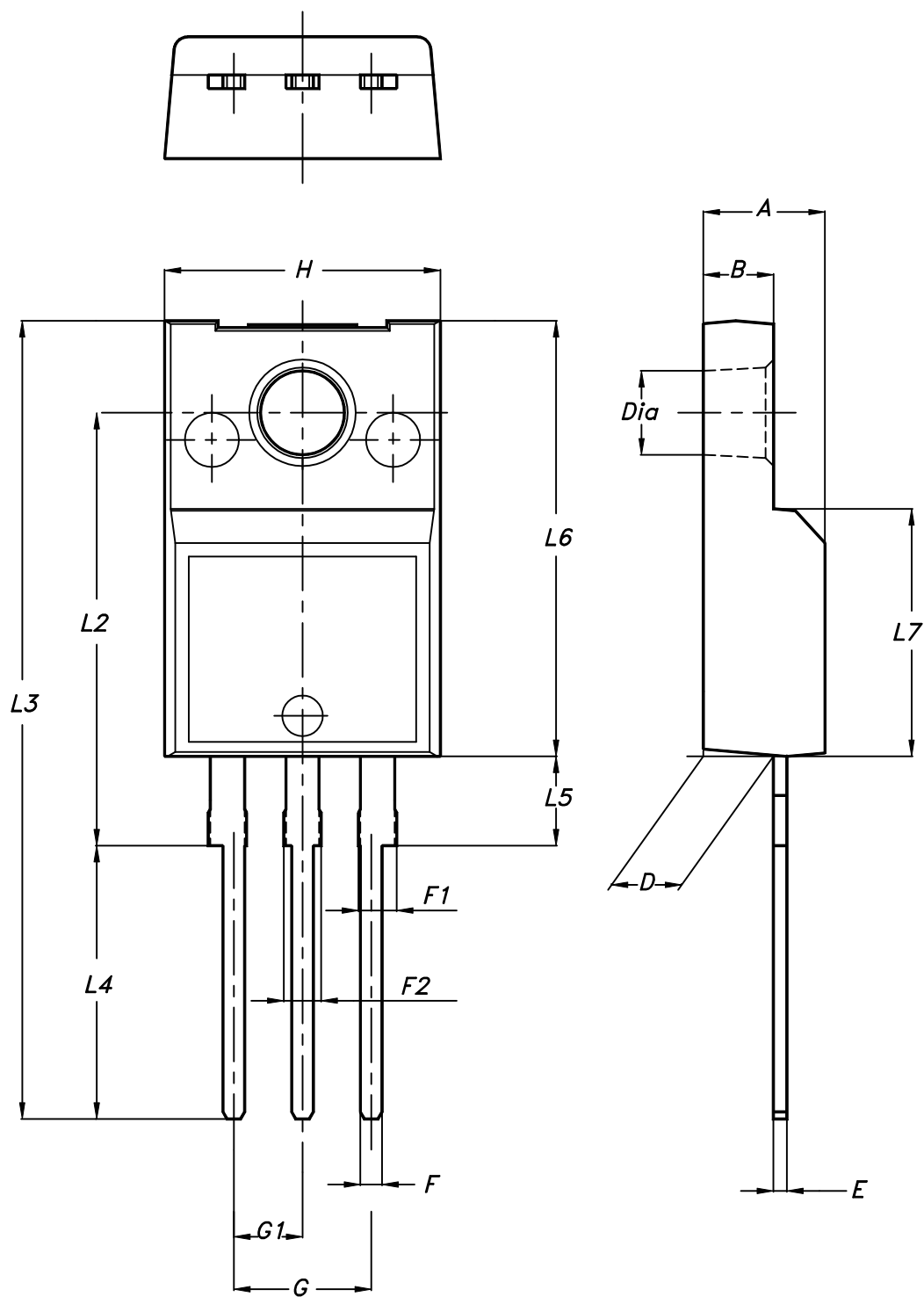
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**Table 11. DPAK (TO-252) tape and reel mechanical data**

| 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-220FP package information

Figure 25. TO-220FP package outline



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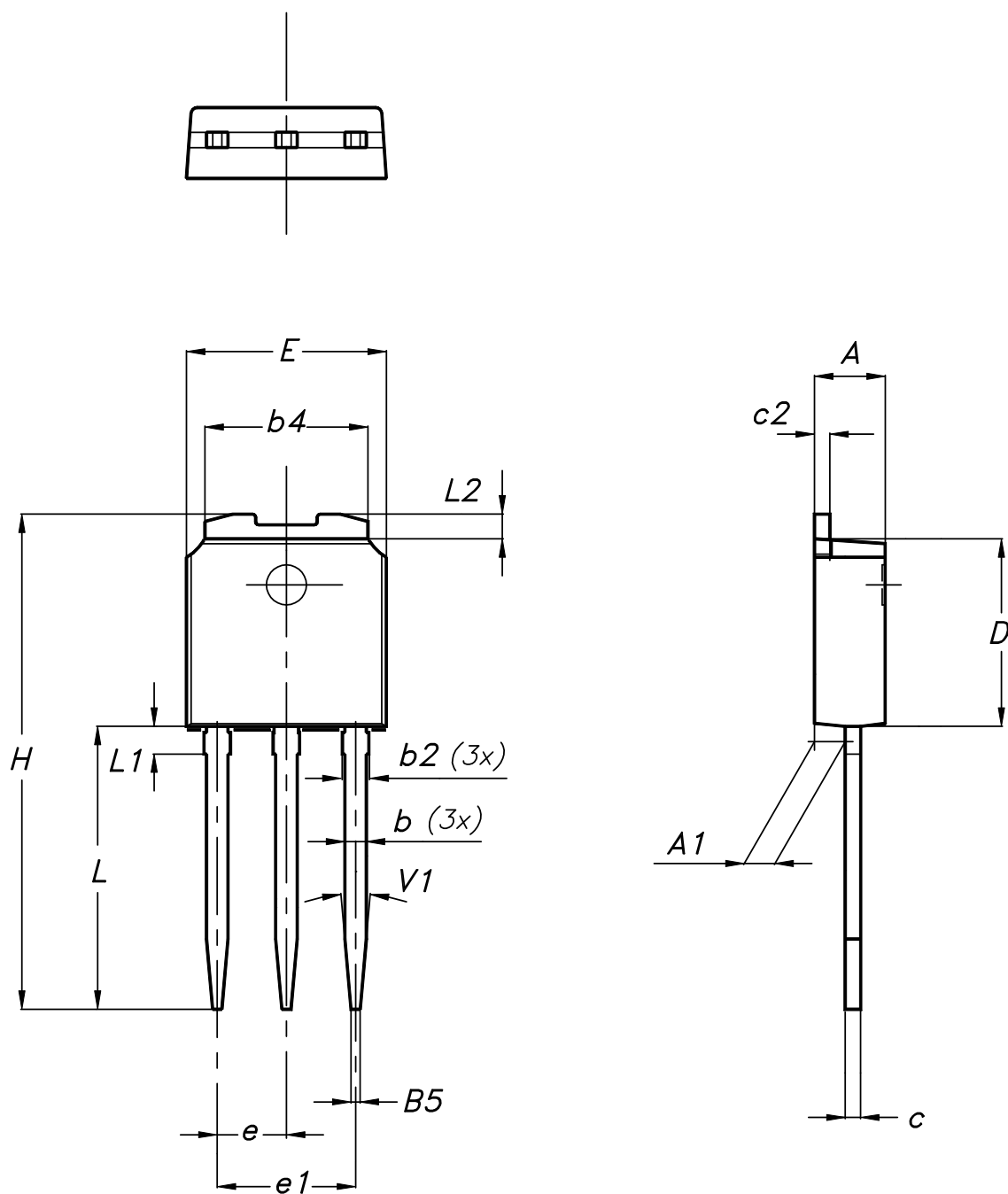


**Table 12.** TO-220FP package mechanical data

| 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  |

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

Figure 26. IPAK (TO-251) type A package outline



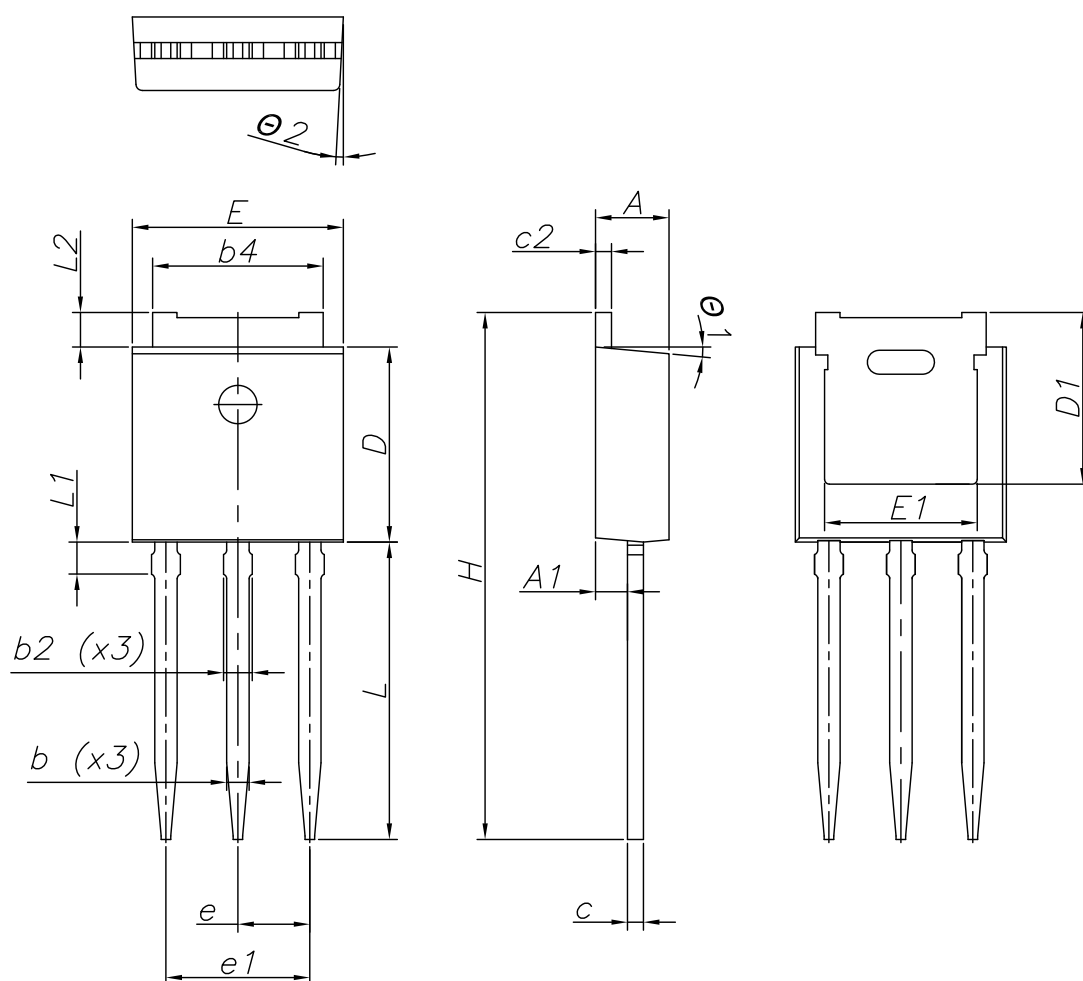
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**Table 13. IPAK (TO-251) type A package mechanical data**

| 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 27. 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°    |

## 5 Ordering information

**Table 15. Order codes**

| Order code | Marking | Package  | Packing       |
|------------|---------|----------|---------------|
| STD7NM60N  | 7NM60N  | DPAK     | Tape and reel |
| STF7NM60N  |         | TO-220FP | Tube          |
| STU7NM60N  |         | IPAK     |               |

## Revision history

**Table 16. Document revision history**

| Date        | Version | Changes  |
|-------------|---------|--|
| 29-Oct-2009 | 1       | First release.   |
| 19-Jul-2010 | 2       | Corrected values in Table 3: Thermal data.   |
| 11-Oct-2010 | 3       | Inserted new value in Table 6: Dynamic   |
| 04-Nov-2010 |         | Changed $R_{DS(on)}$ typical value.  |
| 05-Sep-2018 |         | <p>The part number STP7NM60N has been moved to a separate datasheet.</p> <p>Removed maturity status indication from cover page. The document status is production data.</p> <p>Updated title and features in cover page.</p> <p>Updated <a href="#">Section 1 Electrical ratings</a>, <a href="#">Section 2 Electrical characteristics</a> and <a href="#">Section 4 Package information</a>.</p> <p>Minor text changes.</p> |

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