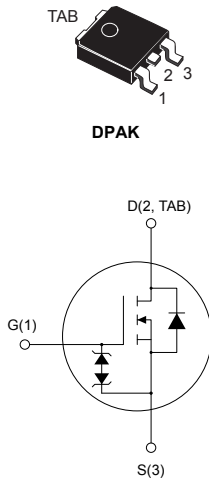


## N-channel 600 V, 350 mΩ typ., 11 A MDmesh M2 Power MOSFET in a DPAK package



AM01476v1\_tab



### Features

| Order code | $V_{DS}$ at $T_J$ max. | $R_{DS(on)}$ max. | $I_D$ |
|------------|------------------------|-------------------|-------|
| STD13N60M2 | 650 V                  | 380 mΩ            | 11 A  |

- Extremely low gate charge
- Excellent output capacitance ( $C_{oss}$ ) profile
- 100% avalanche tested
- Zener-protected

### Applications

- Switching applications

### Description

This device is an N-channel Power MOSFET developed using MDmesh M2 technology. Thanks to its strip layout and an improved vertical structure, the device exhibits low on-resistance and optimized switching characteristics, rendering it suitable for the most demanding high efficiency converters.

#### Product status link

[STD13N60M2](#)

#### Product summary

|                   |               |
|-------------------|---------------|
| <b>Order code</b> | STD13N60M2    |
| <b>Marking</b>    | 13N60M2       |
| <b>Package</b>    | DPAK          |
| <b>Packing</b>    | Tape and reel |

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol         | Parameter   | Value      | Unit             |
|----------------|---|------------|------------------|
| $V_{GS}$       | Gate-source voltage   | $\pm 25$   | V                |
| $I_D$          | Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$  | 11         | A                |
|                | Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$ | 7          |                  |
| $I_{DM}^{(1)}$ | Drain current (pulsed)  | 44         | A                |
| $P_{TOT}$      | Total power dissipation at $T_C = 25\text{ }^\circ\text{C}$     | 110        | W                |
| $dv/dt^{(2)}$  | Peak diode recovery voltage slope                               | 15         | V/ns             |
| $dv/dt^{(3)}$  | MOSFET $dv/dt$ ruggedness                                       | 50         | V/ns             |
| $T_{stg}$      | Storage temperature range                                       | -55 to 150 | $^\circ\text{C}$ |
| $T_J$          | Operating junction temperature range                            |            | $^\circ\text{C}$ |

1. Pulse width is limited by safe operating area.
2.  $I_{SD} \leq 11\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ,  $V_{DS}(\text{peak}) < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$ .
3.  $V_{DS} \leq 480\text{ V}$ .

**Table 2. Thermal data**

| Symbol           | Parameter                               | Value | Unit                      |
|------------------|---|-------|---------------------------|
| $R_{thJC}$       | Thermal resistance, junction-to-case    | 1.14  | $^\circ\text{C}/\text{W}$ |
| $R_{thJA}^{(1)}$ | Thermal resistance, junction-to-ambient | 50    | $^\circ\text{C}/\text{W}$ |

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 $T_J$ max.)                                  | 2.8   | A    |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_J = 25\text{ }^\circ\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ ) | 125   | mJ   |

## 2 Electrical characteristics

$T_C = 25\text{ °C}$  unless otherwise specified.

**Table 4. On/off-state**

| Symbol        | Parameter                         | Test conditions   | Min. | Typ. | Max.     | Unit          |
|---------------|-----------------------------------|---|------|------|----------|---------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage    | $V_{GS} = 0\text{ V}$ , $I_D = 1\text{ mA}$                                   | 600  |      |          | V             |
| $I_{DSS}$     | Zero gate voltage drain current   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$                               |      |      | 1        | $\mu\text{A}$ |
|               |                                   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$ , $T_C = 125\text{ °C}^{(1)}$ |      |      | 100      |               |
| $I_{GSS}$     | Gate body leakage current         | $V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 25\text{ V}$                            |      |      | $\pm 10$ | $\mu\text{A}$ |
| $V_{GS(th)}$  | 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 | $V_{GS} = 10\text{ V}$ , $I_D = 5.5\text{ A}$                                 |      | 350  | 380      | m $\Omega$    |

1. Specified by design, not tested in production.

**Table 5. Dynamic**

| Symbol                     | Parameter                     | Test conditions  | Min. | Typ. | Max. | Unit     |
|----------------------------|-------------------------------|--|------|------|------|----------|
| $C_{iss}$                  | Input capacitance             | $V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$   | -    | 580  | -    | pF       |
| $C_{oss}$                  | Output capacitance            |  | -    | 32   | -    | pF       |
| $C_{rss}$                  | Reverse transfer capacitance  |  | -    | 1.1  | -    | pF       |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{DS} = 0\text{ to }480\text{ V}$ , $V_{GS} = 0\text{ V}$  | -    | 120  | -    | pF       |
| $R_G$                      | Intrinsic gate resistance     | $f = 1\text{ MHz}$ , $I_D = 0\text{ A}$  | -    | 6.6  | -    | $\Omega$ |
| $Q_g$                      | Total gate charge             | $V_{DD} = 480\text{ V}$ , $I_D = 11\text{ A}$ , $V_{GS} = 0\text{ to }10\text{ V}$<br>(see Figure 14. Test circuit for gate charge behavior) | -    | 17   | -    | nC       |
| $Q_{gs}$                   | Gate-source charge            |  | -    | 2.5  | -    | nC       |
| $Q_{gd}$                   | Gate-drain charge             |  | -    | 9    | -    | 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>$R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$  | -    | 11   | -    | ns   |
| $t_r$        | Rise time           |   | -    | 10   | -    | ns   |
| $t_{d(off)}$ | Turn-off-delay time | (see Figure 13. Test circuit for resistive load switching times and Figure 18. Switching time waveform) | -    | 41   | -    | ns   |
| $t_f$        | Fall time           |   | -    | 9.5  | -    | ns   |

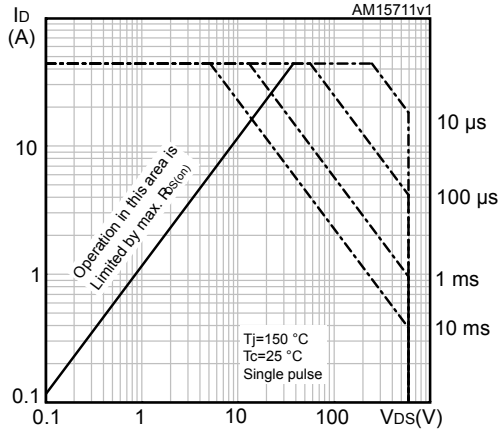
**Table 7. Source-drain diode**

| 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            | $V_{GS} = 0\text{ V}$ , $I_{SD} = 11\text{ A}$                                      | -    |      | 1.6  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 11\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,                       | -    | 297  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       | $V_{DD} = 60\text{ V}$  | -    | 2.8  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      | (see Figure 15. Test circuit for inductive load switching and diode recovery times) | -    | 18.5 |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 11\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,                       | -    | 394  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       | $V_{DD} = 60\text{ V}$ , $T_J = 150\text{ }^\circ\text{C}$                          | -    | 3.8  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      | (see Figure 15. Test circuit for inductive load switching and diode recovery times) | -    | 19   |      | A             |

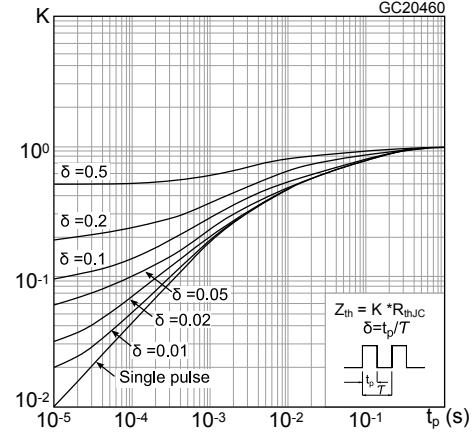
1. Pulse width is limited by safe operating area.
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

## 2.1 Electrical characteristics (curves)

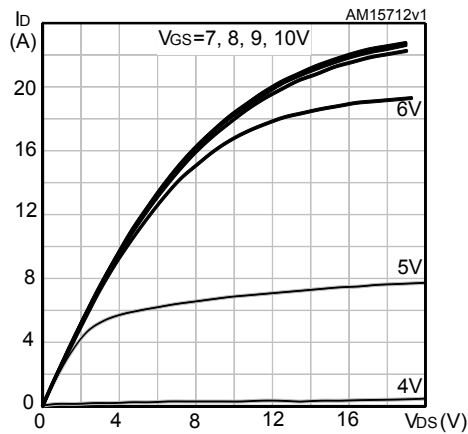
**Figure 1. Safe operating area**



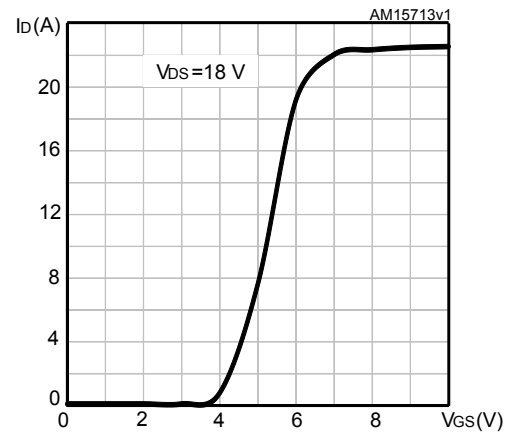
**Figure 2. Normalized transient thermal impedance**



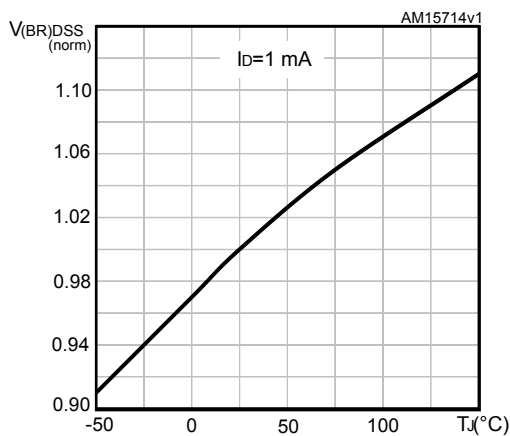
**Figure 3. Output characteristics**



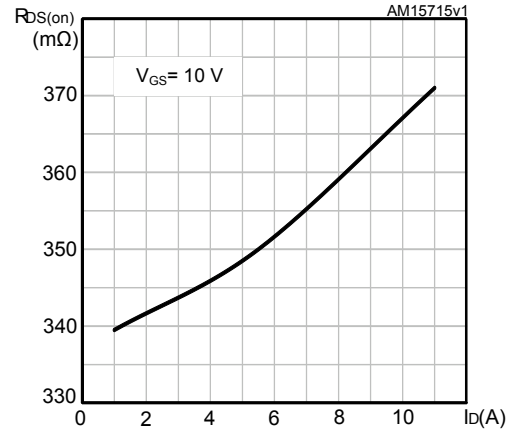
**Figure 4. Transfer characteristics**



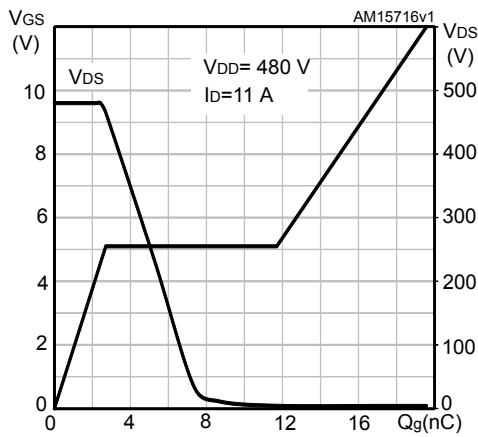
**Figure 5. Normalized  $V_{(BR)DSS}$  vs temperature**



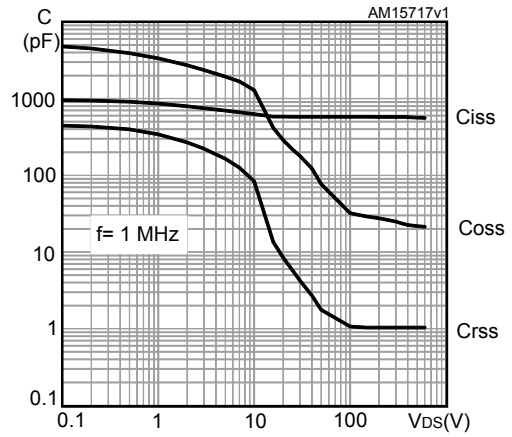
**Figure 6. Static drain-source on-resistance**



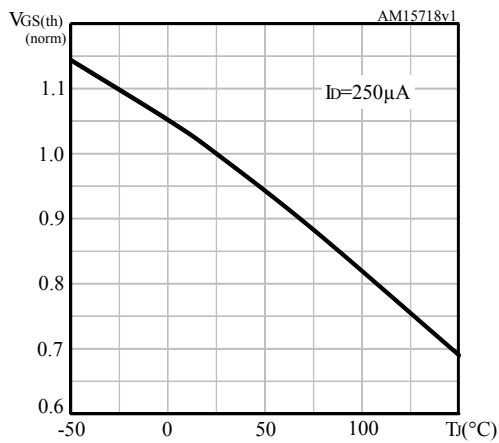
**Figure 7. Gate charge vs gate-source voltage**



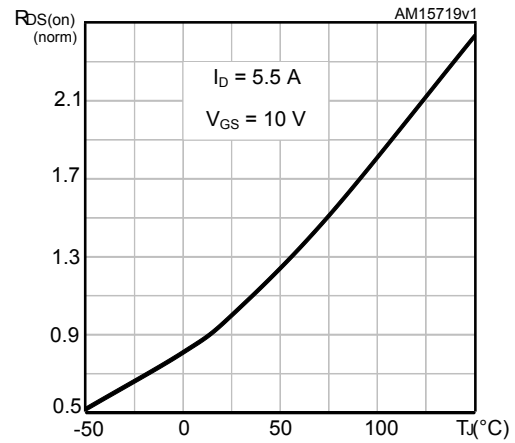
**Figure 8. Capacitance variations**



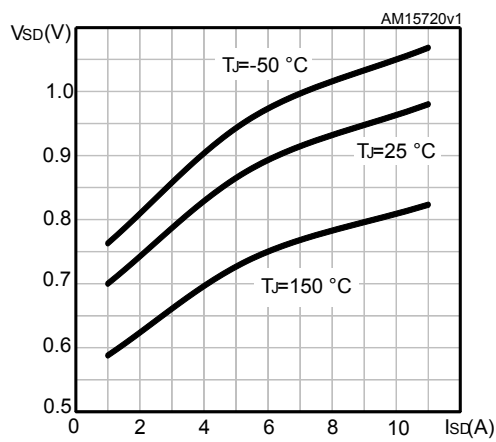
**Figure 9. Normalized gate threshold voltage vs temperature**



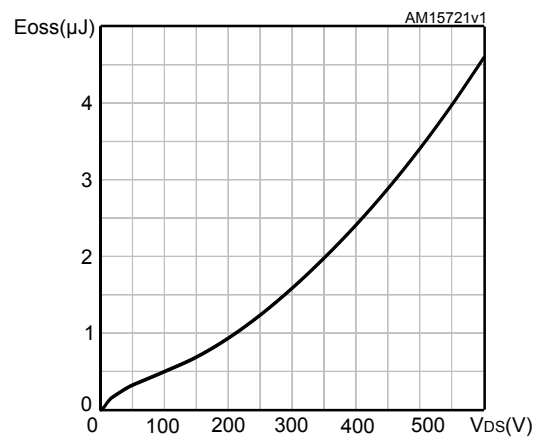
**Figure 10. Normalized on-resistance vs temperature**



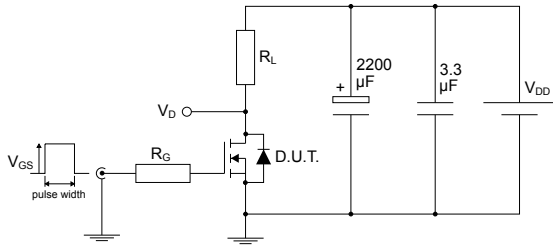
**Figure 11. Source-drain diode forward characteristics**



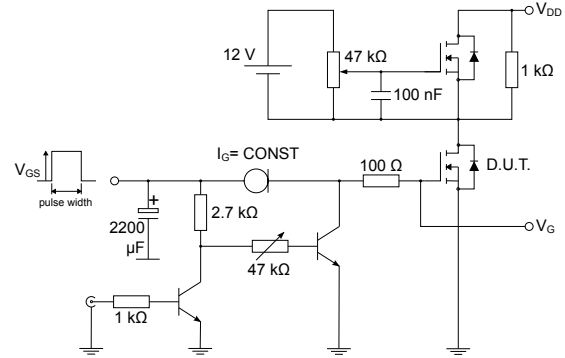
**Figure 12. Output capacitance stored energy**



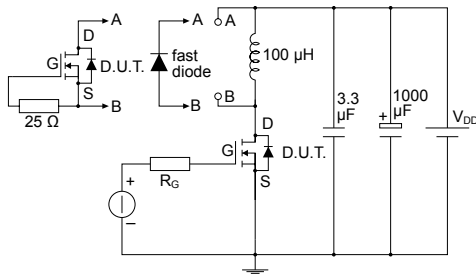
### 3 Test circuits

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


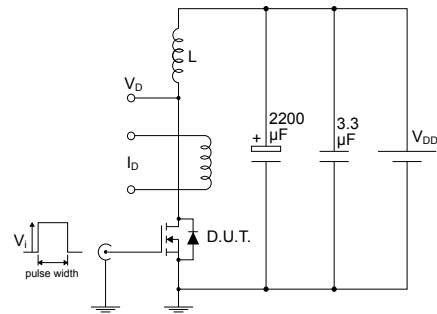
AM01468v1

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


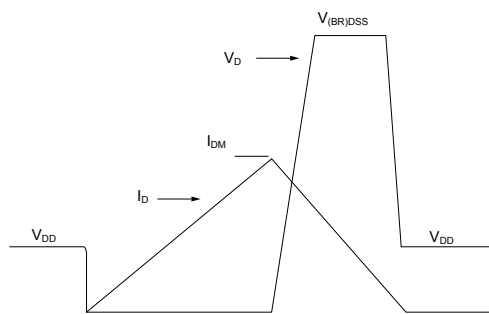
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**Figure 15. Test circuit for inductive load switching and diode recovery times**


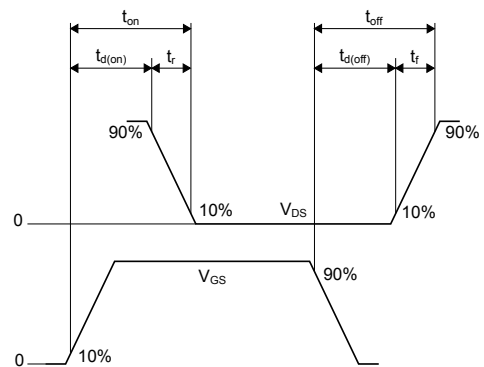
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**Figure 16. Unclamped inductive load test circuit**


AM01471v1

**Figure 17. Unclamped inductive waveform**


AM01472v1

**Figure 18. Switching time waveform**


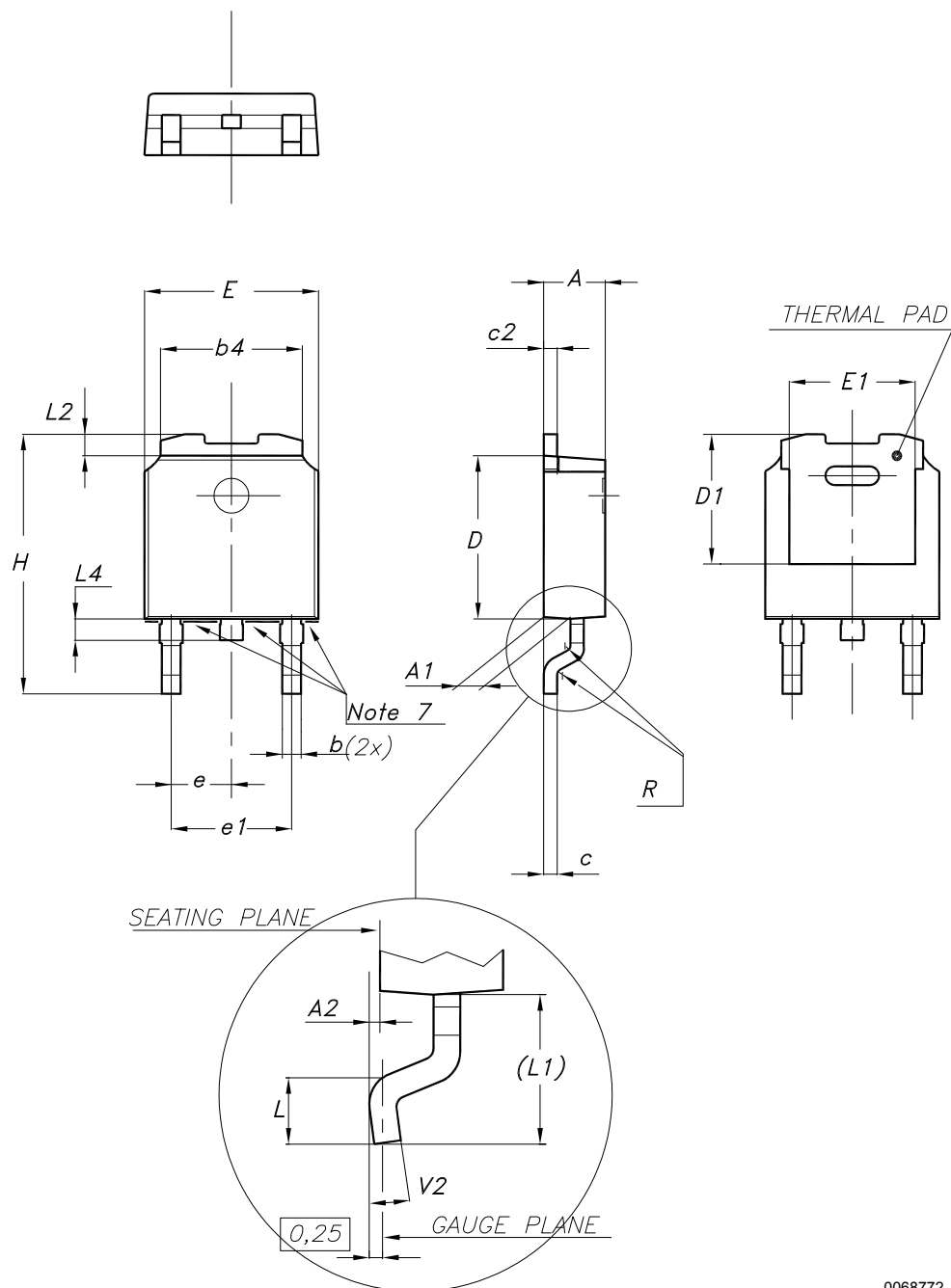
AM01473v1

## 4 Package information

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

### 4.1 DPAK (TO-252) type A2 package information

Figure 19. DPAK (TO-252) type A2 package outline



0068772\_type-A2\_rev34

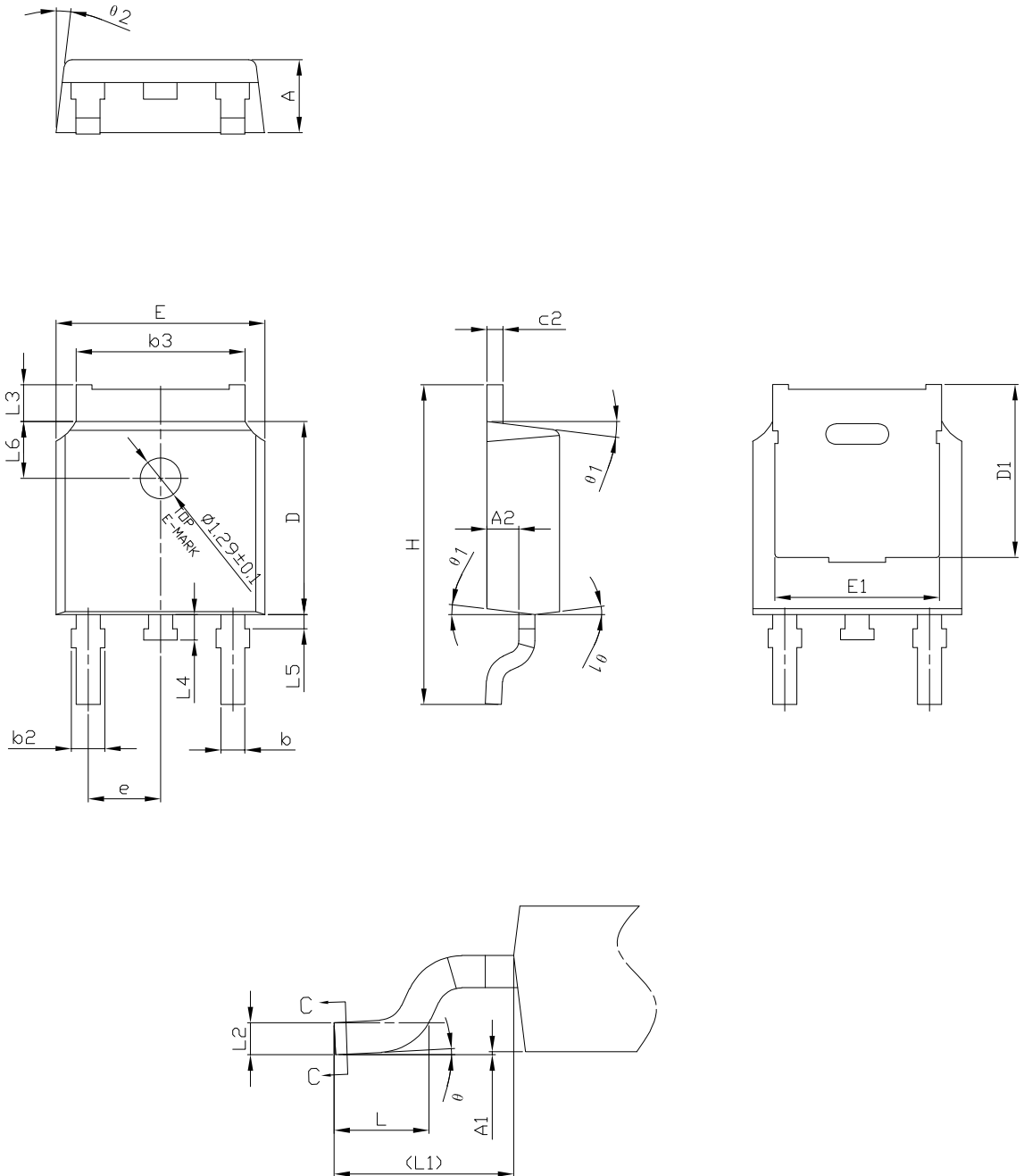


**Table 8. DPAK (TO-252) type A2 mechanical data**

| 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   | 5.10  | 5.20  | 5.30  |
| 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 C3 package information

Figure 20. DPAK (TO-252) type C3 package outline

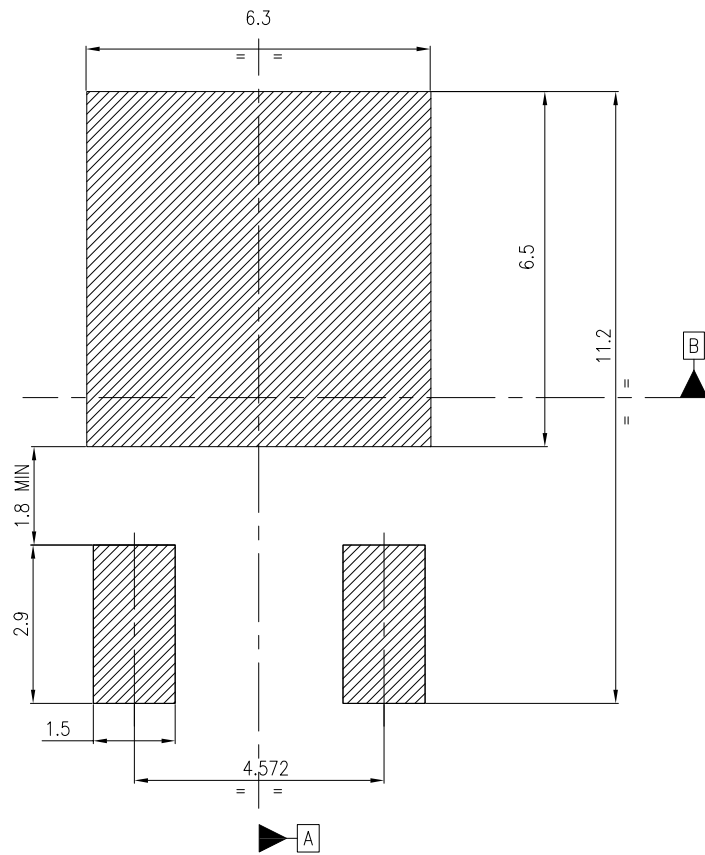


0068772\_type-C3\_rev34

**Table 9. DPAK (TO-252) type C3 mechanical data**

| Dim. | mm       |       |       |
|------|----------|-------|-------|
|      | Min.     | Typ.  | Max.  |
| A    | 2.20     | 2.30  | 2.38  |
| A1   | 0.00     |       | 0.10  |
| A2   | 0.90     | 1.01  | 1.10  |
| b    | 0.72     |       | 0.85  |
| b2   | 0.72     |       | 1.10  |
| b3   | 5.13     | 5.33  | 5.46  |
| c    | 0.47     |       | 0.60  |
| c2   | 0.47     |       | 0.60  |
| D    | 6.00     | 6.10  | 6.20  |
| D1   | 5.20     | 5.45  | 5.70  |
| E    | 6.50     | 6.60  | 6.70  |
| E1   | 5.00     | 5.20  | 5.40  |
| 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   | 0.51 BSC |       |       |
| L3   | 0.90     |       | 1.25  |
| L4   | 0.60     | 0.80  | 1.00  |
| L5   | 0.15     |       | 0.75  |
| L6   | 1.80 REF |       |       |
| θ    | 0°       |       | 8°    |
| θ1   | 5°       | 7°    | 9°    |
| θ2   | 5°       | 7°    | 9°    |

Figure 21. DPAK (TO-252) recommended footprint (dimensions are in mm)



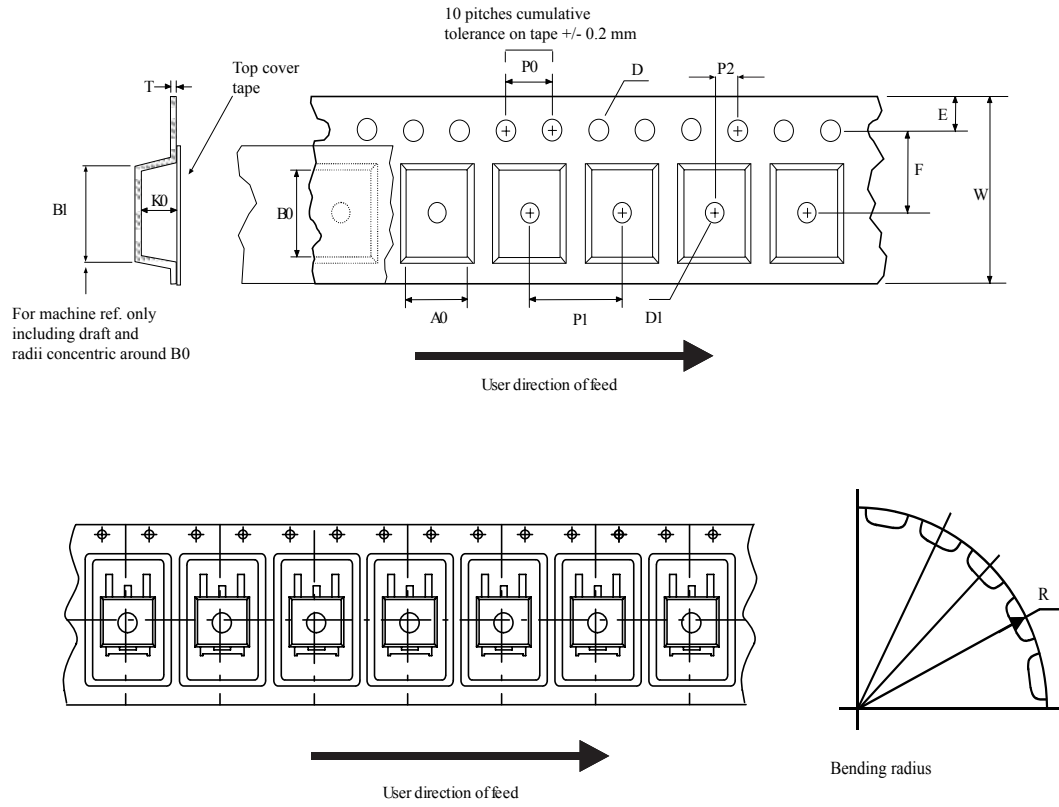
Notes:

- 1) This footprint is able to ensure insulation up to 630 Vrms (according to CEI IEC 664-1)
- 2) The device must be positioned within  $\boxed{\oplus 0.05 \text{ A B}}$

FP\_0068772\_34

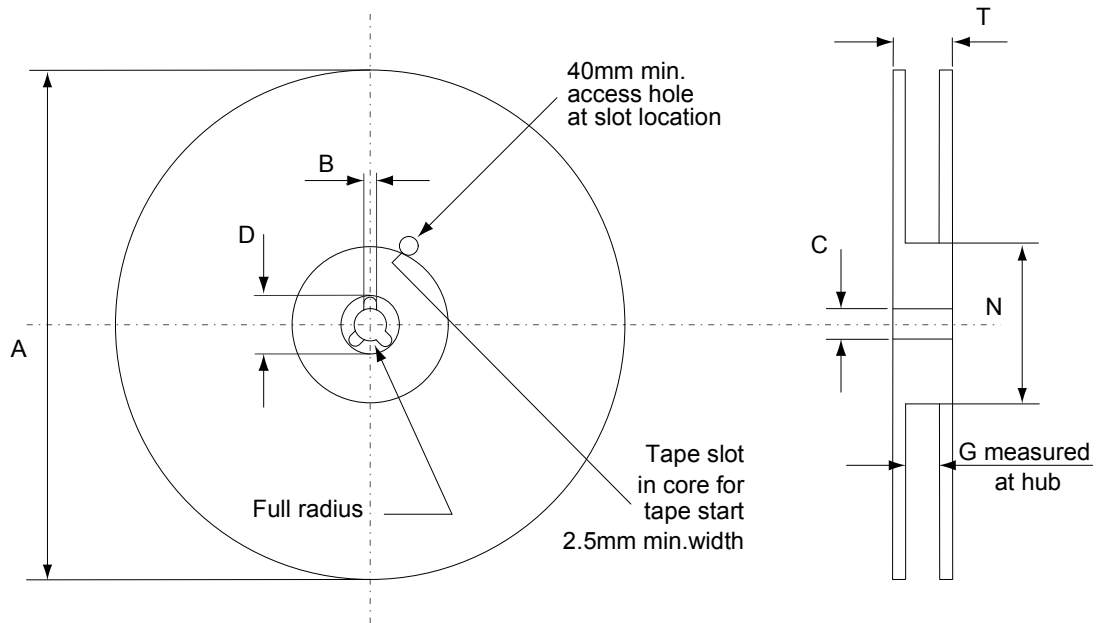
### 4.3 DPAK (TO-252) packing information

Figure 22. DPAK (TO-252) tape outline



AM08852v1

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



AM06038v1

**Table 10. DPAK (TO-252) tape and reel mechanical data**

| Dim. | Tape |      | Dim.      | Reel |      |
|------|------|------|-----------|------|------|
|      | mm   |      |           | 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 |           |      |      |

## Revision history

**Table 11. Document revision history**

| Date        | Revision | Changes   |
|-------------|----------|---|
| 22-Apr-2013 | 1        | First release.  |
| 28-Jun-2013 | 2        | Document status promoted from preliminary data to production data.<br>Minor text changes.   |
| 03-Mar-2014 | 3        | Updated: <i>Table 10</i> and <i>Table 25</i> .<br>Minor text changes.   |
| 12-Sep-2016 | 4        | Updated the title, features and the description.<br>Updated D <sup>2</sup> PAK (TO-263) type A package information, <i>Section 4.2 DPAK (TO-252) type A2 package information</i> , <i>Section 4.3 DPAK (TO-252) type C2 package information</i> and <i>Section 4.4 D<sup>2</sup>PAK and DPAK packing information</i> .  |
| 12-Feb-2019 | 5        | Updated <i>Section 4 Package information</i> .<br>Minor text changes.   |
| 22-Jun-2023 | 6        | The part number STB13N60M2 have been moved to a separate datasheet and the document has been updated accordingly.<br>Updated <a href="#">Section 4.1 DPAK (TO-252) type A2 package information</a> and replaced " <a href="#">Section 4.3 DPAK (TO-252) type C2 package information</a> " with <a href="#">Section 4.2 DPAK (TO-252) type C3 package information</a> .<br>Minor text changes. |

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