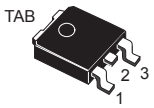
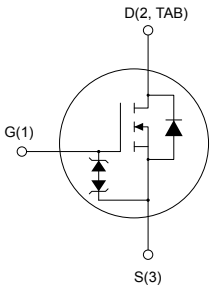
# N-channel 600 V, 350 mΩ typ., 11 A MDmesh M2 Power MOSFET in a DPAK package




DPAK




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 | |
|---|---|
| **Order code** | STD13N60M2 |
| **Marking** | 13N60M2 |
| **Package** | DPAK |
| **Packing** | Tape and reel |

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{GS}$ | Gate-source voltage | ±25 | V |
| $I_D$ | Drain current (continuous) at $T_C$ = 25 °C | 11 | A |
| | Drain current (continuous) at $T_C$ = 100 °C | 7 | |
| $I_{DM}$(1) | Drain current (pulsed) | 44 | A |
| $P_{TOT}$ | Total power dissipation at $T_C$ = 25 °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 | °C |
| $T_J$ | Operating junction temperature range | | °C |

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

**Table 2. Thermal data**

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

1. *When mounted on 1 inch$^2$ 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 °C, $I_D$ = $I_{AR}$, $V_{DD}$ = 50 V) | 125 | mJ |

# 2 Electrical characteristics

$T_C$ = 25 °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 V, $I_D$ = 1 mA | 600 | | | V |
| $I_{DSS}$ | Zero gate voltage drain current | $V_{GS}$ = 0 V, $V_{DS}$ = 600 V | | | 1 | µA |
| | | $V_{GS}$ = 0 V, $V_{DS}$ = 600 V, $T_C$ = 125 °C(1) | | | 100 | |
| $I_{GSS}$ | Gate body leakage current | $V_{DS}$ = 0 V, $V_{GS}$ = ±25 V | | | ±10 | µA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 µA | 2 | 3 | 4 | V |
| $R_{DS(on)}$ | Static drain-source on-resistance | $V_{GS}$ = 10 V, $I_D$ = 5.5 A | | 350 | 380 | mΩ |

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 V, f = 1 MHz, $V_{GS}$ = 0 V | - | 580 | - | pF |
| $C_{oss}$ | Output capacitance | | - | 32 | - | pF |
| $C_{rss}$ | Reverse transfer capacitance | | - | 1.1 | - | pF |
| $C_{oss\ eq.}$(1) | Equivalent output capacitance | $V_{DS}$ = 0 to 480 V, $V_{GS}$ = 0 V | - | 120 | - | pF |
| $R_G$ | Intrinsic gate resistance | f = 1 MHz, $I_D$ = 0 A | - | 6.6 | - | Ω |
| $Q_g$ | Total gate charge | $V_{DD}$ = 480 V, $I_D$ = 11 A, $V_{GS}$ = 0 to 10 V (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. *$C_{oss\ eq.}$ 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 V, $I_D$ = 5.5 A, $R_G$ = 4.7 Ω, $V_{GS}$ = 10 V (see Figure 13. Test circuit for resistive load switching times and Figure 18. Switching time waveform) | - | 11 | - | ns |
| $t_r$ | Rise time | | - | 10 | - | ns |
| $t_{d(off)}$ | Turn-off-delay time | | - | 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 V, $I_{SD}$ = 11 A | - | | 1.6 | V |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 11 A, di/dt = 100 A/µs, $V_{DD}$ = 60 V (see Figure 15. Test circuit for inductive load switching and diode recovery times) | - | 297 | | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 2.8 | | µC |
| $I_{RRM}$ | Reverse recovery current | | - | 18.5 | | A |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 11 A, di/dt = 100 A/µs, $V_{DD}$ = 60 V, $T_J$ = 150 °C (see Figure 15. Test circuit for inductive load switching and diode recovery times) | - | 394 | | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 3.8 | | µC |
| $I_{RRM}$ | Reverse recovery current | | - | 19 | | A |

1. *Pulse width is limited by safe operating area.*
2. *Pulsed: pulse duration = 300 µs, duty cycle 1.5%.*

## 2.1 Electrical characteristics (curves)

**Figure 1. Safe operating area**

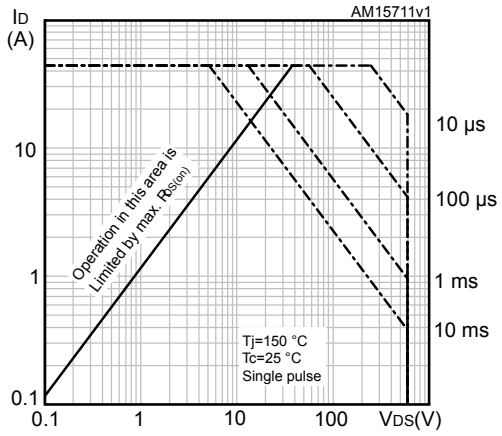



**Figure 2. Normalized transient thermal impedance**

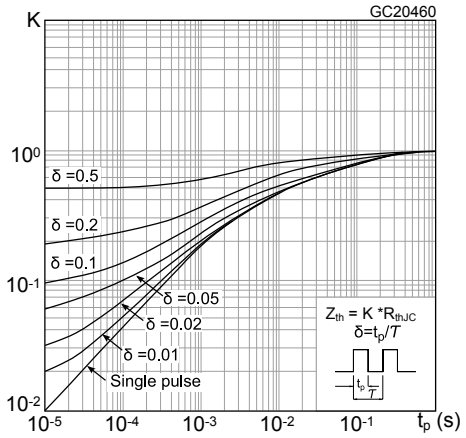



**Figure 3. Output characteristics**

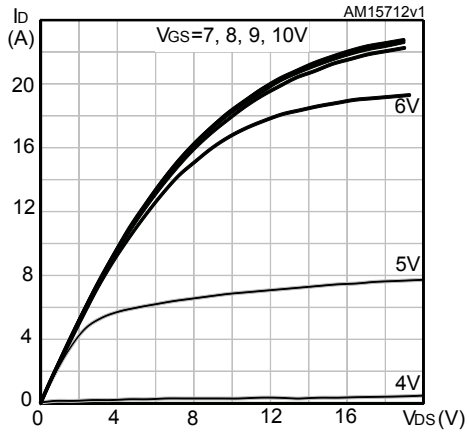



**Figure 4. Transfer characteristics**

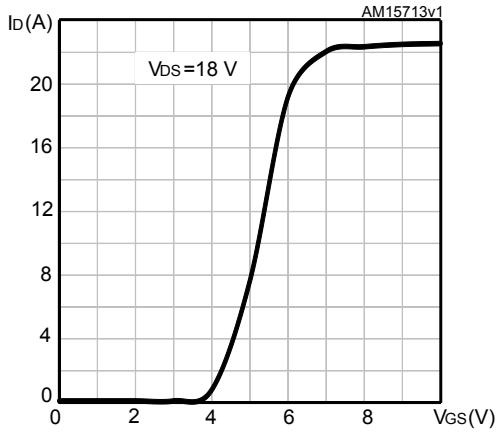



**Figure 5. Normalized $V_{(BR)DSS}$ vs temperature**

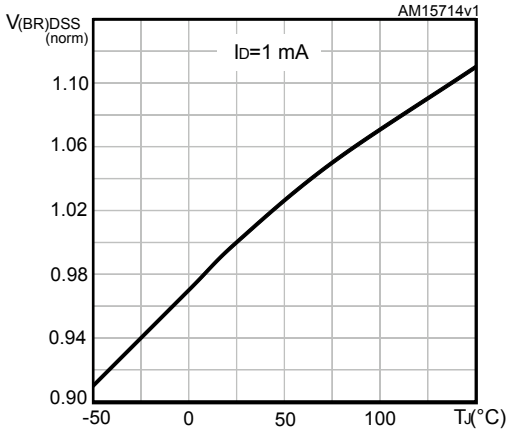



**Figure 6. Static drain-source on-resistance**

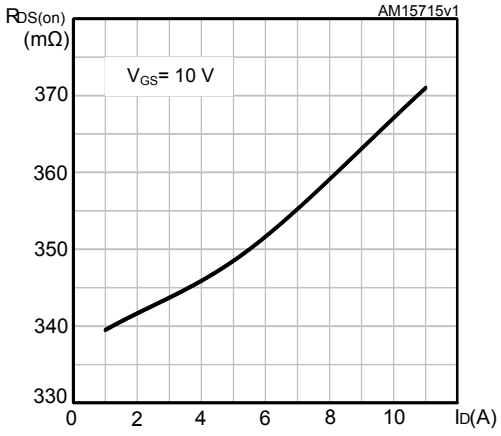


**Figure 7. Gate charge vs gate-source voltage**

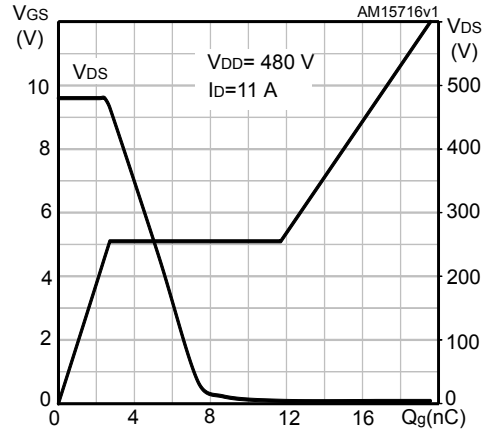



**Figure 8. Capacitance variations**

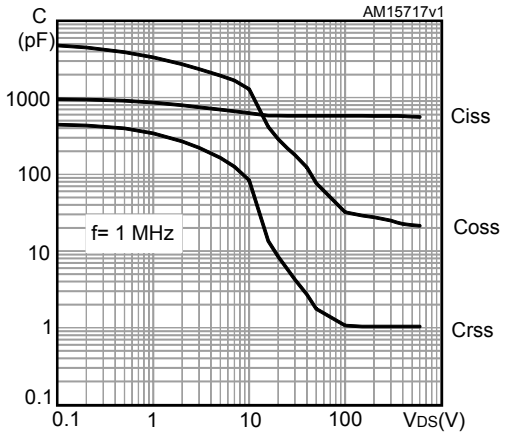



**Figure 9. Normalized gate threshold voltage vs temperature**

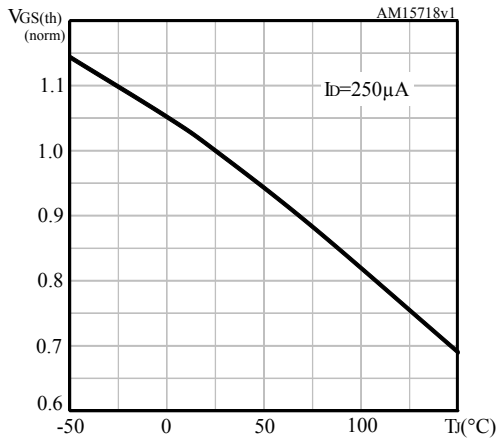



**Figure 10. Normalized on-resistance vs temperature**

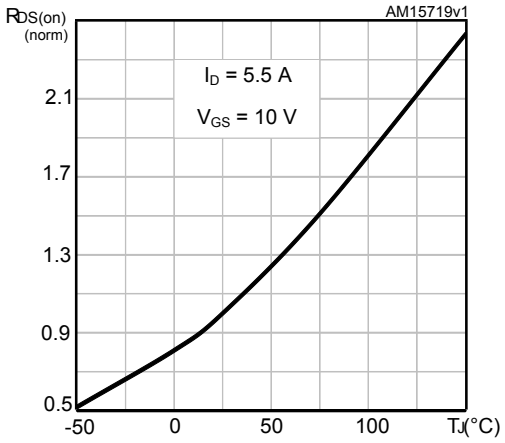



**Figure 11. Source-drain diode forward characteristics**

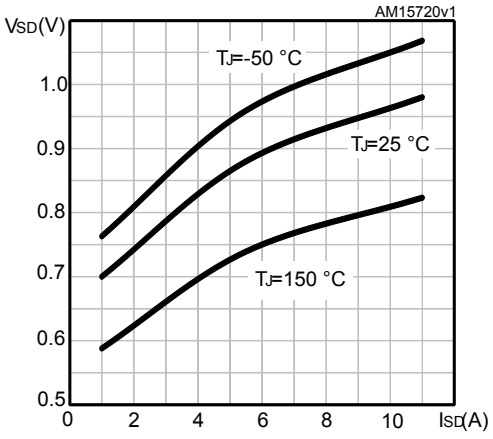
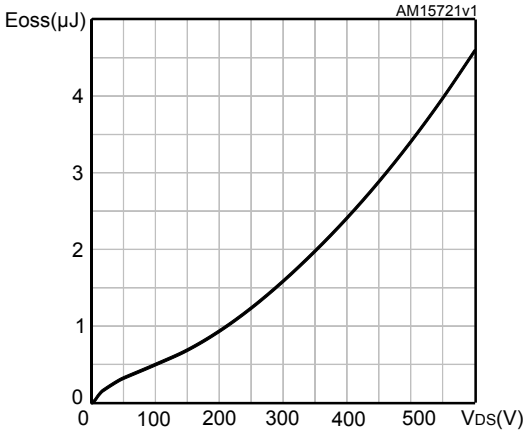
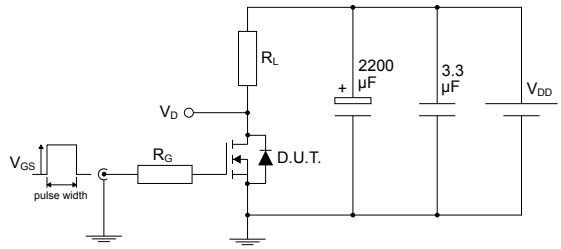



**Figure 12. Output capacitance stored energy**



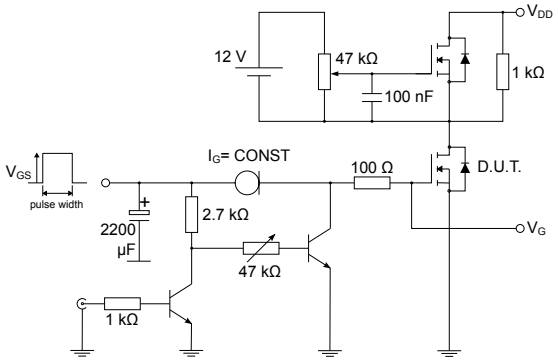
# 3 Test circuits

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



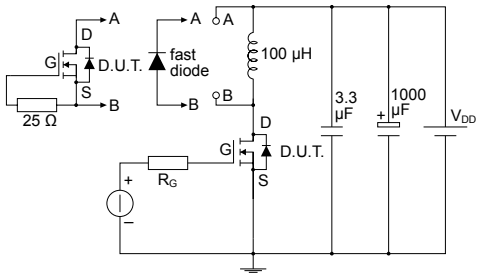

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**Figure 14. Test circuit for gate charge behavior**



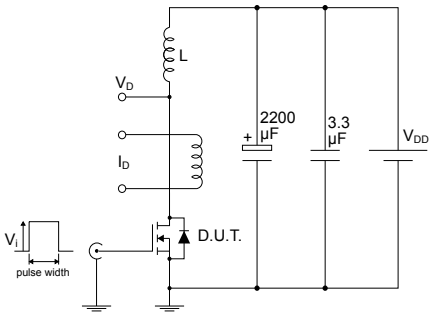

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**Figure 15. Test circuit for inductive load switching and diode recovery times**



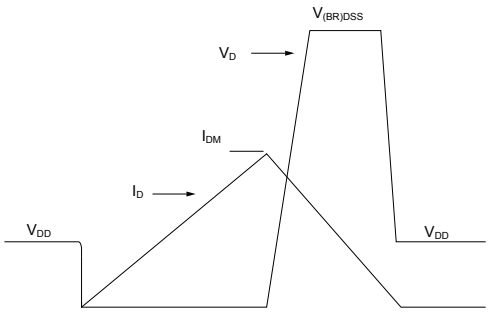

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**Figure 16. Unclamped inductive load test circuit**



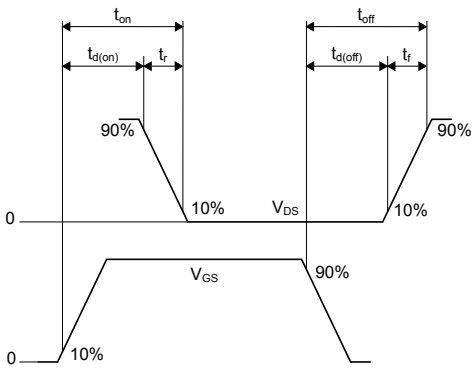

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**Figure 17. Unclamped inductive waveform**




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**Figure 18. Switching time waveform**



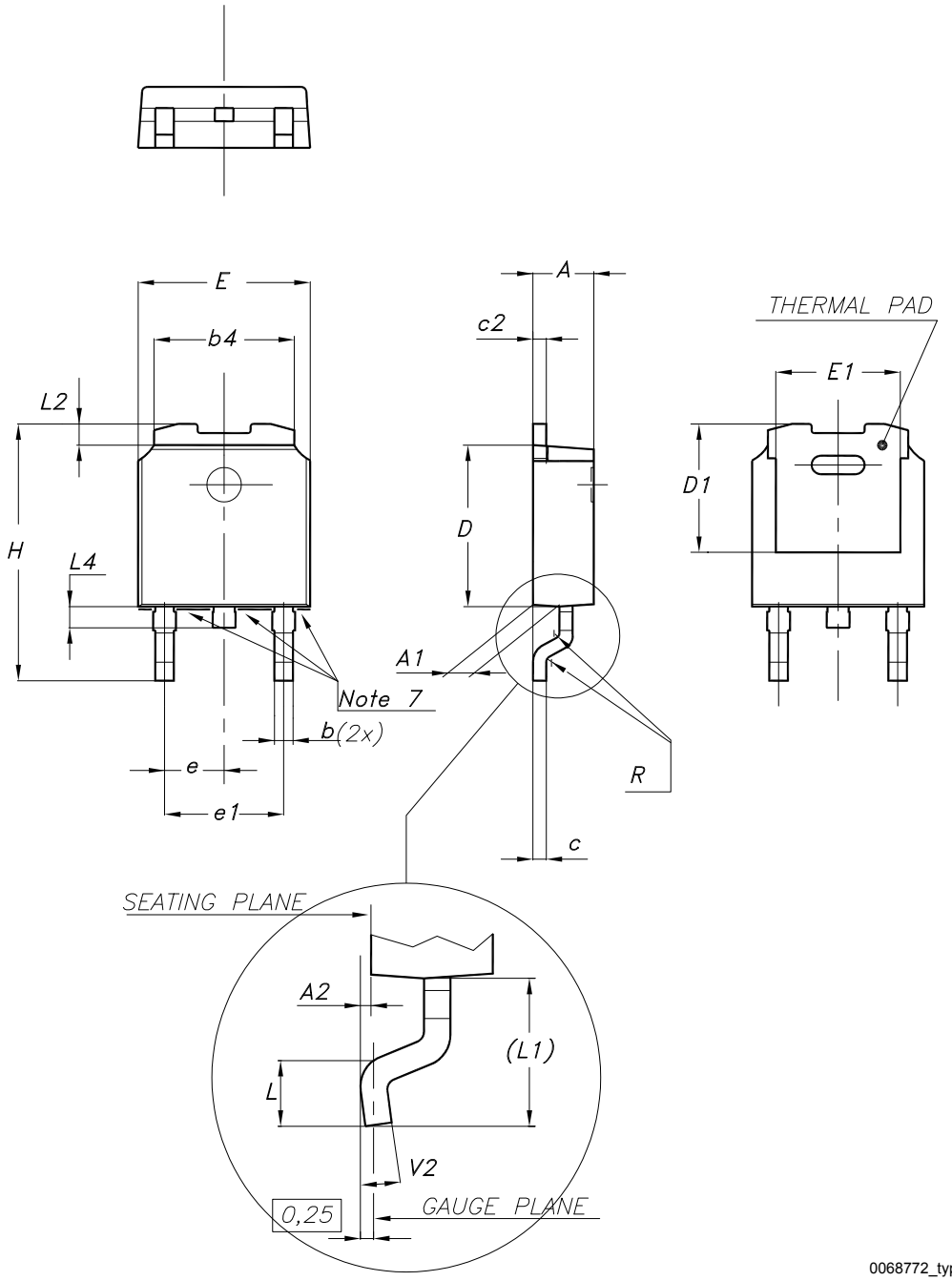

AM01473v1

# 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. ECOPACK is an ST trademark.

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

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



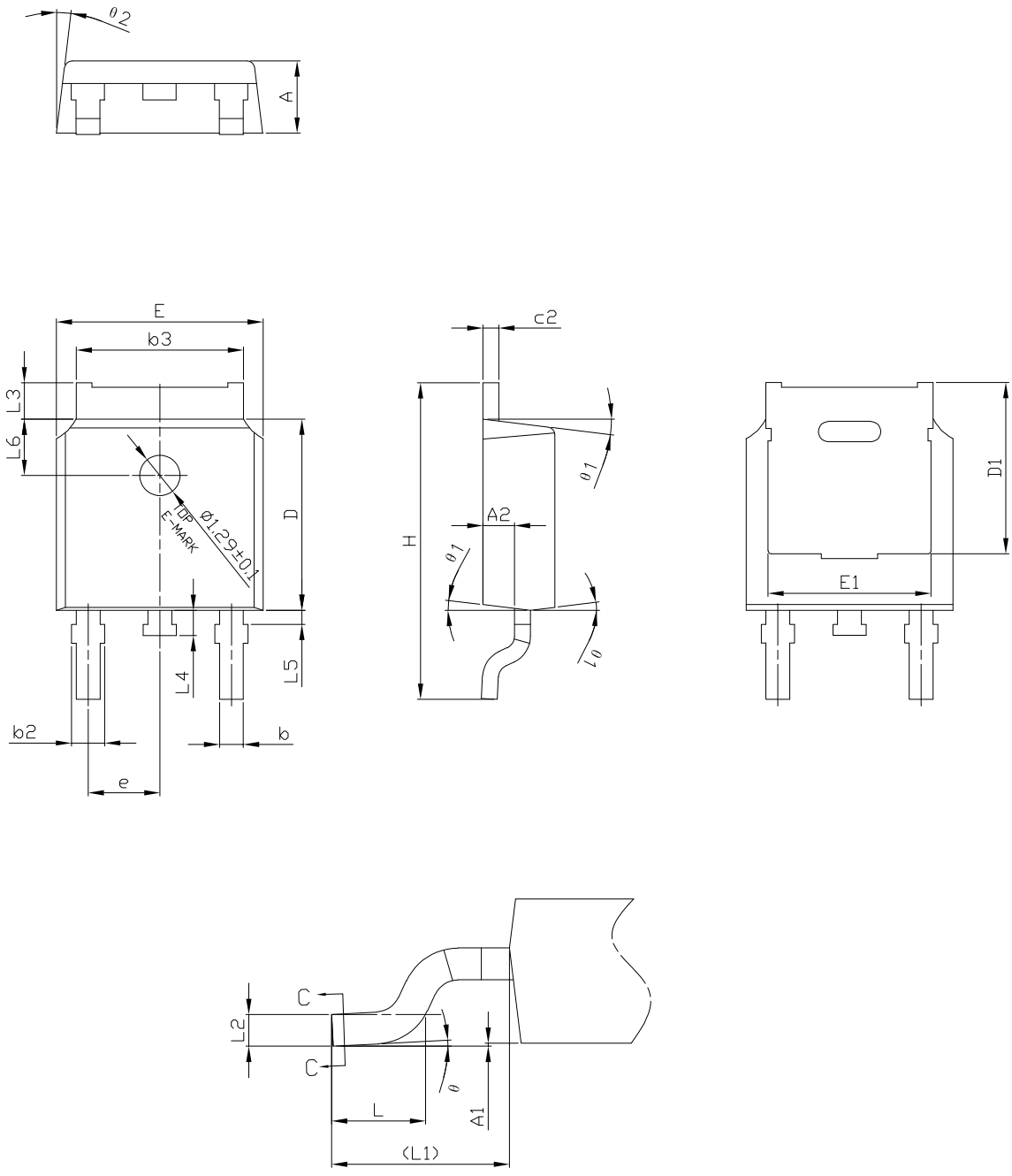

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Table 8. **DPAK (TO-252) type A2 mechanical data**

| 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**

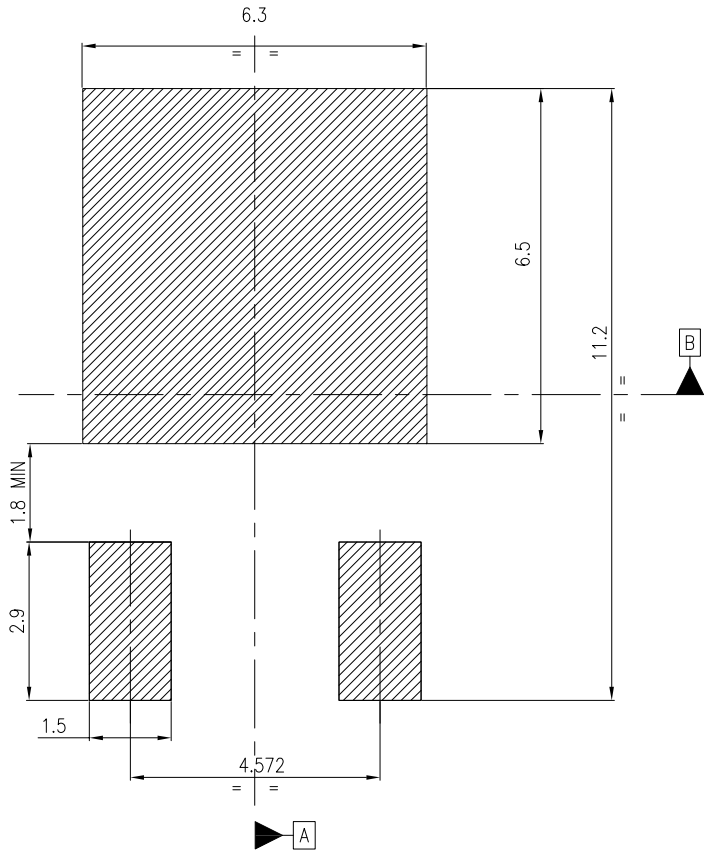



0068772_type-C3_rev34

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 ⌖ 0.05 A B

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## 4.3 DPAK (TO-252) packing information

Figure 22. **DPAK (TO-252) tape outline**

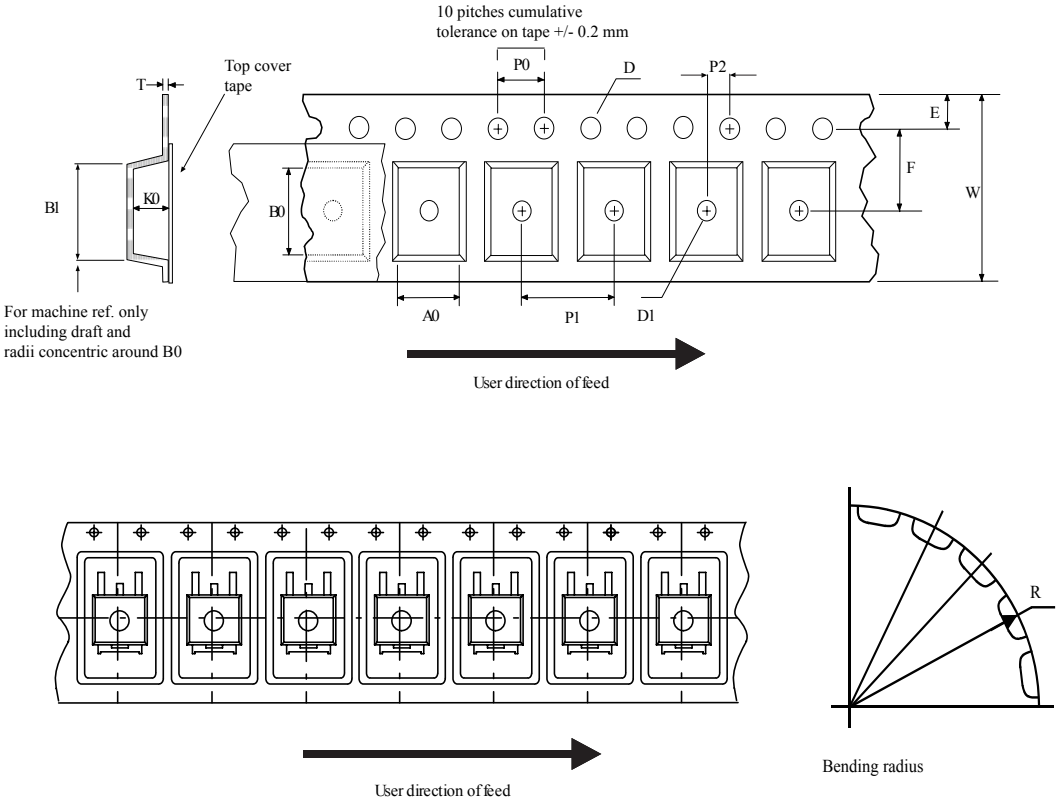
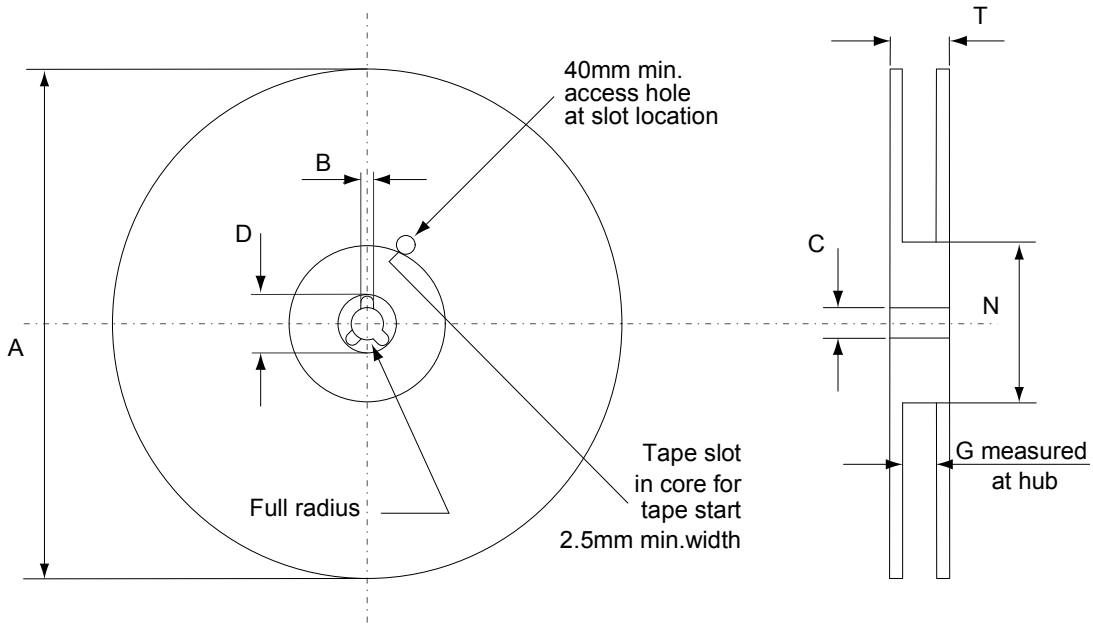


Figure 23. **DPAK (TO-252) reel outline**




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Table 10. **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 | | | |

## 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: *Table 10* and *Table 25*.<br>Minor text changes. |
| 12-Sep-2016 | 4 | Updated the title, features and the description.<br>Updated D²PAK (TO-263) type A package information, *Section 4.2 DPAK (TO-252) type A2 package information*, *Section 4.3 DPAK (TO-252) type C2 package information* and *Section 4.4 D²PAK and DPAK packing information*. |
| 12-Feb-2019 | 5 | Updated *Section 4 Package information*.<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 Section 4.1 DPAK (TO-252) type A2 package information and replaced "*Section 4.3 DPAK (TO-252) type C2 package information*" with Section 4.2 DPAK (TO-252) type C3 package information.<br>Minor text changes. |

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