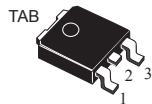
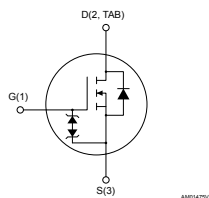


## N-channel 600 V, 286 mΩ typ., 12 A MDmesh DM6 Power MOSFET in a DPAK package


**DPAK**


### Features

| Order code  | $V_{DS}$ | $R_{DS(on)}$ max. | $I_D$ |
|-------------|----------|-------------------|-------|
| STD15N60DM6 | 600 V    | 338 mΩ            | 12 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

STD15N60DM6

#### Product summary

|                   |               |
|-------------------|---------------|
| <b>Order code</b> | STD15N60DM6   |
| <b>Marking</b>    | 15N60DM6      |
| <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 $T_C = 25\text{ }^\circ\text{C}$  | 12         | A                |
|                | Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$ | 7.3        |                  |
| $I_{DM}^{(1)}$ | Drain current (pulsed)                                          | 32         | A                |
| $P_{TOT}$      | Total power dissipation at $T_C = 25\text{ }^\circ\text{C}$     | 110        | W                |
| $I_{AR}^{(2)}$ | Avalanche current, repetitive or not repetitive                 | 3          | A                |
| $E_{AS}^{(3)}$ | Single pulse avalanche energy                                   | 240        | mJ               |
| $dv/dt^{(4)}$  | Peak diode recovery voltage slope                               | 100        | V/ns             |
| $di/dt^{(4)}$  | Peak diode recovery current slope                               | 1000       | A/ $\mu\text{s}$ |
| $dv/dt^{(5)}$  | MOSFET $dv/dt$ ruggedness                                       | 100        | V/ns             |
| $T_{stg}$      | Storage temperature range                                       | -55 to 150 | $^\circ\text{C}$ |
| $T_J$          | Operating junction temperature range                            |            |                  |

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.  $I_{SD} \leq 12\text{ A}$ ,  $V_{DS(peak)} < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$ .
5.  $V_{DS} \leq 480\text{ V}$ .

**Table 2. Thermal data**

| Symbol              | Parameter                        | Value | Unit               |
|---------------------|----------------------------------|-------|--------------------|
| $R_{thj-case}$      | Thermal resistance junction-case | 1.14  | $^\circ\text{C/W}$ |
| $R_{thj-pcb}^{(1)}$ | Thermal resistance junction-pcb  | 50    |                    |

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

## 2 Electrical characteristics

( $T_C = 25\text{ °C}$  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       | $\mu\text{A}$ |
|               |                                   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$ , $T_C = 125\text{ °C}$ <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 | $V_{GS} = 10\text{ V}$ , $I_D = 6\text{ A}$                                            |      | 286  | 338     | 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             | $V_{GS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{DS} = 0\text{ V}$                                                                         | -    | 607  | -    | $\mu\text{F}$ |
| $C_{oss}$                  | Output capacitance            |                                                                                                                                              | -    | 40   | -    |               |
| $C_{rss}$                  | Reverse transfer capacitance  |                                                                                                                                              | -    | 4    | -    |               |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{DS} = 0\text{ to }480\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                  | -    | 100  | -    | $\mu\text{F}$ |
| $R_G$                      | Intrinsic gate resistance     | $f = 1\text{ MHz}$ open drain                                                                                                                | -    | 5.7  | -    | $\Omega$      |
| $Q_g$                      | Total gate charge             | $V_{DD} = 480\text{ V}$ , $I_D = 12\text{ A}$ , $V_{GS} = 0\text{ to }10\text{ V}$<br>(see Figure 14. Test circuit for gate charge behavior) | -    | 15.3 | -    | nC            |
| $Q_{gs}$                   | Gate-source charge            |                                                                                                                                              | -    | 4.1  | -    |               |
| $Q_{gd}$                   | 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 5. Switching times**

| Symbol       | Parameter           | Test conditions                                                                                                                                                                                                 | Min. | Typ. | Max. | Unit |
|--------------|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 300\text{ V}$ , $I_D = 6\text{ A}$ ,<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) | -    | 8.8  | -    | ns   |
| $t_r$        | Rise time           |                                                                                                                                                                                                                 | -    | 7.4  | -    |      |
| $t_{d(off)}$ | Turn-off delay time |                                                                                                                                                                                                                 | -    | 29.2 | -    |      |
| $t_f$        | Fall time           |                                                                                                                                                                                                                 | -    | 7.2  | -    |      |

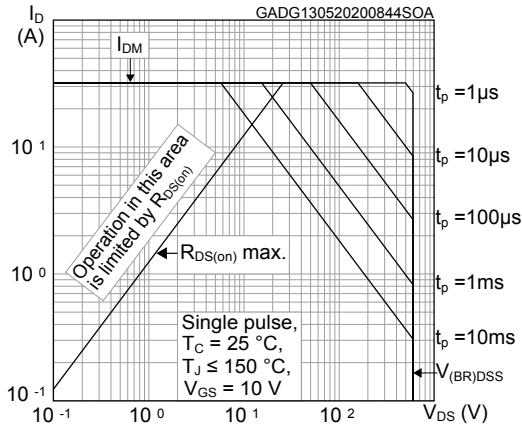
**Table 6. Source-drain diode**

| Symbol          | Parameter                     | Test conditions                                                                     | Min. | Typ.  | Max. | Unit          |
|-----------------|-------------------------------|-------------------------------------------------------------------------------------|------|-------|------|---------------|
| $I_{SD}$        | Source-drain current          |                                                                                     | -    |       | 12   | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                     | -    |       | 32   | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $V_{GS} = 0\text{ V}$ , $I_{SD} = 12\text{ A}$                                      | -    |       | 1.6  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 12\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,                       | -    | 85    |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       | $V_{DD} = 60\text{ V}$                                                              | -    | 0.268 |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      | (see Figure 15. Test circuit for inductive load switching and diode recovery times) | -    | 6.3   |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 12\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,                       | -    | 147   |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       | $V_{DD} = 60\text{ V}$ , $T_J = 150\text{ }^\circ\text{C}$                          | -    | 0.661 |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      | (see Figure 15. Test circuit for inductive load switching and diode recovery times) | -    | 9     |      | A             |

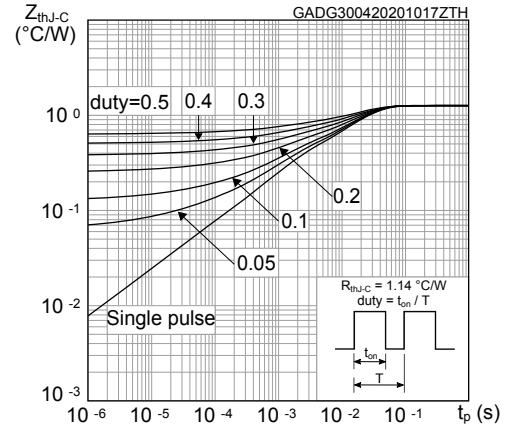
1. Pulse width is limited by safe operating area.
2. Pulse test: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

## 2.1 Electrical characteristics (curves)

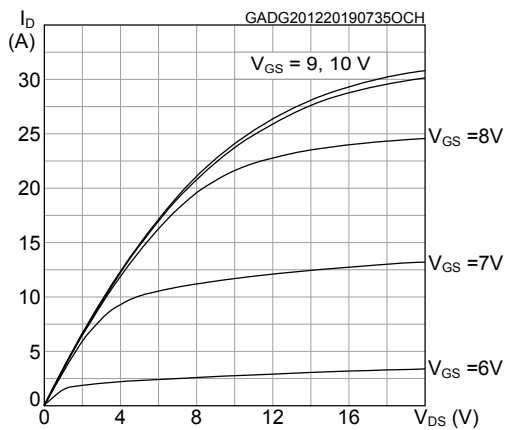
**Figure 1. Safe operating area**



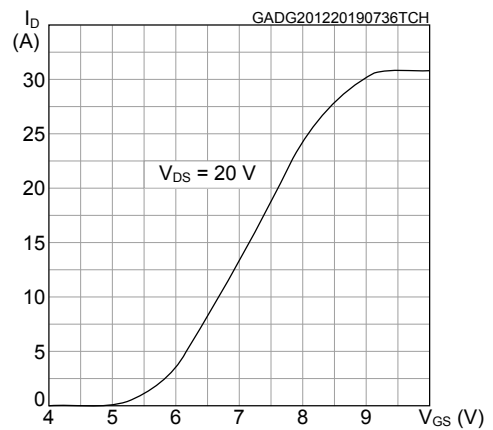
**Figure 2. Maximum transient thermal impedance**



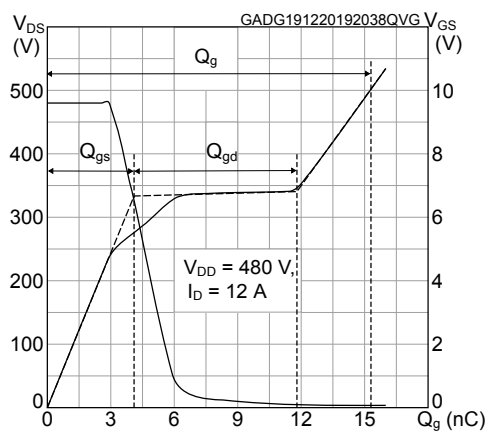
**Figure 3. Typical output characteristics**



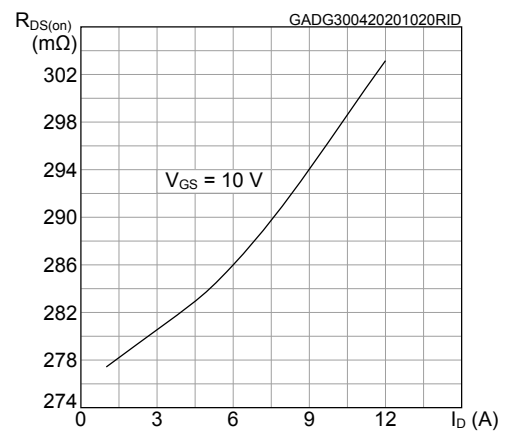
**Figure 4. Typical transfer characteristics**



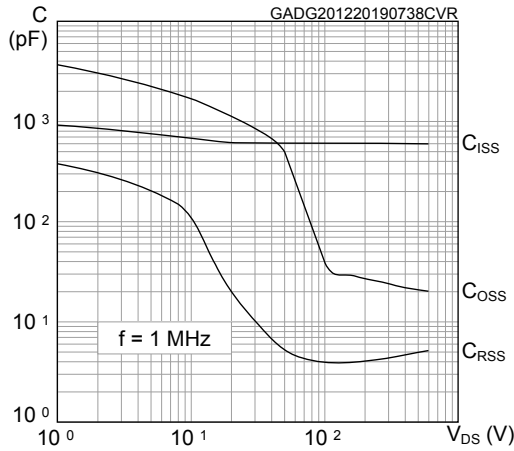
**Figure 5. Typical gate charge characteristics**



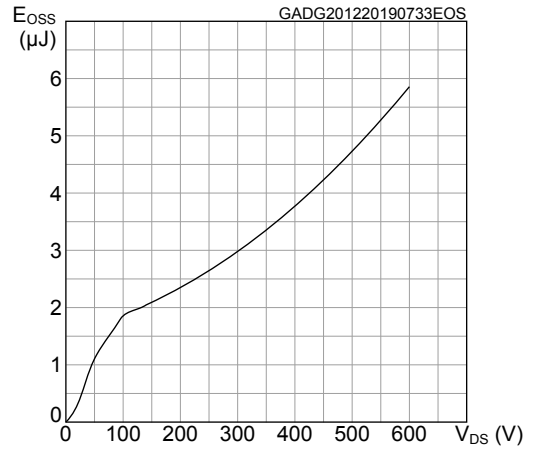
**Figure 6. Typical drain-source on-resistance**



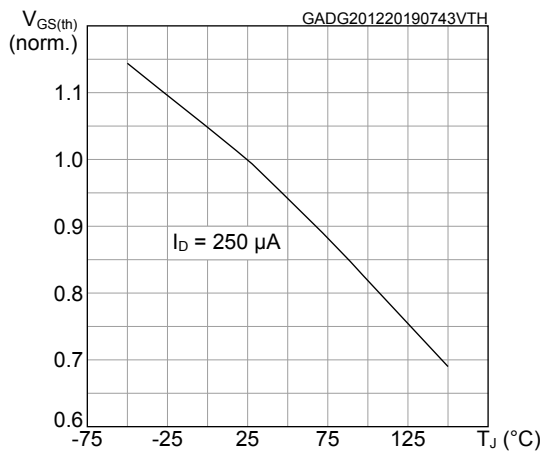
**Figure 7. Typical capacitance characteristics**



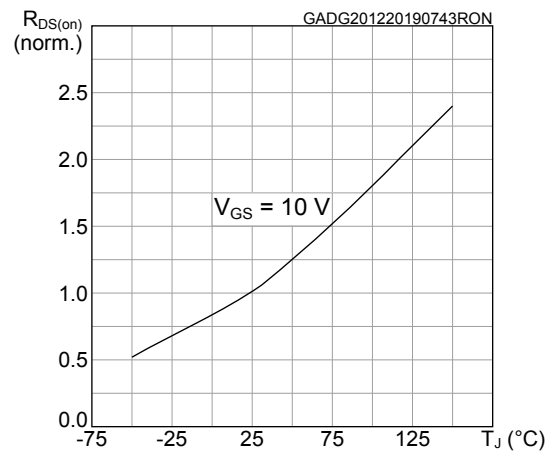
**Figure 8. Typical output capacitance stored energy**



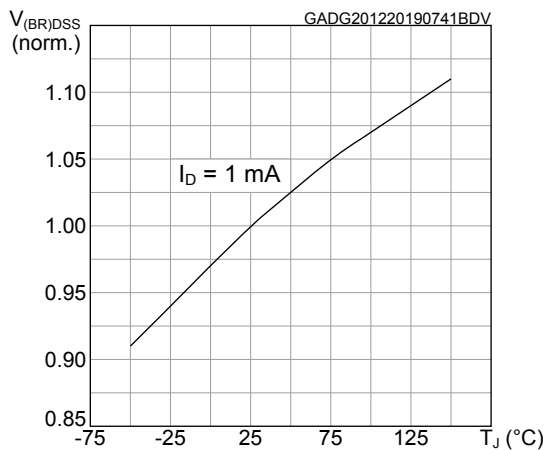
**Figure 9. Normalized gate threshold vs temperature**



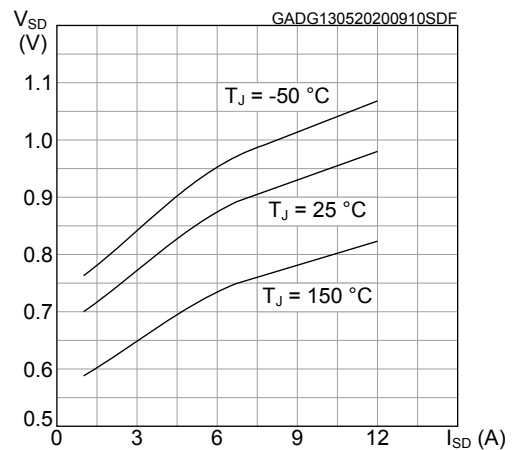
**Figure 10. Normalized on-resistance vs temperature**



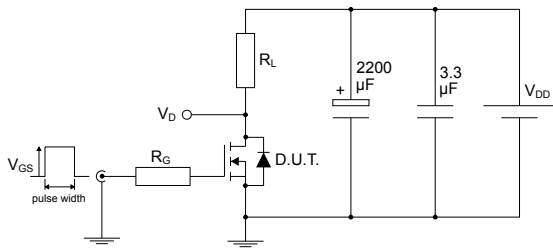
**Figure 11. Normalized breakdown voltage vs temperature**



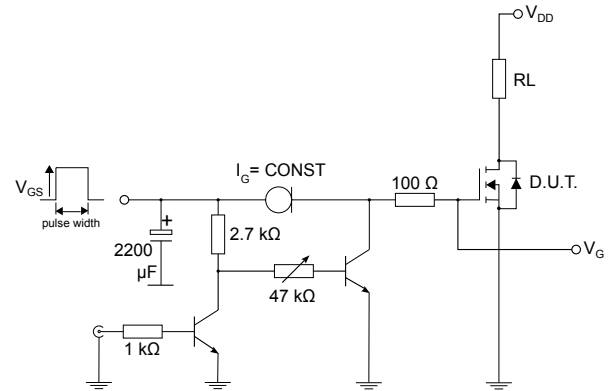
**Figure 12. Typical reverse diode forward characteristics**



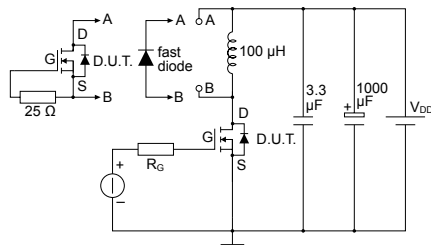
### 3 Test circuits

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


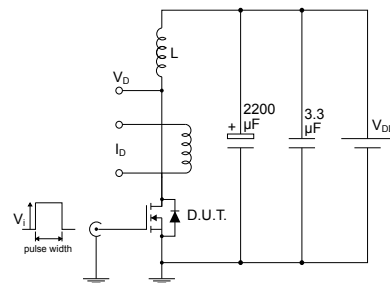
AM01468v1

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


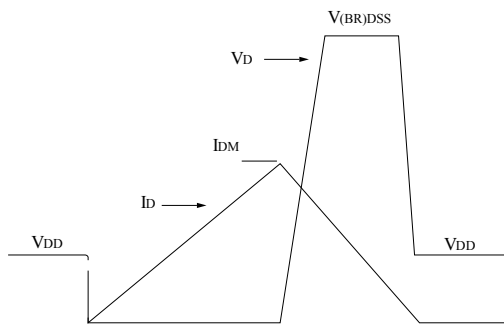
AM01469v10

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


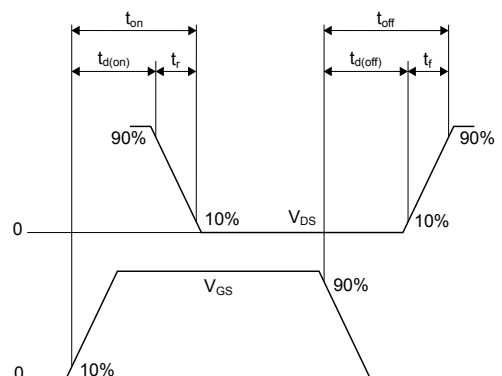
AM01470v1

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


AM01471v1

**Figure 17. Unclamped inductive waveform**


AM01472v1

**Figure 18. Switching time waveform**


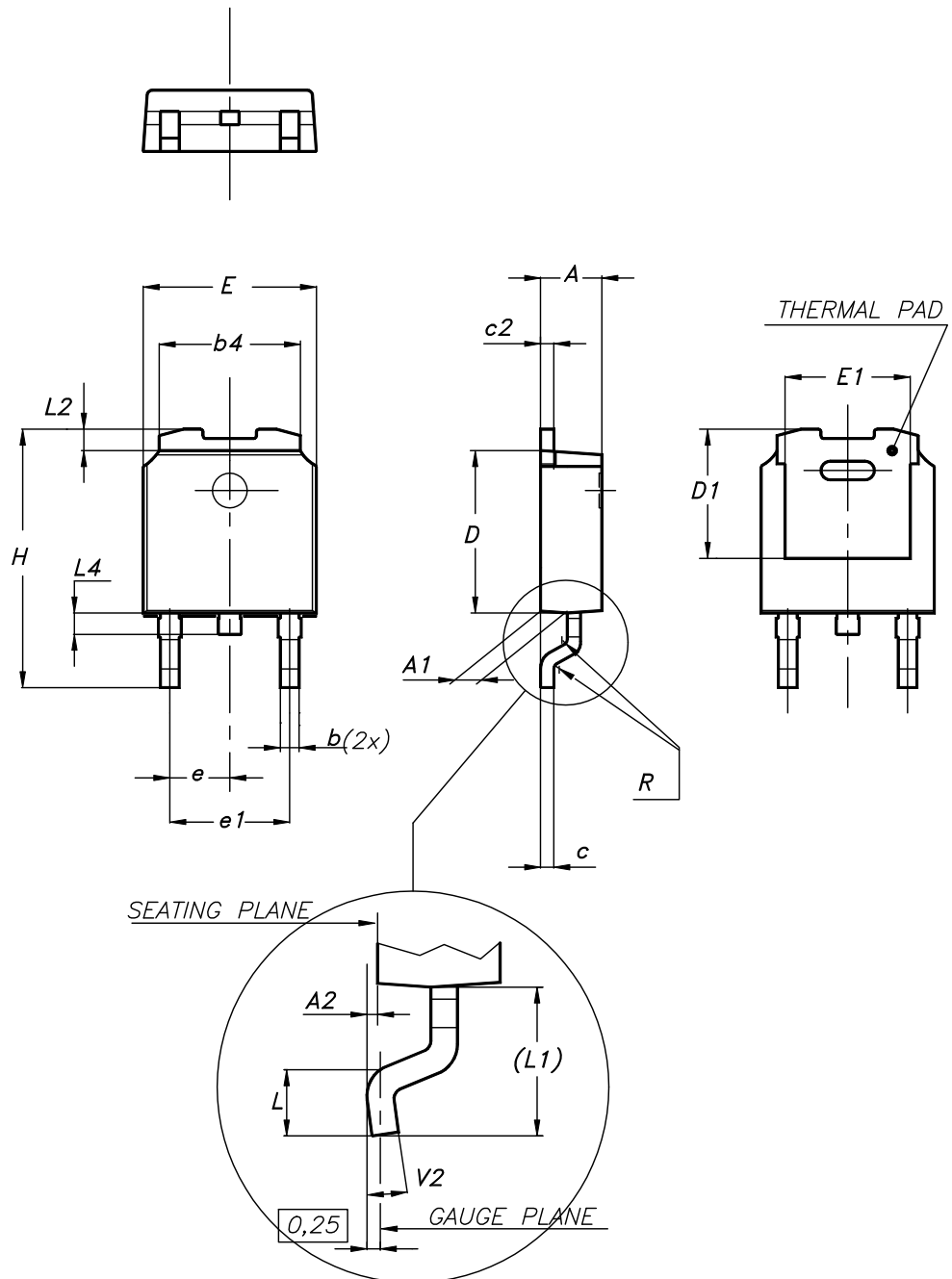
AM01473v1

## 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\_rev27

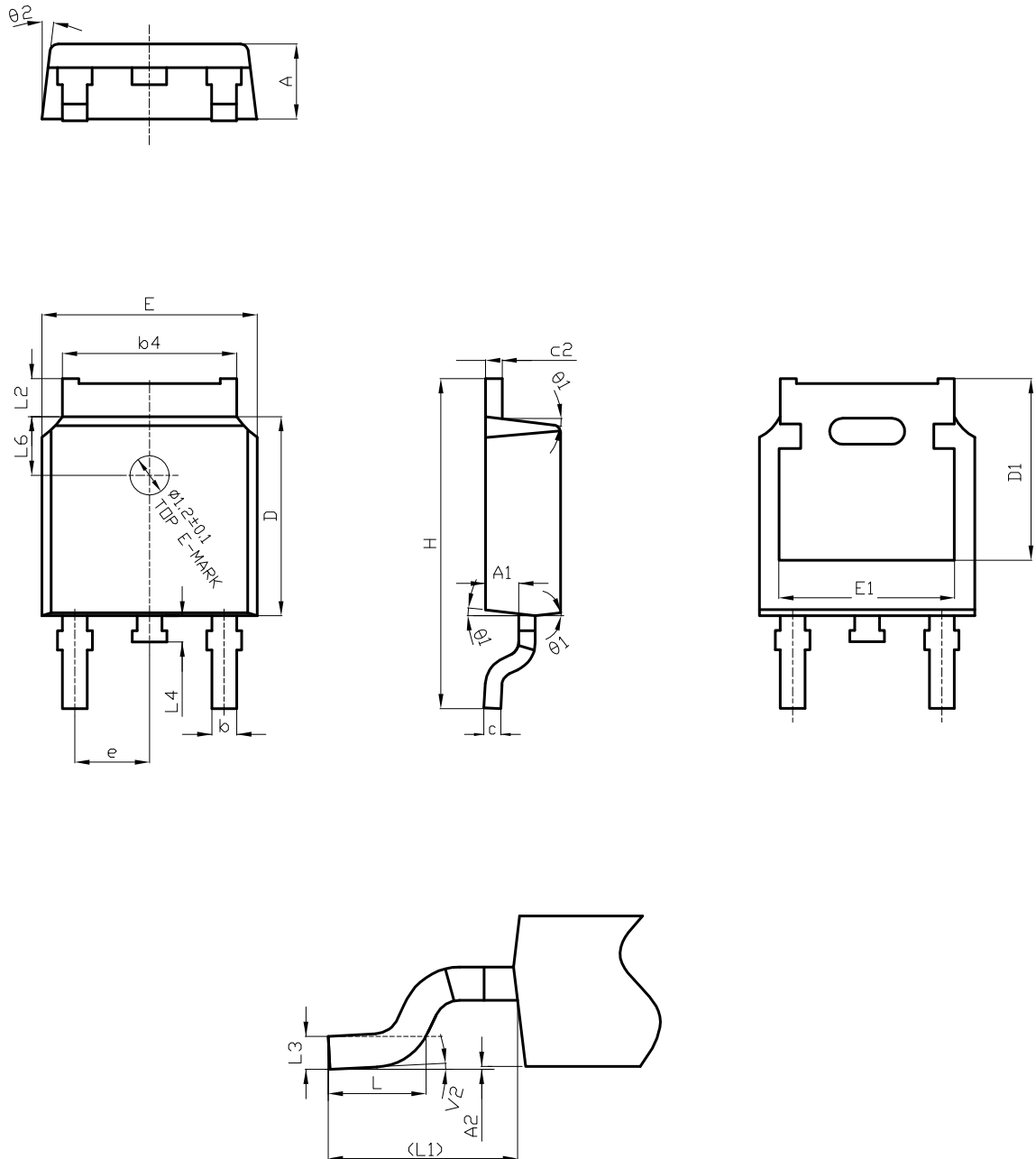


**Table 7. DPAK (TO-252) type A2 mechanical data**

| 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°    |

## 4.2 DPAK (TO-252) type C2 package information

Figure 20. DPAK (TO-252) type C2 package outline

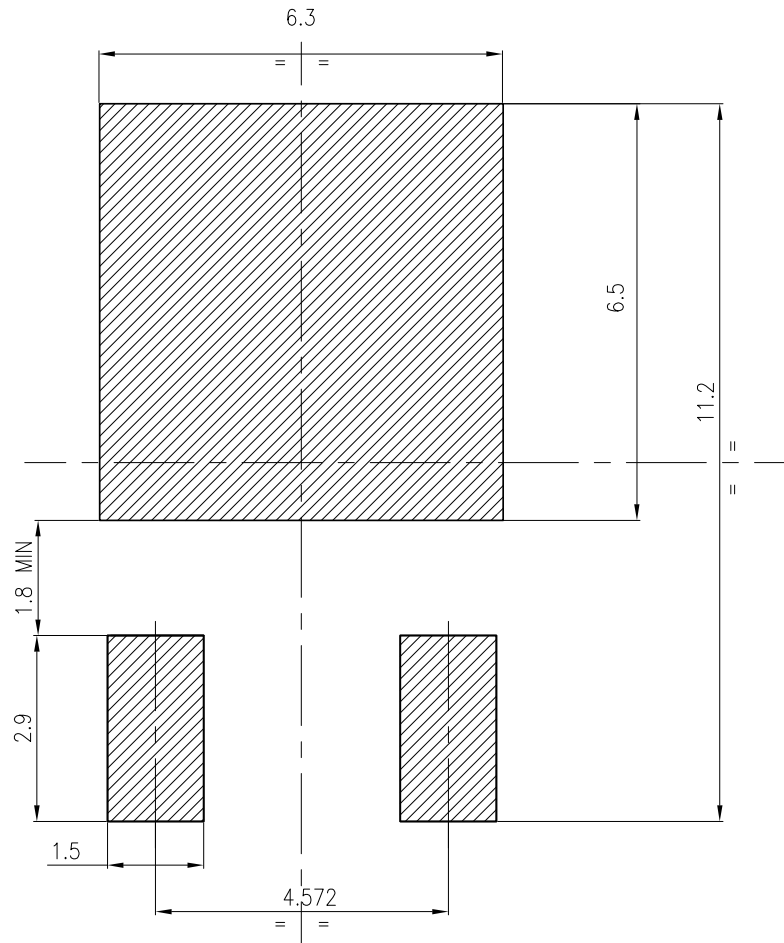


0068772\_type-C2\_rev27

**Table 8. DPAK (TO-252) type C2 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   | 5.10     |       | 5.60  |
| E    | 6.50     | 6.60  | 6.70  |
| E1   | 5.20     |       | 5.50  |
| 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°    |

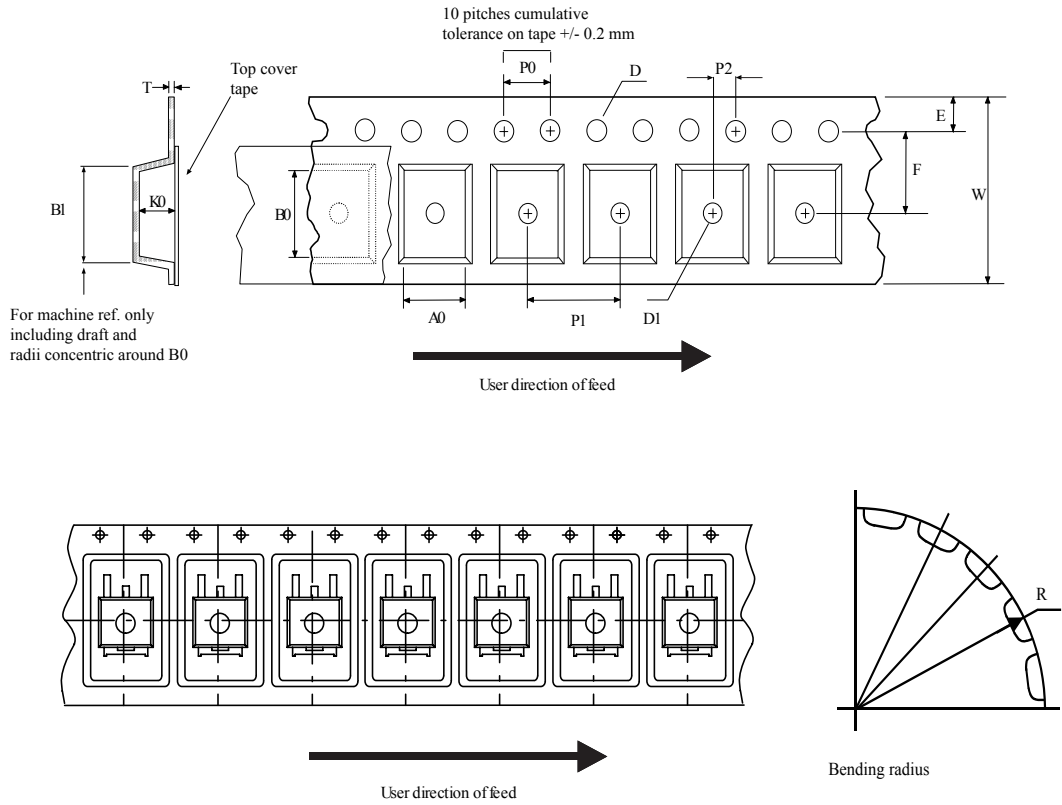
Figure 21. DPAK (TO-252) recommended footprint (dimensions are in mm)



FP\_0068772\_27

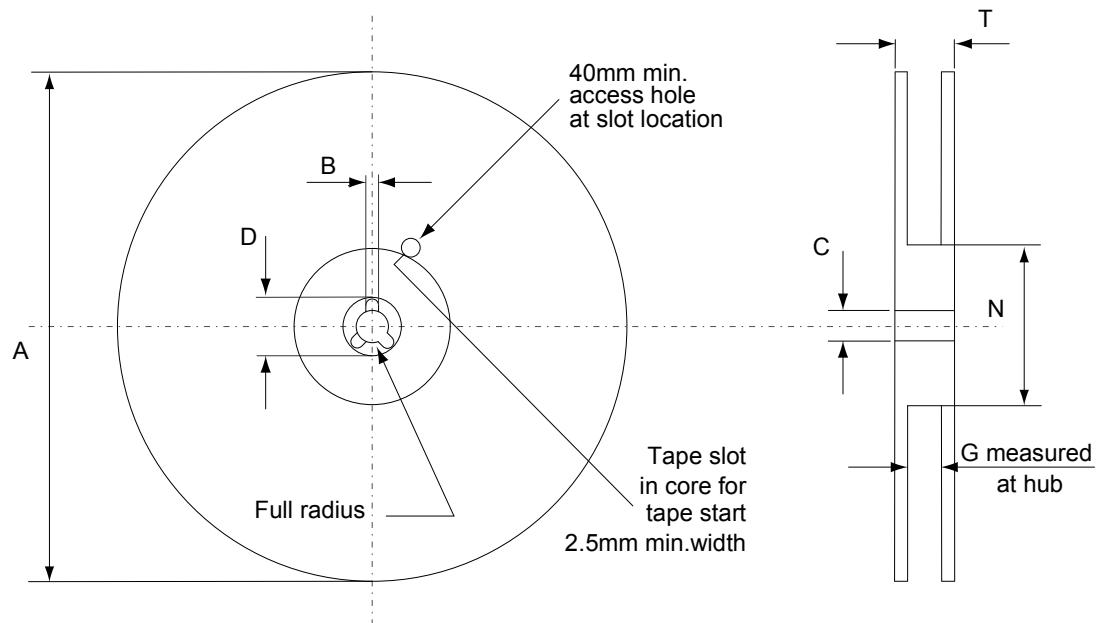
### 4.3 DPAK (TO-252) packing information

Figure 22. DPAK (TO-252) tape outline



AM08852v1

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



AM06038v1

**Table 9. 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 10. Document revision history**

| Date        | Revision | Changes        |
|-------------|----------|----------------|
| 19-May-2020 | 1        | First release. |

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