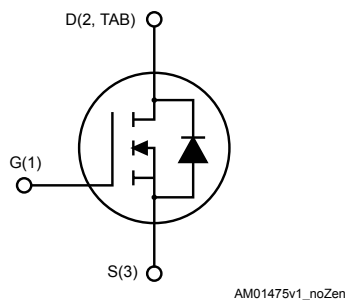
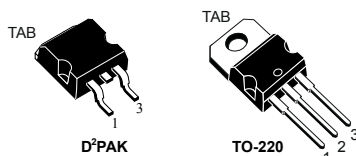


### N-channel 600 V, 0.4 $\Omega$ typ., 11 A, MDmesh™ II Power MOSFETs in D<sup>2</sup>PAK and TO-220 packages



## Features

| Order codes | V <sub>DSS</sub><br>(@ T <sub>Jmax</sub> ) | R <sub>DS(on)</sub> max. | I <sub>D</sub> | Package            |
|-------------|--------------------------------------------|--------------------------|----------------|--------------------|
| STB11NM60T4 | 650 V                                      | 0.45 $\Omega$            | 11 A           | D <sup>2</sup> PAK |
| STP11NM60   |                                            |                          |                | TO-220             |

- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance

## Applications

- Switching applications

## Description

These devices are N-channel Power MOSFETs developed using the second generation of MDmesh™ technology. These revolutionary Power MOSFETs associate a vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. They are therefore suitable for the most demanding high-efficiency converters.

### Product status link

[STB11NM60T4](#)

[STP11NM60](#)

### Product summary

| Order code | STB11NM60T4        |
|------------|--------------------|
| Marking    | B11NM60            |
| Package    | D <sup>2</sup> PAK |
| Packing    | Tape and reel      |
| Order code | STP11NM60          |
| Marking    | P11NM60            |
| Package    | TO-220             |
| Packing    | Tube               |

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol         | Parameter                                           | Value      | Unit |
|----------------|-----------------------------------------------------|------------|------|
| $V_{DS}$       | Gate-source voltage                                 | 600        | V    |
| $V_{GS}$       | Gate- source voltage                                | ±30        | V    |
| $I_D$          | Drain current (continuous) at $T_C = 25\text{ °C}$  | 11         | A    |
| $I_D$          | Drain current (continuous) at $T_C = 100\text{ °C}$ | 7          |      |
| $I_{DM}^{(1)}$ | Drain current (pulsed)                              | 44         | A    |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ °C}$           | 160        | W    |
| $dv/dt^{(2)}$  | Peak diode recovery voltage slope                   | 15         | V/ns |
| $T_{stg}$      | Storage temperature range                           | -65 to 150 | °C   |
| $T_j$          | Operating junction temperature range                |            |      |

1. Pulse width limited by safe operating area.

2.  $I_{SD} \leq 11\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_j \leq T_{JMAX}$ .

**Table 2. Thermal data**

| Symbol              | Parameter                           | Value              |        | Unit |
|---------------------|-------------------------------------|--------------------|--------|------|
|                     |                                     | D <sup>2</sup> PAK | TO-220 |      |
| $R_{thj-case}$      | Thermal resistance junction-case    | 0.78               |        | °C/W |
| $R_{thj-amb}$       | Thermal resistance junction-ambient |                    | 62.5   |      |
| $R_{thj-pcb}^{(1)}$ | Thermal resistance junction-pcb     | 35                 |        |      |

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

**Table 3. Avalanche characteristics**

| Symbol   | Parameter                                                                                                | Value | Unit |
|----------|----------------------------------------------------------------------------------------------------------|-------|------|
| $I_{AR}$ | Avalanche current, repetitive or non-repetitive (pulse width limited by $T_{Jmax}$ )                     | 5.5   | A    |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_j = 25\text{ °C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ ) | 350   | mJ   |

## 2 Electrical characteristics

( $T_C = 25\text{ }^{\circ}\text{C}$  unless otherwise specified).

**Table 4. On/off states**

| Symbol        | Parameter                         | Test conditions                                                                                | Min. | Typ. | Max.      | Unit          |
|---------------|-----------------------------------|------------------------------------------------------------------------------------------------|------|------|-----------|---------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage    | $V_{GS} = 0\text{ V}$ , $I_D = 250\text{ }\mu\text{A}$                                         | 600  |      |           | V             |
| $I_{DSS}$     | Zero gate voltage drain current   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$                                                |      |      | 1         | $\mu\text{A}$ |
|               |                                   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$ ,<br>$T_C = 125\text{ }^{\circ}\text{C}^{(1)}$ |      |      | 10        | $\mu\text{A}$ |
| $I_{GSS}$     | Gate-body leakage current         | $V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 30\text{ V}$                                             |      |      | $\pm 100$ | nA            |
| $V_{GS(th)}$  | Gate threshold voltage            | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                                             | 3    | 4    | 5         | V             |
| $R_{DS(on)}$  | Static drain-source on-resistance | $V_{GS} = 10\text{ V}$ , $I_D = 5.5\text{ A}$                                                  |      | 0.4  | 0.45      | $\Omega$      |

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

**Table 5. Dynamic**

| Symbol                     | Parameter                     | Test conditions                                                                                                                                  | Min. | Typ. | Max. | Unit     |
|----------------------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|----------|
| $C_{iss}$                  | Input capacitance             | $V_{DS} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$                                                                              | -    | 1000 | -    | pF       |
| $C_{oss}$                  | Output capacitance            |                                                                                                                                                  | -    | 230  | -    | pF       |
| $C_{rss}$                  | Reverse transfer capacitance  |                                                                                                                                                  | -    | 25   | -    | pF       |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{DS} = 0\text{ V to } 480\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                   | -    | 100  | -    | pF       |
| $R_G$                      | Intrinsic gate resistance     | $f = 1\text{ MHz}$ open drain                                                                                                                    | -    | 1.6  | -    | $\Omega$ |
| $Q_g$                      | Total gate charge             | $V_{DD} = 480\text{ V}$ , $I_D = 11\text{ A}$ ,<br>$V_{GS} = 0\text{ to } 10\text{ V}$<br>(see Figure 12. Test circuit for gate charge behavior) | -    | 30   | -    | nC       |
| $Q_{gs}$                   | Gate-source charge            |                                                                                                                                                  | -    | 10   | -    | nC       |
| $Q_{gd}$                   | Gate-drain charge             |                                                                                                                                                  | -    | 15   | -    | nC       |

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    | $V_{DD} = 300\text{ V}$ , $I_D = 5.5\text{ A}$ ,<br>$R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$<br>(see Figure 11. Test circuit for resistive load switching times and Figure 16. Switching time waveform)                | -    | 20   | -    | ns   |
| $t_r$         | Rise time             |                                                                                                                                                                                                                                  | -    | 20   | -    | ns   |
| $t_{r(Voff)}$ | Off-voltage rise time | $V_{DD} = 480\text{ V}$ , $I_D = 11\text{ A}$ ,<br>$R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$ (see Figure 13. Test circuit for inductive load switching and diode recovery times and Figure 16. Switching time waveform) | -    | 6    | -    | ns   |
| $t_f$         | Fall time             |                                                                                                                                                                                                                                  | -    | 11   | -    | ns   |
| $t_c$         | Cross-over time       |                                                                                                                                                                                                                                  | -    | 19   | -    | ns   |

**Table 7. Source drain diode**

| Symbol          | Parameter                     | Test conditions                                                                                                                                                                                                     | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                                                                                                     | -    |      | 11   | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                                                                                                     | -    |      | 44   | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $V_{GS} = 0\text{ V}$ , $I_{SD} = 11\text{ A}$                                                                                                                                                                      | -    |      | 1.5  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 11\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 100\text{ V}$<br>(see Figure 13. Test circuit for inductive load switching and diode recovery times)                                     | -    | 390  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                     | -    | 3.8  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                     | -    | 19.5 |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 11\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 100\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$<br>(see Figure 13. Test circuit for inductive load switching and diode recovery times) | -    | 570  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                     | -    | 5.7  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                     | -    | 20   |      | 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 1. Safe operating area

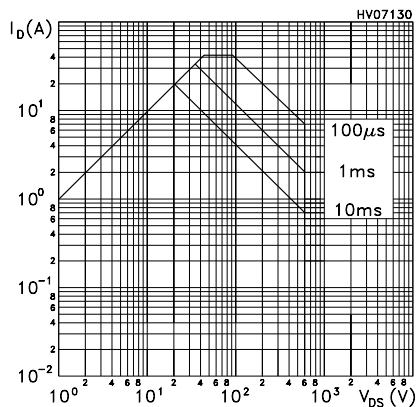


Figure 2. Thermal impedance

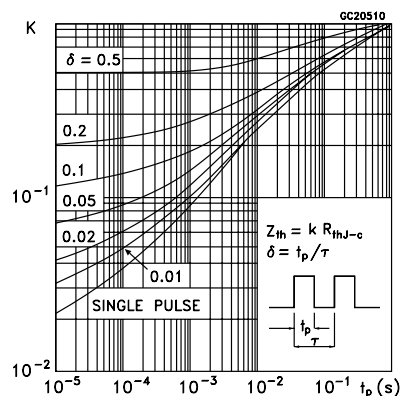


Figure 3. Output characteristics

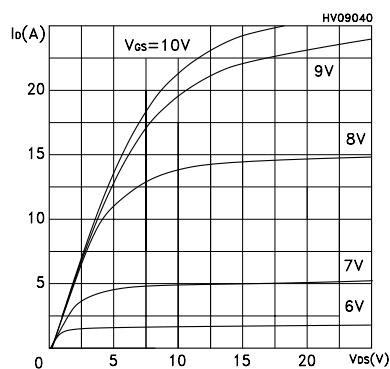


Figure 4. Transfer characteristics

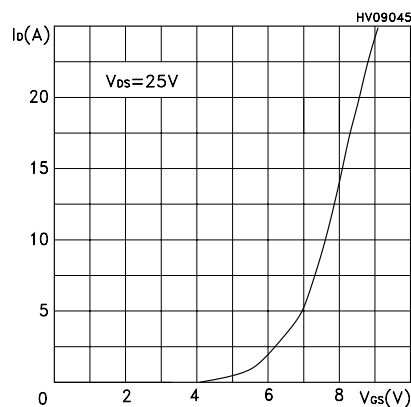


Figure 5. Normalized gate threshold voltage vs temperature

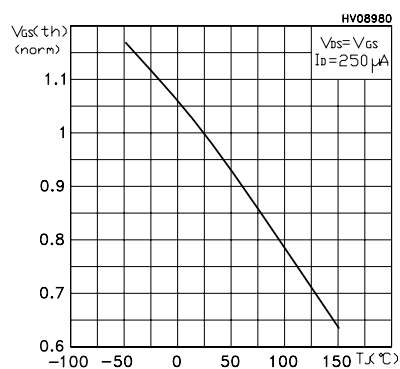
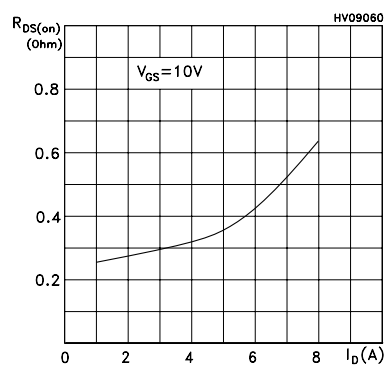
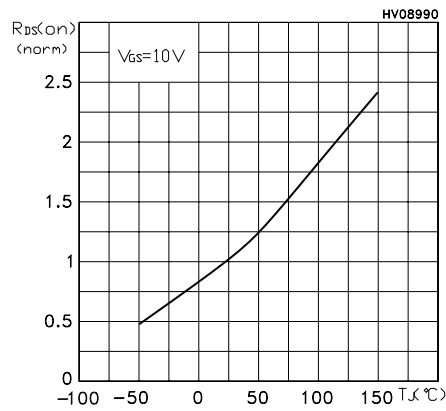
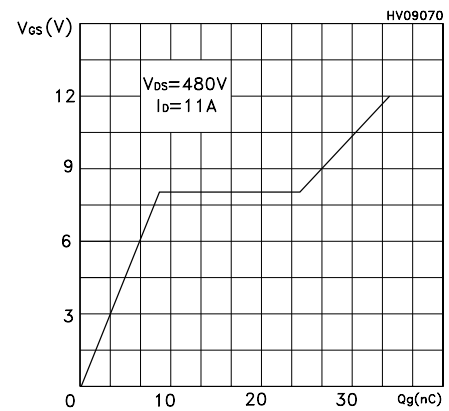
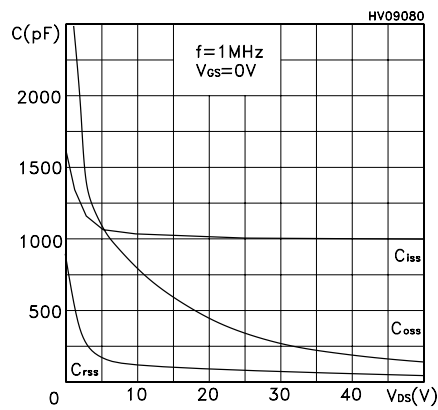
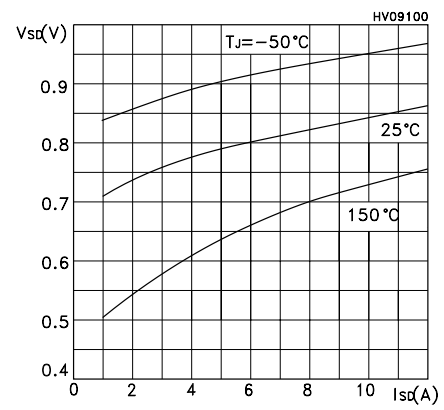
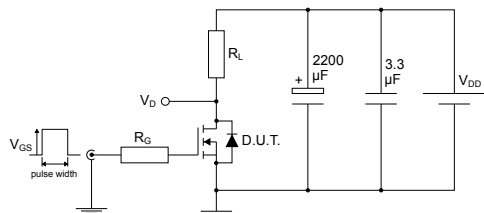


Figure 6. Static drain-source on-resistance

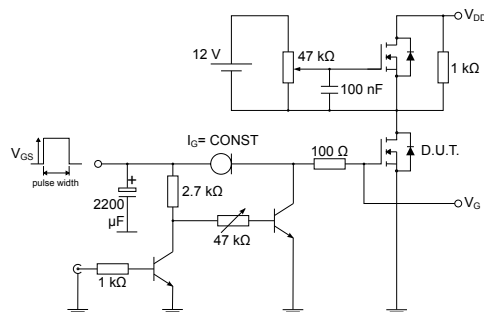


**Figure 7. Normalized on-resistance vs temperature**

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

**Figure 9. Capacitance variations**

**Figure 10. Source-drain diode forward characteristics**


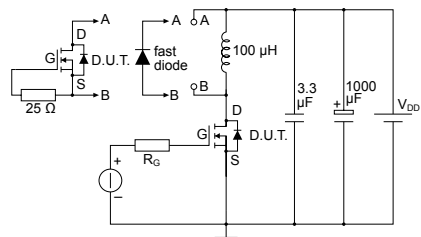
### 3 Test circuits

**Figure 11. Test circuit for resistive load switching times**


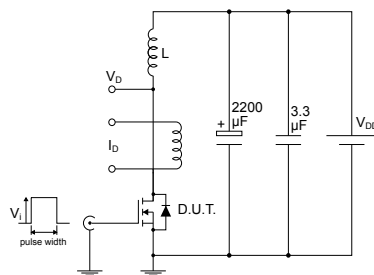
AM01468v1

**Figure 12. Test circuit for gate charge behavior**


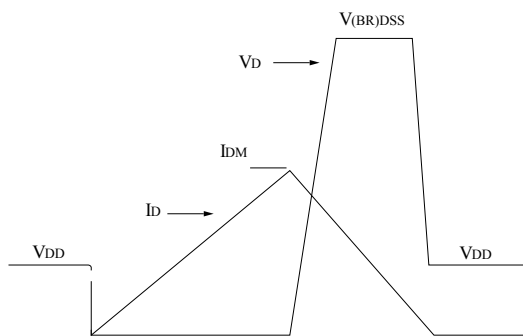
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**Figure 13. Test circuit for inductive load switching and diode recovery times**


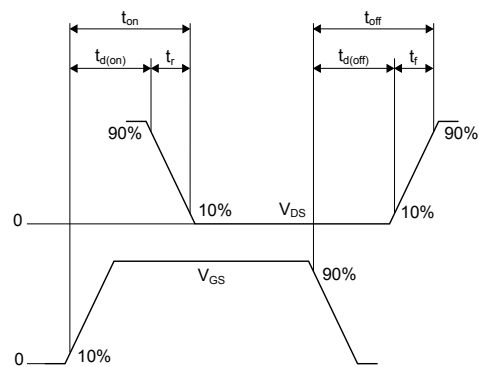
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**Figure 14. Unclamped inductive load test circuit**


AM01471v1

**Figure 15. Unclamped inductive waveform**


AM01472v1

**Figure 16. Switching time waveform**


AM01473v1

## **4 Package information**

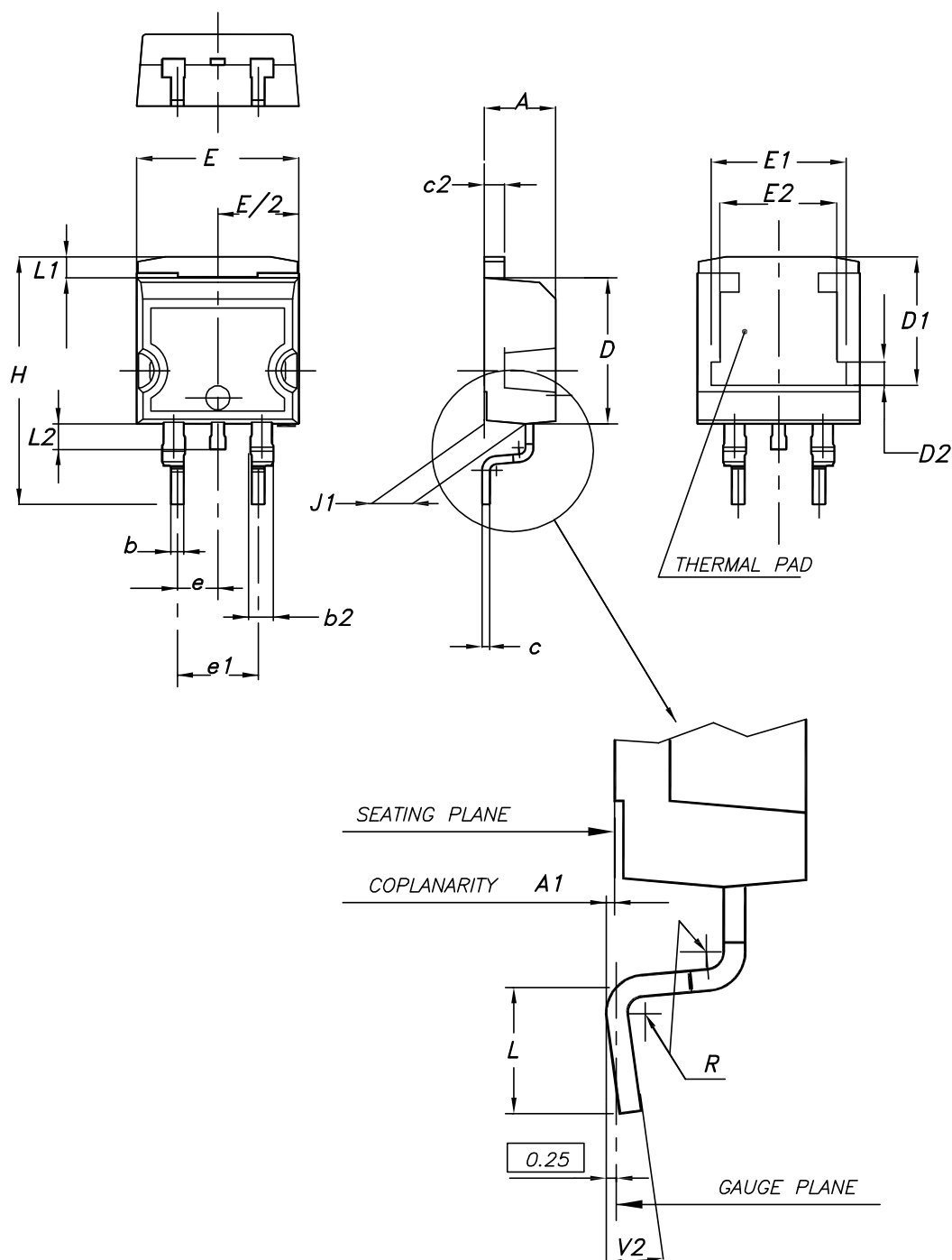
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In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK® is an ST trademark.



## 4.1 D<sup>2</sup>PAK (TO-263) type A package information

Figure 17. D<sup>2</sup>PAK (TO-263) type A package outline



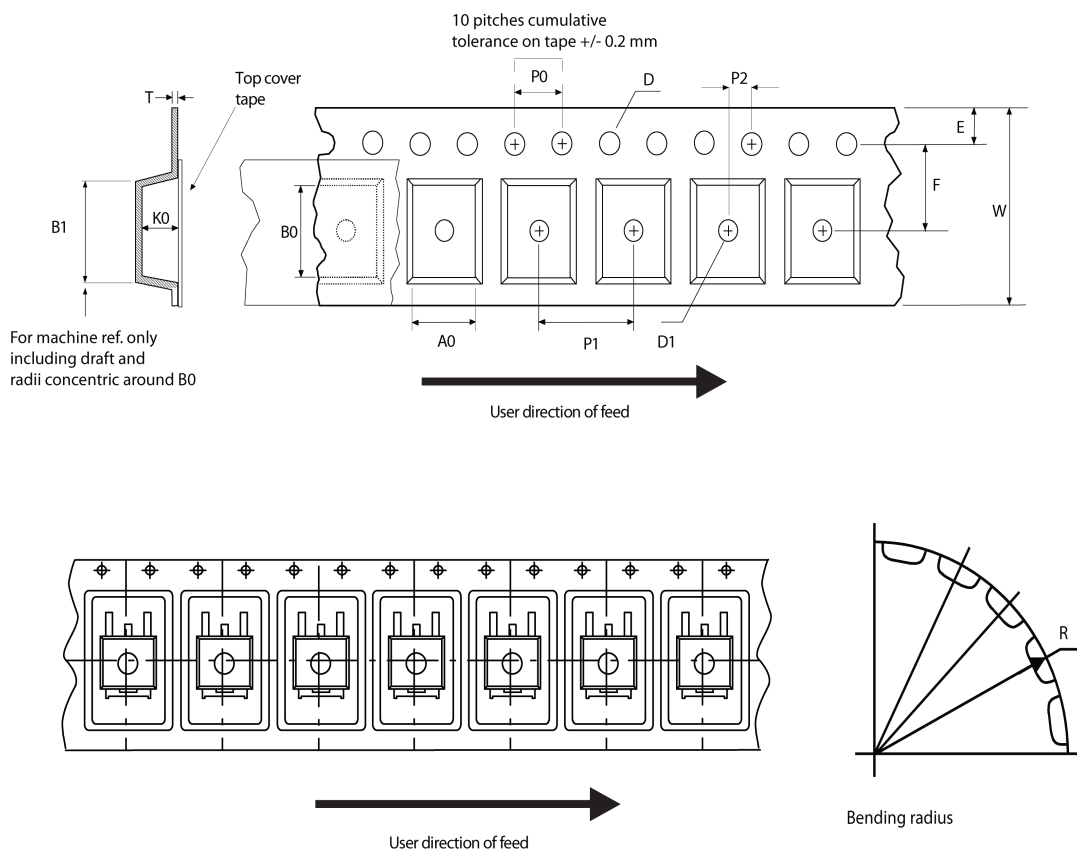
0079457\_25

**Table 8. D<sup>2</sup>PAK (TO-263) type A package mechanical data**

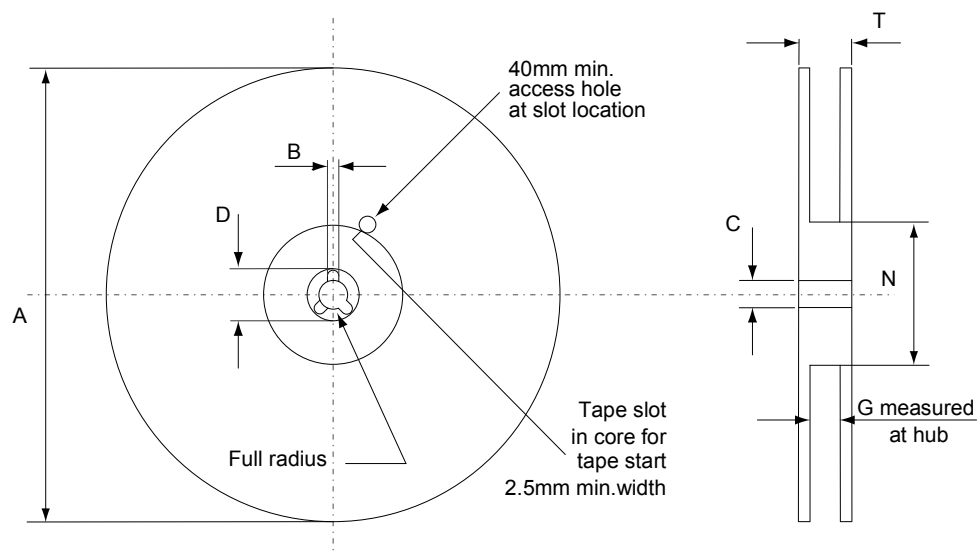
| Dim. | mm    |      |       |
|------|-------|------|-------|
|      | Min.  | Typ. | Max.  |
| A    | 4.40  |      | 4.60  |
| A1   | 0.03  |      | 0.23  |
| b    | 0.70  |      | 0.93  |
| b2   | 1.14  |      | 1.70  |
| c    | 0.45  |      | 0.60  |
| c2   | 1.23  |      | 1.36  |
| D    | 8.95  |      | 9.35  |
| D1   | 7.50  | 7.75 | 8.00  |
| D2   | 1.10  | 1.30 | 1.50  |
| E    | 10.00 |      | 10.40 |
| E1   | 8.30  | 8.50 | 8.70  |
| E2   | 6.85  | 7.05 | 7.25  |
| e    |       | 2.54 |       |
| e1   | 4.88  |      | 5.28  |
| H    | 15.00 |      | 15.85 |
| J1   | 2.49  |      | 2.69  |
| L    | 2.29  |      | 2.79  |
| L1   | 1.27  |      | 1.40  |
| L2   | 1.30  |      | 1.75  |
| R    |       | 0.40 |       |
| V2   | 0°    |      | 8°    |

## 4.2 D<sup>2</sup>PAK packing information

Figure 18. D<sup>2</sup>PAK tape outline



AM08852v1

**Figure 19. D<sup>2</sup>PAK reel outline**


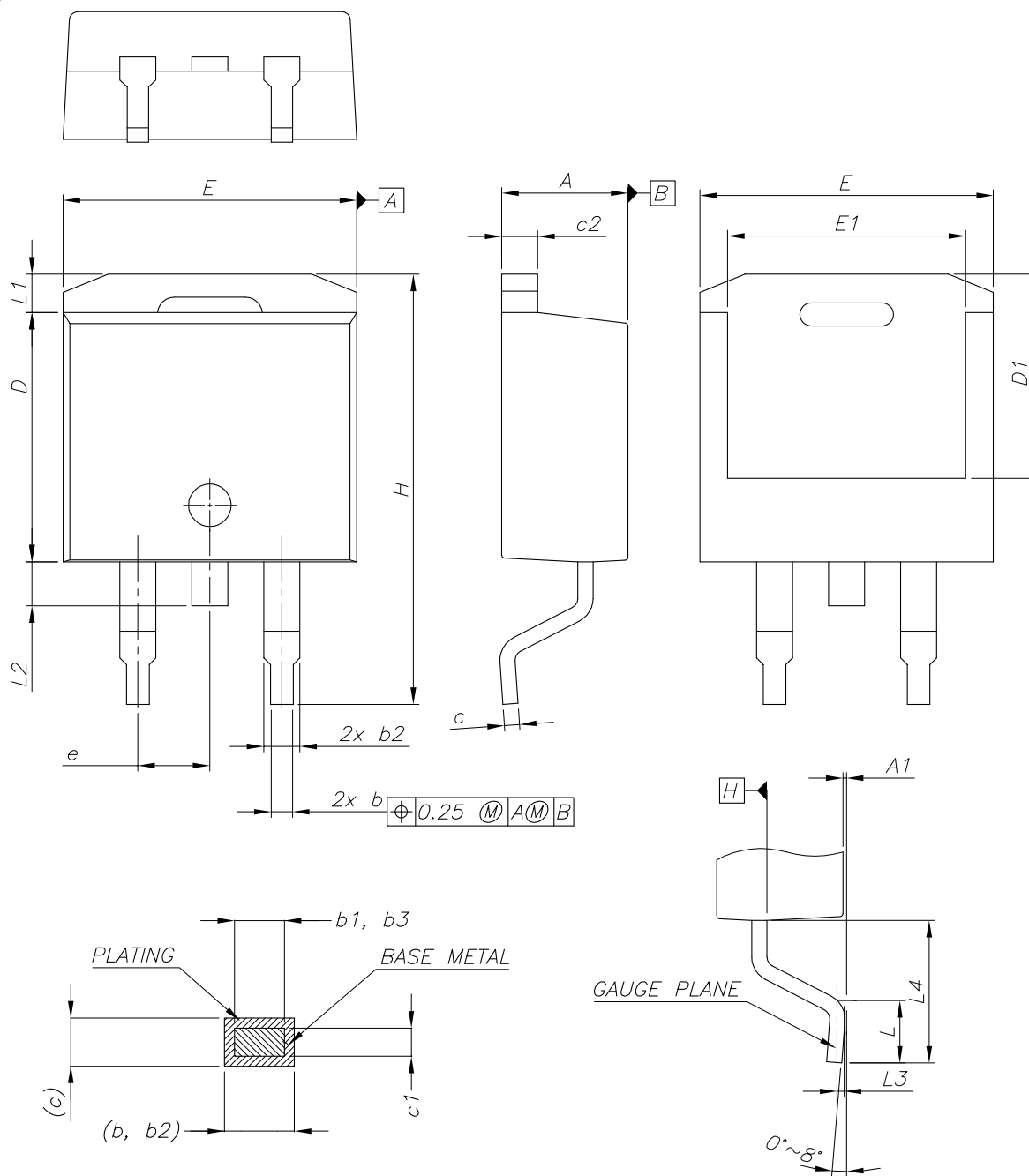
AM06038v1

**Table 9. D<sup>2</sup>PAK tape and reel mechanical data**

| Tape |      |      | Reel          |      |      |
|------|------|------|---------------|------|------|
| Dim. | mm   |      | Dim.          | mm   |      |
|      | Min. | Max. |               | Min. | Max. |
| A0   | 10.5 | 10.7 | A             |      | 330  |
| B0   | 15.7 | 15.9 | B             | 1.5  |      |
| D    | 1.5  | 1.6  | C             | 12.8 | 13.2 |
| D1   | 1.59 | 1.61 | D             | 20.2 |      |
| E    | 1.65 | 1.85 | G             | 24.4 | 26.4 |
| F    | 11.4 | 11.6 | N             | 100  |      |
| K0   | 4.8  | 5.0  | T             |      | 30.4 |
| P0   | 3.9  | 4.1  |               |      |      |
| P1   | 11.9 | 12.1 | Base quantity |      | 1000 |
| P2   | 1.9  | 2.1  | Bulk quantity |      | 1000 |
| R    | 50   |      |               |      |      |
| T    | 0.25 | 0.35 |               |      |      |
| W    | 23.7 | 24.3 |               |      |      |

### 4.3 D<sup>2</sup>PAK (TO-263) type B package information

Figure 20. D<sup>2</sup>PAK (TO-263) type B package outline

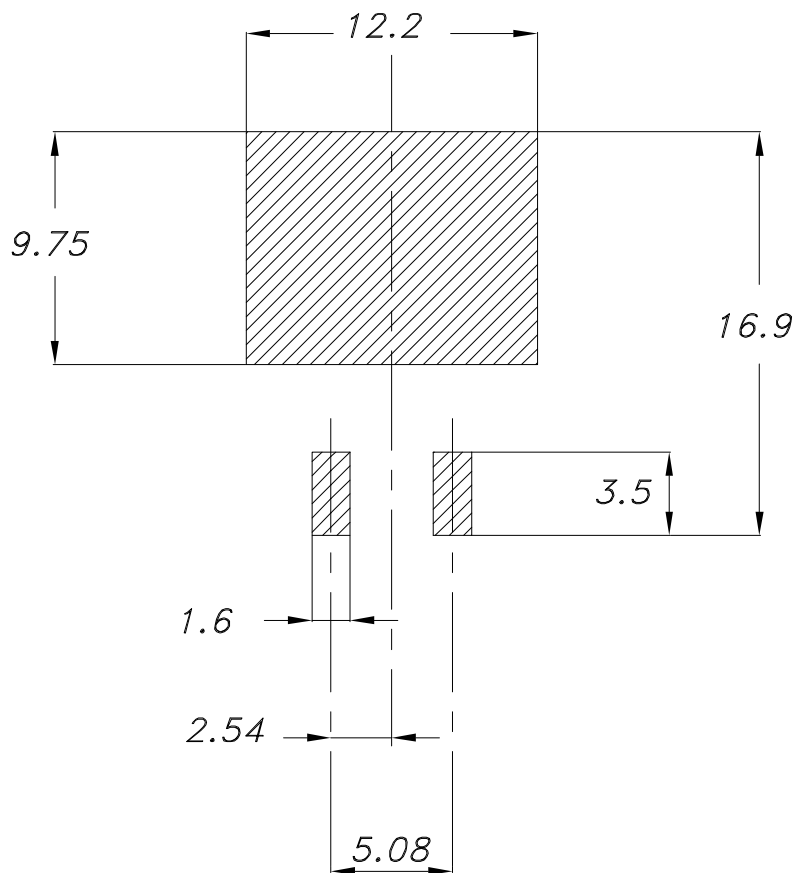


0079457\_25\_B

**Table 10. D<sup>2</sup>PAK (TO-263) type B mechanical data**

| Dim. | mm       |      |       |
|------|----------|------|-------|
|      | Min.     | Typ. | Max.  |
| A    | 4.36     |      | 4.56  |
| A1   | 0        |      | 0.25  |
| b    | 0.70     |      | 0.90  |
| b1   | 0.51     |      | 0.89  |
| b2   | 1.17     |      | 1.37  |
| b3   | 1.36     |      | 1.46  |
| c    | 0.38     |      | 0.694 |
| c1   | 0.38     |      | 0.534 |
| c2   | 1.19     |      | 1.34  |
| D    | 8.60     |      | 9.00  |
| D1   | 6.90     |      | 7.50  |
| E    | 10.15    |      | 10.55 |
| E1   | 8.10     |      | 8.70  |
| e    | 2.54 BSC |      |       |
| H    | 15.00    |      | 15.60 |
| L    | 1.90     |      | 2.50  |
| L1   |          |      | 1.65  |
| L2   |          |      | 1.78  |
| L3   |          | 0.25 |       |
| L4   | 4.78     |      | 5.28  |

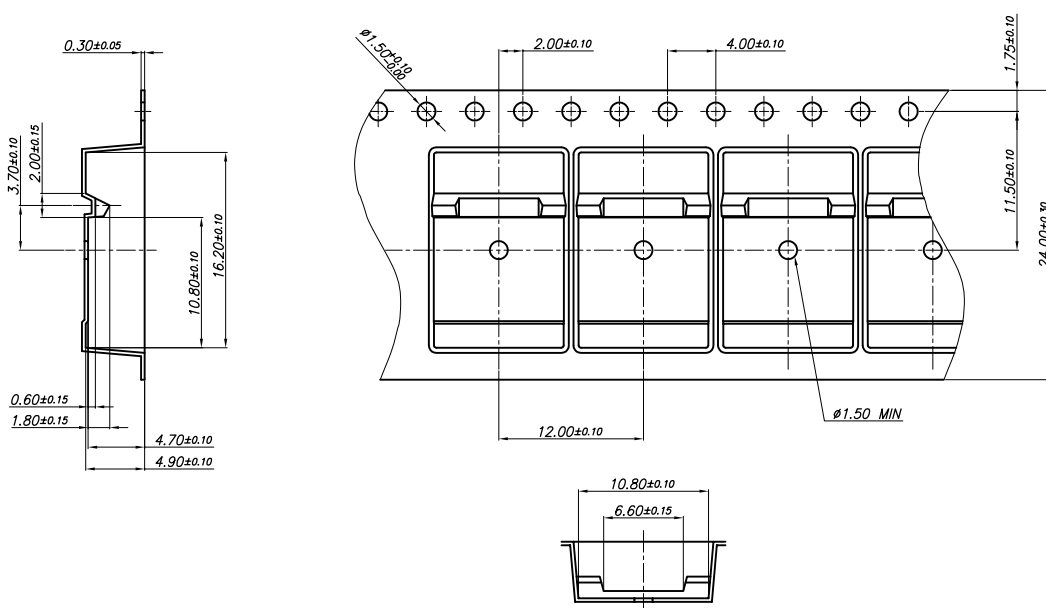
Figure 21. D<sup>2</sup>PAK (TO-263) recommended footprint (dimensions are in mm)



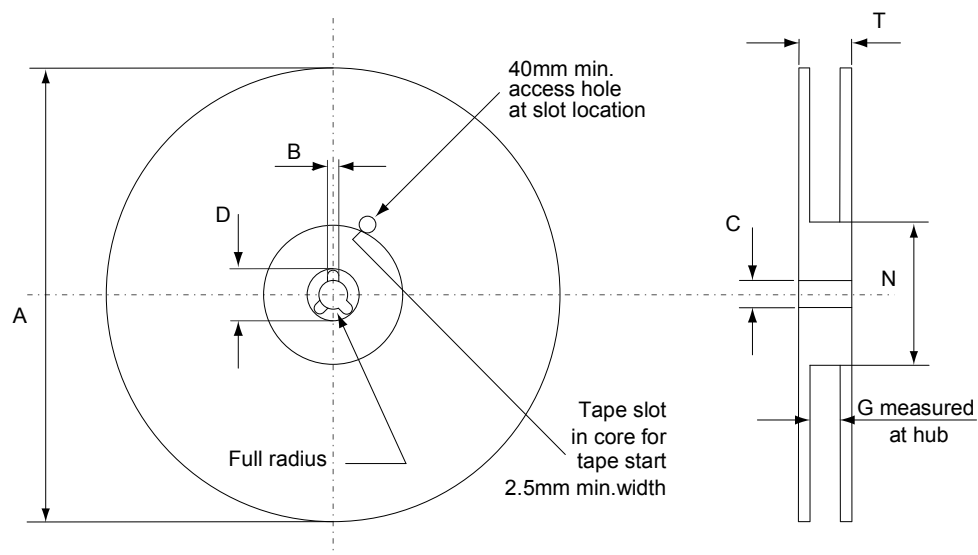
Footprint

#### 4.4 D<sup>2</sup>PAK type B packing information

Figure 22. D<sup>2</sup>PAK type B tape outline



**Figure 23. D<sup>2</sup>PAK type B reel outline**



AM06038v1

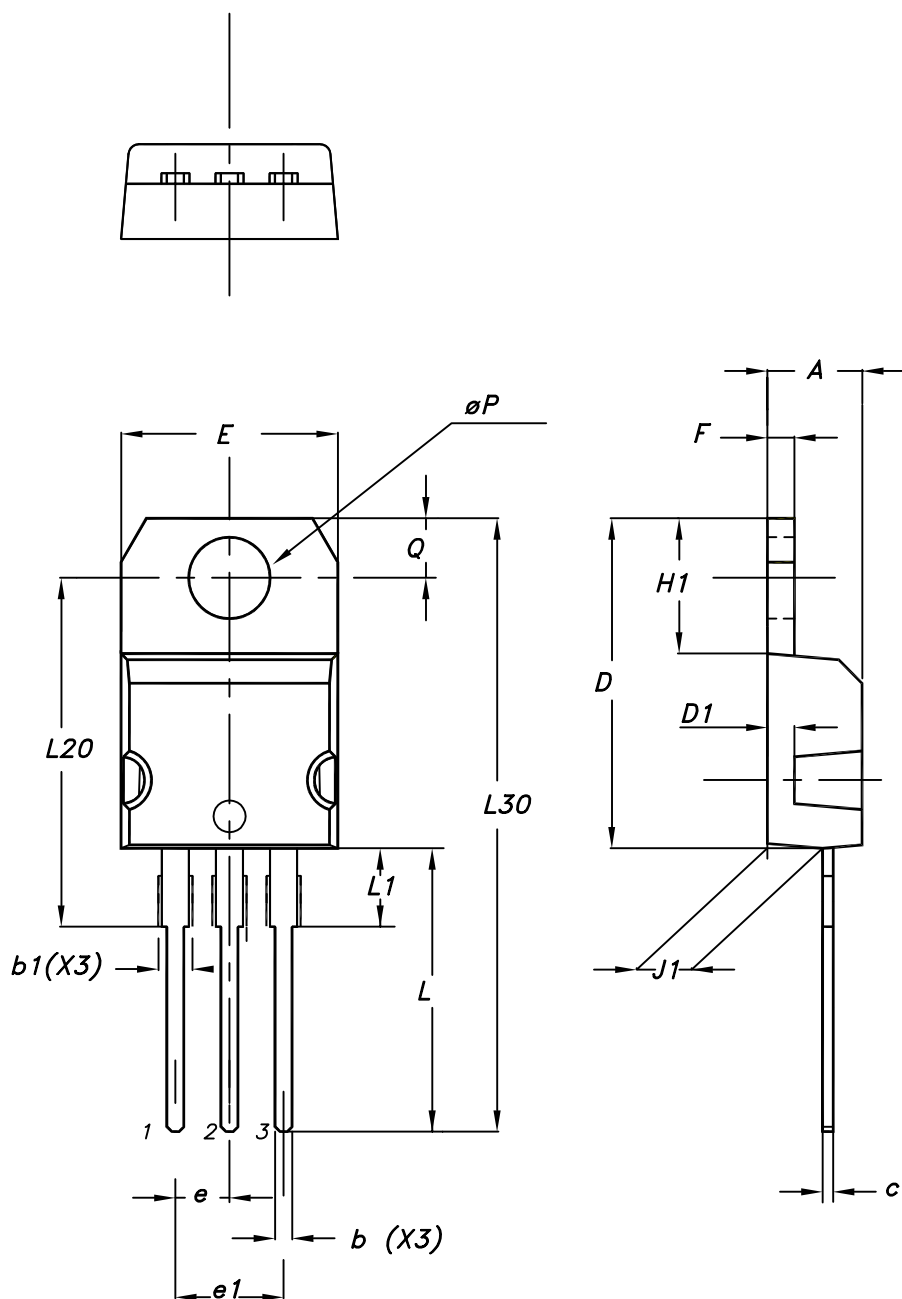
**Table 11. D<sup>2</sup>PAK type B reel mechanical data**

| Dim. | mm   |      |
|------|------|------|
|      | Min. | Max. |
| A    |      | 330  |
| B    | 1.5  |      |
| C    | 12.8 | 13.2 |
| D    | 20.2 |      |
| G    | 24.4 | 26.4 |
| N    | 100  |      |
| T    |      | 30.4 |



## 4.5 TO-220 type A package information

Figure 24. 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  |

## Revision history

**Table 13. Document revision history**

| Date        | Version | Changes                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 09-Sep-2004 | 1       | First release                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 10-Jun-2005 | 2       | Typing error, wrong description                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 26-Jul-2006 | 3       | The document has been reformatted, no content change                                                                                                                                                                                                                                                                                                                                                                                                                |
| 31-Aug-2006 | 4       | Typo mistake on order code                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 21-Dec-2006 | 5       | Various changes on "Test conditions" for Table 5. and Table 6.                                                                                                                                                                                                                                                                                                                                                                                                      |
| 12-Jan-2007 | 6       | Order code has been corrected                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 01-Oct-2018 | 7       | <p>The part numbers STB11NM60-1 and STP11NM60FP have been moved to a separate datasheet and the document has been updated accordingly.</p> <p>Modified <a href="#">Table 1. Absolute maximum ratings</a>, <a href="#">Table 2. Thermal data</a> and <a href="#">Table 5. Dynamic</a>.</p> <p>Modified <a href="#">Section 2.1 Electrical characteristics (curves)</a>.</p> <p>Updated <a href="#">Section 4 Package information</a>.</p> <p>Minor text changes.</p> |

## Contents

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