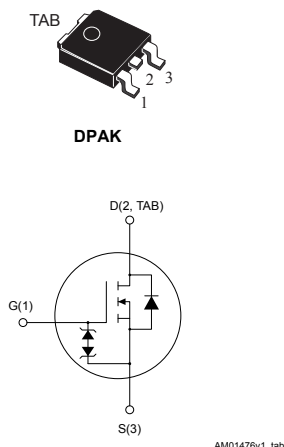


## N-channel 600 V, 345 mΩ typ., 10 A MDmesh DM6 Power MOSFET in a DPAK package



### Features

| Order code  | $V_{DS}$ | $R_{DS(on)}$ max. | $I_D$ |
|-------------|----------|-------------------|-------|
| STD12N60DM6 | 600 V    | 390 mΩ            | 10 A  |

- Fast-recovery body diode
- Lower  $R_{DS(on)}$  per area vs previous generation
- Low gate charge, input capacitance and resistance
- 100% avalanche tested
- Extremely high dv/dt ruggedness
- Zener-protected

### Applications

- Switching applications

### Description

This high-voltage N-channel Power MOSFET is part of the MDmesh DM6 fast-recovery diode series. Compared with the previous MDmesh fast generation, DM6 combines very low recovery charge ( $Q_{rr}$ ), recovery time ( $t_{rr}$ ) and excellent improvement in  $R_{DS(on)}$  per area with one of the most effective switching behaviors available in the market for the most demanding high-efficiency bridge topologies and ZVS phase-shift converters.



#### Product status link

[STD12N60DM6](#)

#### Product summary

|            |               |
|------------|---------------|
| Order code | STD12N60DM6   |
| Marking    | 12N60DM6      |
| Package    | DPAK          |
| Packing    | 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 $T_C = 25\text{ }^{\circ}\text{C}$  | 10         | A                  |
|                | Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$ | 6.3        |                    |
| $I_{DM}^{(1)}$ | Drain current (pulsed)                                            | 28         | A                  |
| $P_{TOT}$      | Total power dissipation at $T_C = 25\text{ }^{\circ}\text{C}$     | 90         | W                  |
| $I_{AR}^{(2)}$ | Avalanche current, repetitive or not repetitive                   | 3          | A                  |
| $E_{AS}^{(3)}$ | Single pulse avalanche energy                                     | 195        | mJ                 |
| $dv/dt^{(4)}$  | Peak diode recovery voltage slope                                 | 100        | V/ns               |
| $di/dt^{(4)}$  | Peak diode recovery current slope                                 | 1000       | A/ $\mu$ s         |
| $dv/dt^{(5)}$  | MOSFET $dv/dt$ ruggedness                                         | 100        | 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. Pulse width limited by  $T_J$  max.
3. Starting  $T_J = 25\text{ }^{\circ}\text{C}$ ,  $I_D = I_{AR}$ ,  $V_{DD} = 50\text{ V}$ .
4.  $I_{SD} \leq 10\text{ A}$ ,  $V_{DS}(\text{peak}) < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$ .
5.  $V_{DS} \leq 480\text{ V}$ .

**Table 2. Thermal data**

| Symbol              | Parameter                        | Value | Unit                 |
|---------------------|----------------------------------|-------|----------------------|
| $R_{thj-case}$      | Thermal resistance junction-case | 1.39  | $^{\circ}\text{C/W}$ |
| $R_{thj-pcb}^{(1)}$ | Thermal resistance junction-pcb  | 50    | $^{\circ}\text{C/W}$ |

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

## 2 Electrical characteristics

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

**Table 3. On/off states**

| Symbol        | Parameter                         | Test conditions                                                                                      | Min. | Typ. | Max.    | Unit          |
|---------------|-----------------------------------|------------------------------------------------------------------------------------------------------|------|------|---------|---------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage    | $V_{GS} = 0\text{ V}$ , $I_D = 1\text{ mA}$                                                          | 600  |      |         | V             |
| $I_{DSS}$     | Zero gate voltage drain current   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$                                                      |      |      | 1       | $\mu\text{A}$ |
|               |                                   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$ , $T_C = 125\text{ }^{\circ}\text{C}$ <sup>(1)</sup> |      |      | 100     |               |
| $I_{GSS}$     | Gate-body leakage current         | $V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 25\text{ V}$                                                   |      |      | $\pm 5$ | $\mu\text{A}$ |
| $V_{GS(th)}$  | Gate threshold voltage            | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                                                   | 3.25 | 4    | 4.75    | V             |
| $R_{DS(on)}$  | Static drain-source on-resistance | $V_{GS} = 10\text{ V}$ , $I_D = 5\text{ A}$                                                          |      | 345  | 390     | m $\Omega$    |

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

**Table 4. Dynamic**

| Symbol                     | Parameter                     | Test conditions                                                                                                                              | Min. | Typ. | Max. | Unit     |
|----------------------------|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|----------|
| $C_{iss}$                  | Input capacitance             | $V_{GS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{DS} = 0\text{ V}$                                                                         | -    | 508  | -    | pF       |
| $C_{oss}$                  | Output capacitance            |                                                                                                                                              | -    | 28   | -    | pF       |
| $C_{rss}$                  | Reverse transfer capacitance  |                                                                                                                                              | -    | 4.7  | -    | pF       |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{DS} = 0\text{ to }480\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                  | -    | 100  | -    | pF       |
| $R_G$                      | Intrinsic gate resistance     | $f = 1\text{ MHz}$ open drain                                                                                                                | -    | 5.8  | -    | $\Omega$ |
| $Q_g$                      | Total gate charge             | $V_{DD} = 480\text{ V}$ , $I_D = 10\text{ A}$ , $V_{GS} = 0\text{ to }10\text{ V}$<br>(see Figure 14. Test circuit for gate charge behavior) | -    | 17   | -    | nC       |
| $Q_{gs}$                   | Gate-source charge            |                                                                                                                                              | -    | 3.8  | -    | nC       |
| $Q_{gd}$                   | Gate-drain charge             |                                                                                                                                              | -    | 9.3  | -    | 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 5. Switching times**

| Symbol       | Parameter           | Test conditions                                                                                         | Min. | Typ. | Max. | Unit |
|--------------|---------------------|---------------------------------------------------------------------------------------------------------|------|------|------|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 300\text{ V}$ , $I_D = 5\text{ A}$ ,<br>$R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$    | -    | 11   | -    | ns   |
| $t_r$        | Rise time           |                                                                                                         | -    | 4.3  | -    | ns   |
| $t_{d(off)}$ | Turn-off delay time | (see Figure 13. Test circuit for resistive load switching times and Figure 18. Switching time waveform) | -    | 26   | -    | ns   |
| $t_f$        | Fall time           |                                                                                                         | -    | 7.3  | -    | ns   |

**Table 6. Source-drain diode**

| Symbol          | Parameter                     | Test conditions                                                                                                                                                                                                    | Min. | Typ.  | Max. | Unit          |
|-----------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------|------|---------------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                                                                                                    | -    |       | 10   | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                                                                                                    | -    |       | 28   | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $V_{GS} = 0\text{ V}$ , $I_{SD} = 10\text{ A}$                                                                                                                                                                     | -    |       | 1.6  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 10\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60\text{ V}$<br>(see Figure 15. Test circuit for inductive load switching and diode recovery times)                                     | -    | 80    |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                    | -    | 0.288 |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      | $I_{SD} = 10\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60\text{ V}$ , $T_J = 150\text{ }^\circ\text{C}$<br>(see Figure 15. Test circuit for inductive load switching and diode recovery times) | -    | 7.2   |      | A             |
| $t_{rr}$        | Reverse recovery time         |                                                                                                                                                                                                                    | -    | 148   |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                    | -    | 0.680 |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                    | -    | 9.2   |      | 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**

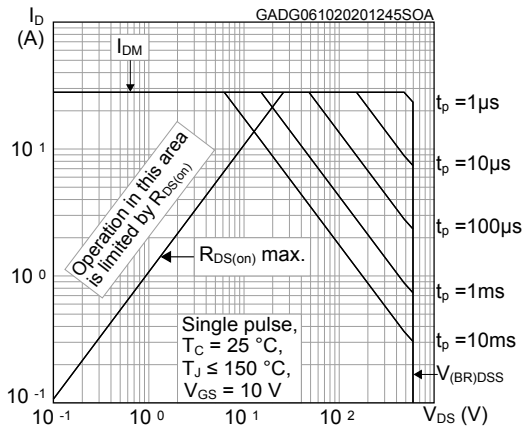


**Figure 2. Maximum transient thermal impedance**

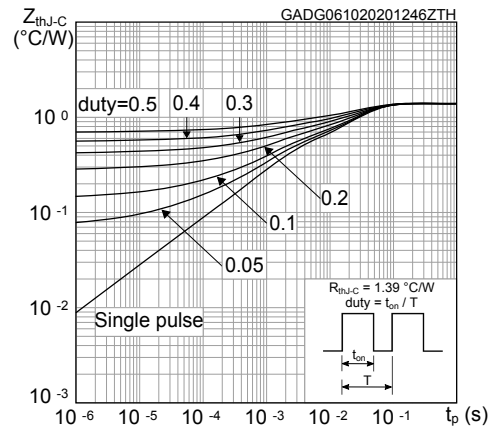


**Figure 3. Typical output characteristics**

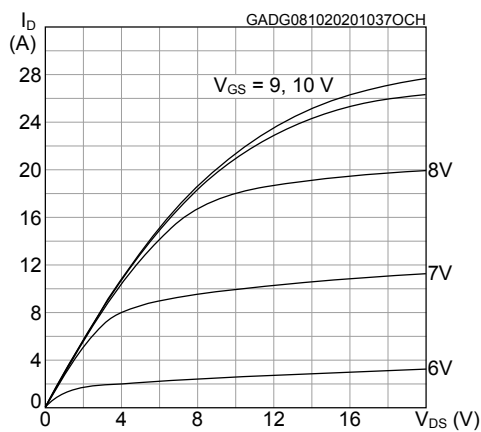


**Figure 4. Typical transfer characteristics**

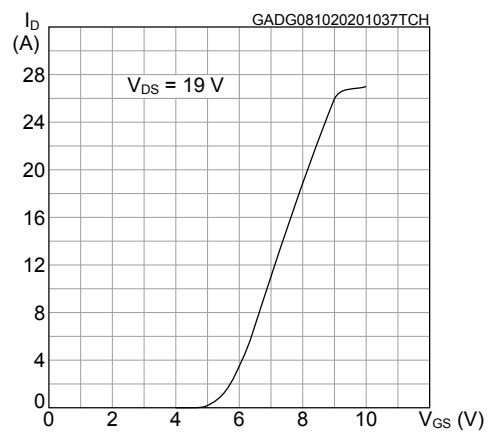


**Figure 5. Typical gate charge characteristics**

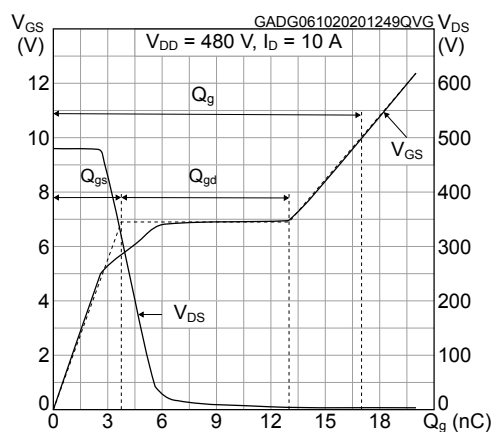


**Figure 6. Typical drain-source on-resistance**

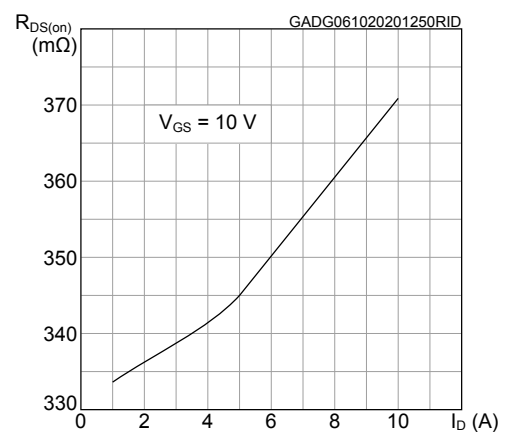


**Figure 7. Typical capacitance characteristics**

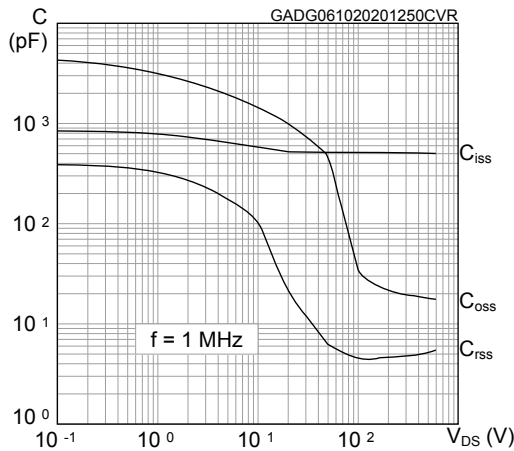


**Figure 8. Typical output capacitance stored energy**

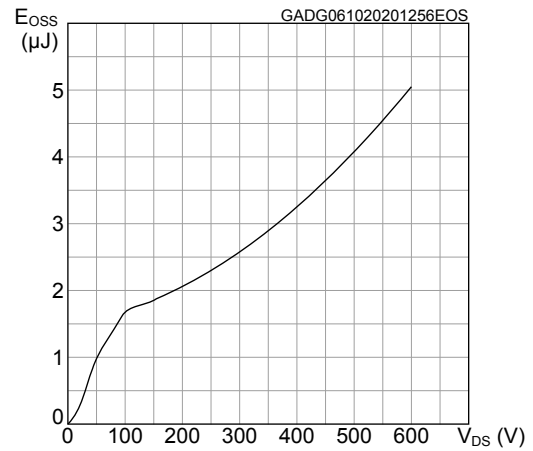


**Figure 9. Normalized gate threshold vs temperature**

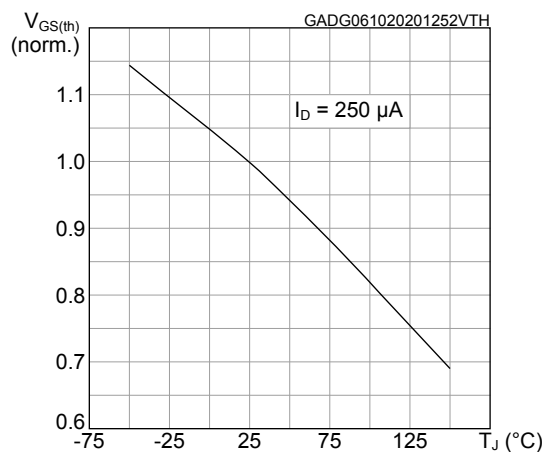


**Figure 10. Normalized on-resistance vs temperature**

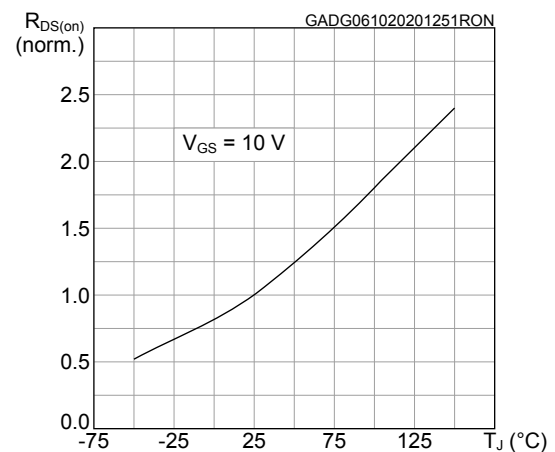


**Figure 11. Normalized breakdown voltage vs temperature**

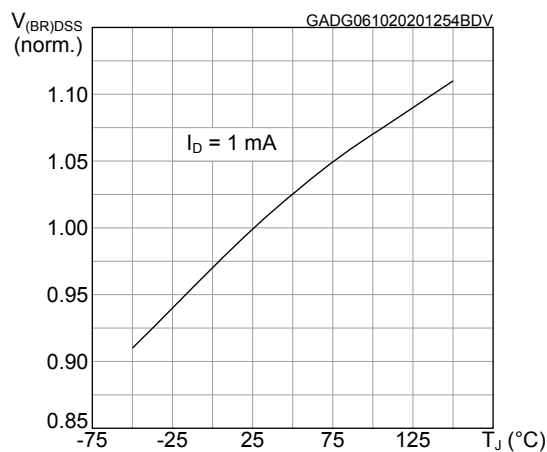
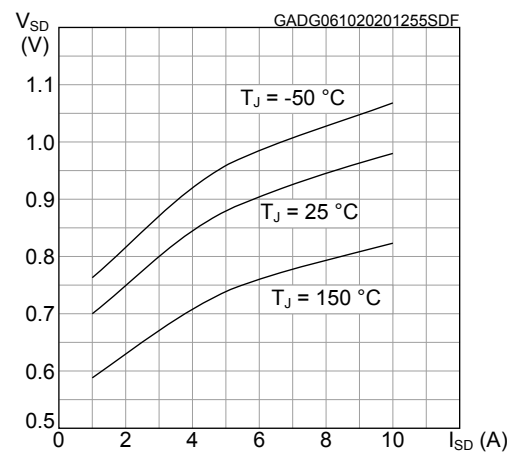
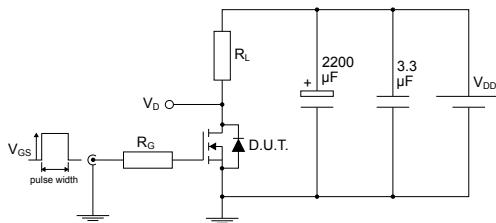


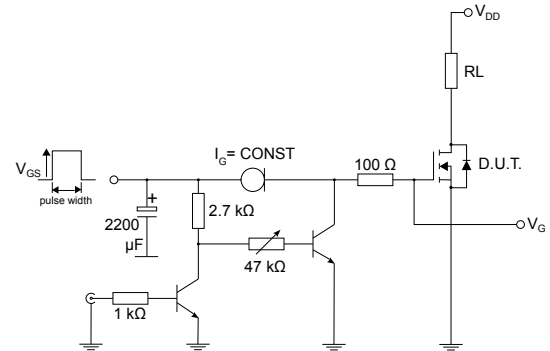
**Figure 12. Typical reverse diode forward characteristics**



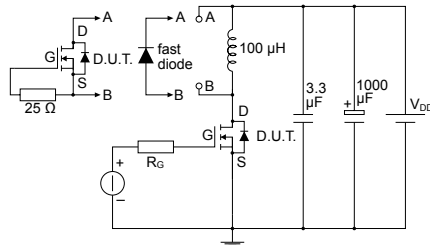
### 3 Test circuits

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


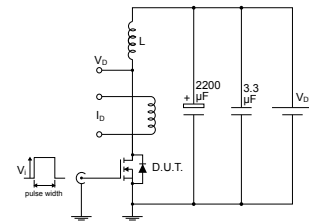
AM01468v1

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


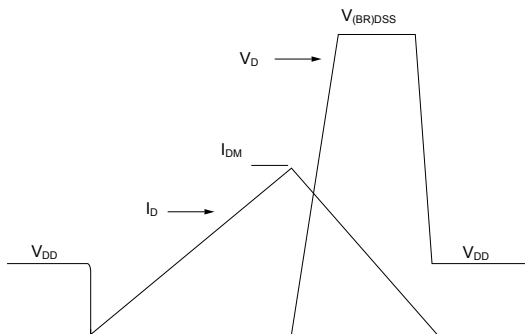
AM01469v10

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


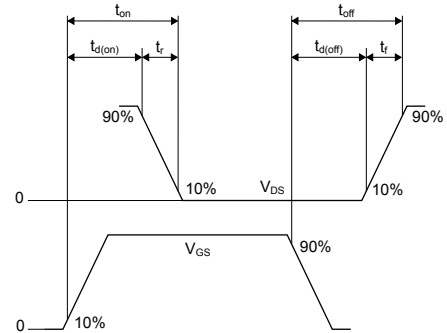
AM01470v1

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


AM01471v1

**Figure 17. Unclamped inductive waveform**


AM01472v1

**Figure 18. Switching time waveform**


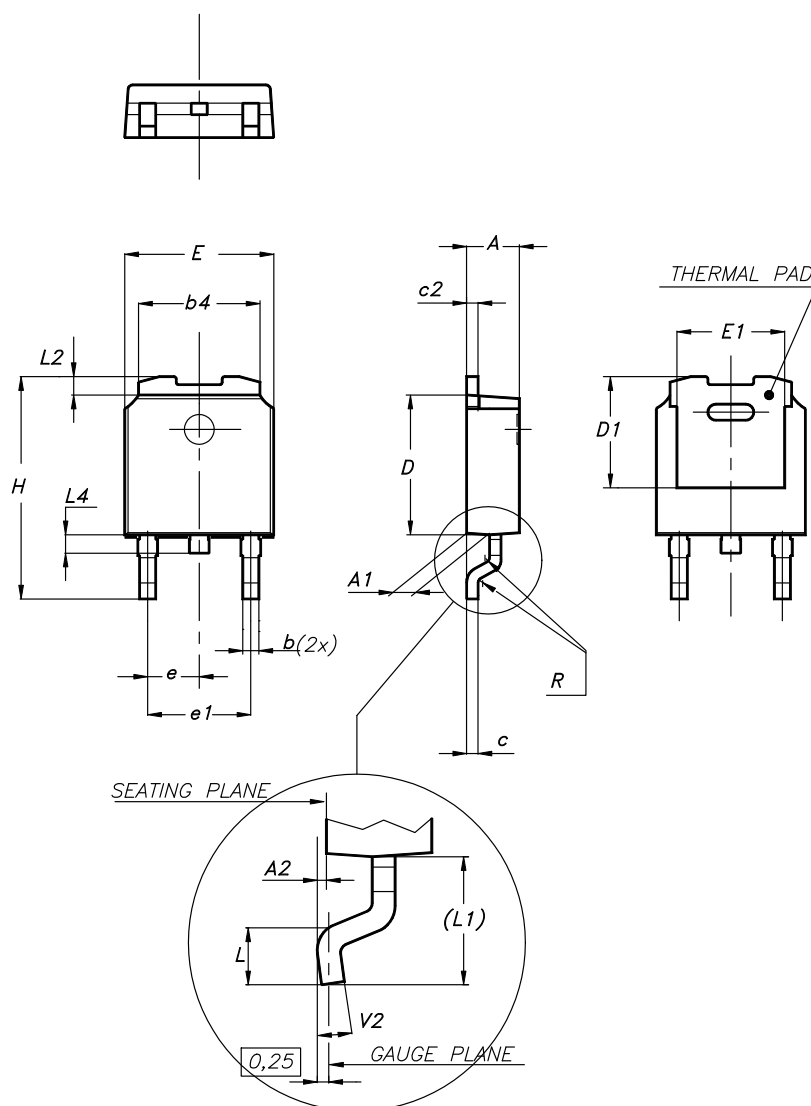
AM01473v1

## 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**

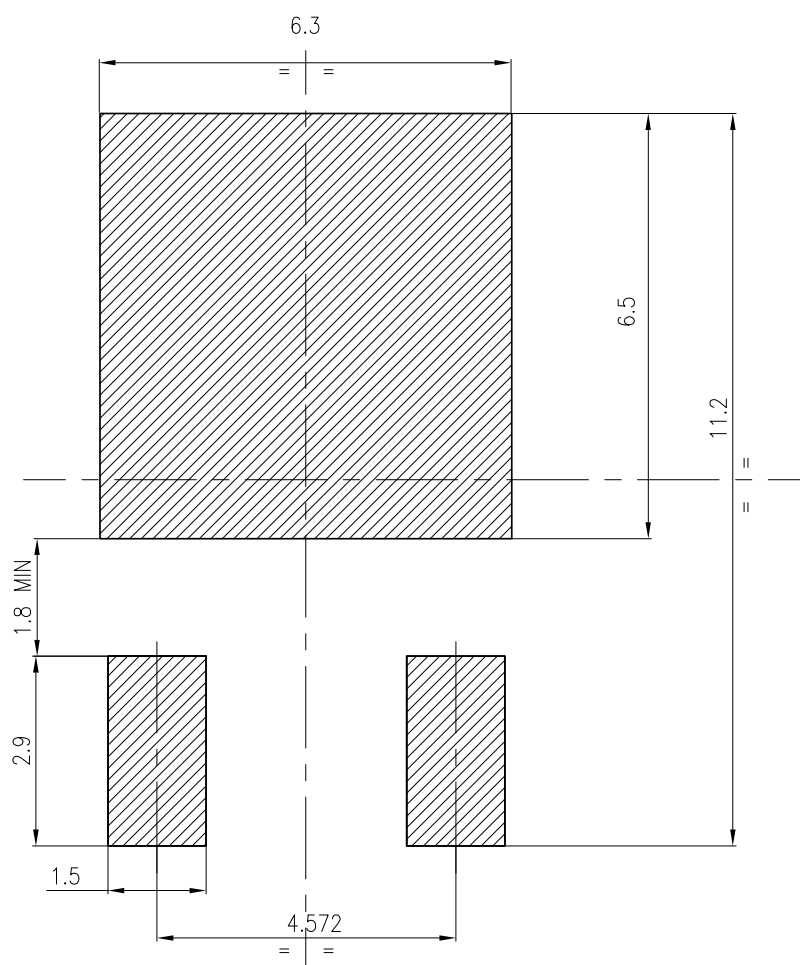


0068772\_type-A2\_rev30

**Table 7. 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°    |

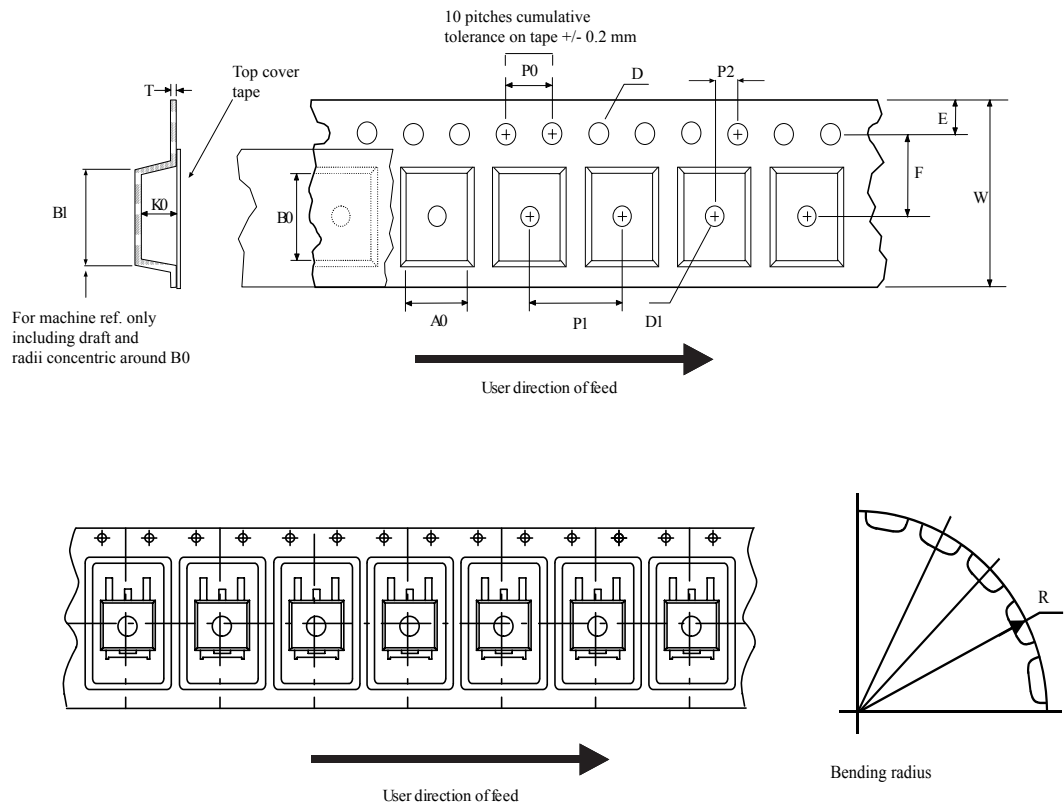
**Figure 20. DPAK (TO-252) recommended footprint (dimensions are in mm)**



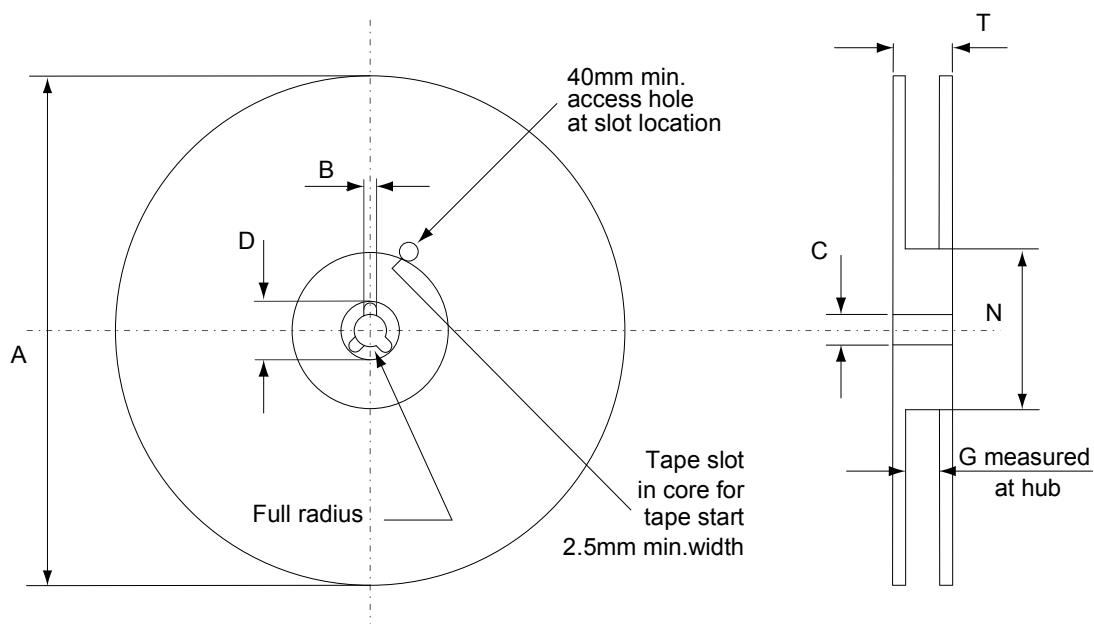
FP\_0068772\_30

## 4.2 DPAK (TO-252) packing information

**Figure 21. DPAK (TO-252) tape outline**



AM08852v1

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


AM06038v1

**Table 8. 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 9. Document revision history**

| Date        | Version | Changes        |
|-------------|---------|----------------|
| 09-Oct-2020 | 1       | First release. |

## Contents

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