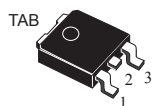
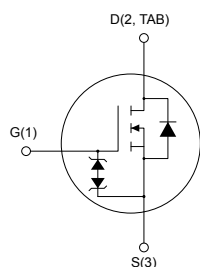


## N-channel 600 V, 320 mΩ typ., 10 A, MDmesh M6 Power MOSFET in a DPAK package



DPAK



AM01475V1



### Product status link

[STD13N60M6](#)

### Product summary

|            |               |
|------------|---------------|
| Order code | STD13N60M6    |
| Marking    | 13N60M6       |
| Package    | DPAK          |
| Packing    | Tape and reel |

### Features

| Order code | V <sub>DS</sub> | R <sub>DS(on)</sub> max. | I <sub>D</sub> | P <sub>TOT</sub> |
|------------|-----------------|--------------------------|----------------|------------------|
| STD13N60M6 | 600 V           | 380 mΩ                   | 10 A           | 92 W             |

- Reduced switching losses
- Lower R<sub>DS(on)</sub> per area vs previous generation
- Low gate input resistance
- 100% avalanche tested
- Zener-protected

### Applications

- Switching applications
- LLC converters
- Boost PFC converters

### Description

The new MDmesh M6 technology incorporates the most recent advancements to the well-known and consolidated MDmesh family of SJ MOSFETs. STMicroelectronics builds on the previous generation of MDmesh devices through its new M6 technology, which combines excellent R<sub>DS(on)</sub> per area improvement with one of the most effective switching behaviors available, as well as a user-friendly experience for maximum end-application efficiency.

# 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 $T_{case} = 25\text{ }^{\circ}\text{C}$  | 10         | A                  |
|                | Drain current (continuous) at $T_{case} = 100\text{ }^{\circ}\text{C}$ | 6.4        |                    |
| $I_{DM}^{(1)}$ | Drain current (pulsed)                                                 | 28         | A                  |
| $P_{TOT}$      | Total power dissipation at $T_{case} = 25\text{ }^{\circ}\text{C}$     | 92         | W                  |
| $I_{AR}^{(2)}$ | Avalanche current, repetitive or not repetitive                        | 2          | A                  |
| $E_{AS}^{(3)}$ | Single pulse avalanche energy                                          | 140        | mJ                 |
| $dv/dt^{(4)}$  | Peak diode recovery voltage slope                                      | 15         | V/ns               |
| $dv/dt^{(5)}$  | MOSFET $dv/dt$ ruggedness                                              | 100        |                    |
| $T_{stg}$      | 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  $T_{jmax}$ .
3. Starting  $T_j = 25\text{ }^{\circ}\text{C}$ ,  $I_D = I_{AR}$ ,  $V_{DD} = 50\text{ V}$ .
4.  $I_{SD} \leq 10\text{ A}$ ,  $di/dt = 400\text{ A}/\mu\text{s}$ ,  $V_{DS(peak)} < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$
5.  $V_{DS} \leq 480\text{ V}$

**Table 2. Thermal data**

| Symbol              | Parameter                        | Value | Unit                        |
|---------------------|----------------------------------|-------|-----------------------------|
| $R_{thj-case}$      | Thermal resistance junction-case | 1.36  | $^{\circ}\text{C}/\text{W}$ |
| $R_{thj-pcb}^{(1)}$ | Thermal resistance junction-pcb  | 50    |                             |

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

## 2 Electrical characteristics

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

**Table 3. Static**

| Symbol                      | Parameter                         | Test conditions                                                                                                                   | Min. | Typ. | Max.    | Unit          |
|-----------------------------|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|------|------|---------|---------------|
| $V_{(\text{BR})\text{DSS}}$ | Drain-source breakdown voltage    | $V_{\text{GS}} = 0\text{ V}$ , $I_{\text{D}} = 1\text{ mA}$                                                                       | 600  |      |         | V             |
| $I_{\text{DSS}}$            | Zero gate voltage drain current   | $V_{\text{GS}} = 0\text{ V}$ , $V_{\text{DS}} = 600\text{ V}$                                                                     |      |      | 1       | $\mu\text{A}$ |
|                             |                                   | $V_{\text{GS}} = 0\text{ V}$ , $V_{\text{DS}} = 600\text{ V}$ ,<br>$T_{\text{case}} = 125\text{ }^{\circ}\text{C}$ <sup>(1)</sup> |      |      | 100     |               |
| $I_{\text{GSS}}$            | Gate-body leakage current         | $V_{\text{DS}} = 0\text{ V}$ , $V_{\text{GS}} = \pm 25\text{ V}$                                                                  |      |      | $\pm 5$ | $\mu\text{A}$ |
| $V_{\text{GS(th)}}$         | Gate threshold voltage            | $V_{\text{DS}} = V_{\text{GS}}$ , $I_{\text{D}} = 250\text{ }\mu\text{A}$                                                         | 3.25 | 4    | 4.75    | V             |
| $R_{\text{DS(on)}}$         | Static drain-source on-resistance | $V_{\text{GS}} = 10\text{ V}$ , $I_{\text{D}} = 5\text{ A}$                                                                       |      | 320  | 380     | m $\Omega$    |

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

**Table 4. Dynamic**

| Symbol                     | Parameter                     | Test conditions                                                                                                                                                        | Min. | Typ. | Max. | Unit     |
|----------------------------|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|----------|
| $C_{\text{iss}}$           | Input capacitance             | $V_{\text{DS}} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{\text{GS}} = 0\text{ V}$                                                                                     | -    | 509  | -    | pF       |
| $C_{\text{oss}}$           | Output capacitance            |                                                                                                                                                                        | -    | 34.4 | -    |          |
| $C_{\text{rss}}$           | Reverse transfer capacitance  |                                                                                                                                                                        | -    | 4.2  | -    |          |
| $C_{\text{oss eq.}}^{(1)}$ | Equivalent output capacitance | $V_{\text{DS}} = 0\text{ to }480\text{ V}$ , $V_{\text{GS}} = 0\text{ V}$                                                                                              | -    | 94   | -    | pF       |
| $R_{\text{G}}$             | Intrinsic gate resistance     | $f = 1\text{ MHz}$ , $I_{\text{D}} = 0\text{ A}$                                                                                                                       | -    | 5.6  | -    | $\Omega$ |
| $Q_{\text{g}}$             | Total gate charge             | $V_{\text{DD}} = 480\text{ V}$ , $I_{\text{D}} = 10\text{ A}$ ,<br>$V_{\text{GS}} = 0\text{ to }10\text{ V}$<br>(see Figure 14. Test circuit for gate charge behavior) | -    | 13   | -    | nC       |
| $Q_{\text{gs}}$            | Gate-source charge            |                                                                                                                                                                        | -    | 3.4  | -    |          |
| $Q_{\text{gd}}$            | Gate-drain charge             |                                                                                                                                                                        | -    | 6.4  | -    |          |

1.  $C_{\text{oss eq.}}$  is defined as a constant equivalent capacitance giving the same charging time as  $C_{\text{oss}}$  when  $V_{\text{DS}}$  increases from 0 to 80%  $V_{\text{DSS}}$ .

**Table 5. Switching times**

| Symbol              | Parameter           | Test conditions                                                                                                                                                                                                                                 | Min. | Typ. | Max. | Unit |
|---------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $t_{\text{d(on)}}$  | Turn-on delay time  | $V_{\text{DD}} = 300\text{ V}$ , $I_{\text{D}} = 5\text{ A}$ ,<br>$R_{\text{G}} = 4.7\text{ }\Omega$ , $V_{\text{GS}} = 10\text{ V}$<br>(see Figure 13. Test circuit for resistive load switching times and Figure 18. Switching time waveform) | -    | 15.8 | -    | ns   |
| $t_{\text{r}}$      | Rise time           |                                                                                                                                                                                                                                                 | -    | 6.5  | -    |      |
| $t_{\text{d(off)}}$ | Turn-off delay time |                                                                                                                                                                                                                                                 | -    | 25.5 | -    |      |
| $t_{\text{f}}$      | Fall time           |                                                                                                                                                                                                                                                 | -    | 9.4  | -    |      |

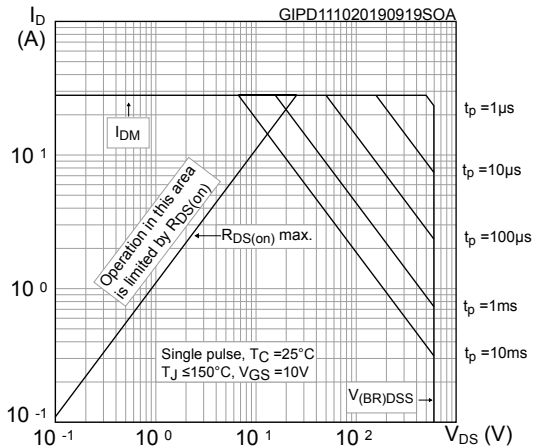
**Table 6. Source-drain diode**

| 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)                                     | -    | 182  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                    | -    | 1.35 |      | $\mu\text{C}$ |
| $I_{RRM}$       | 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) | -    | 14.8 |      | A             |
| $t_{rr}$        | Reverse recovery time         |                                                                                                                                                                                                                    | -    | 253  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                    | -    | 2    |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                    | -    | 16   |      | A             |

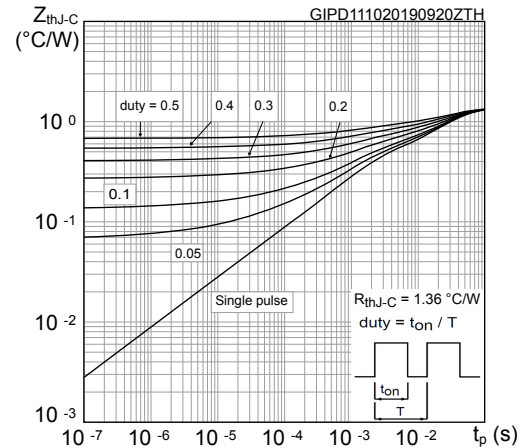
1. Pulse width is limited by safe operating area.
2. Pulse test: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

## 2.1 Electrical characteristics (curves)

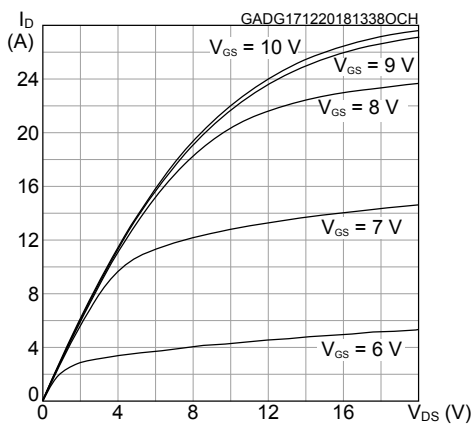
**Figure 1. Safe operating area**



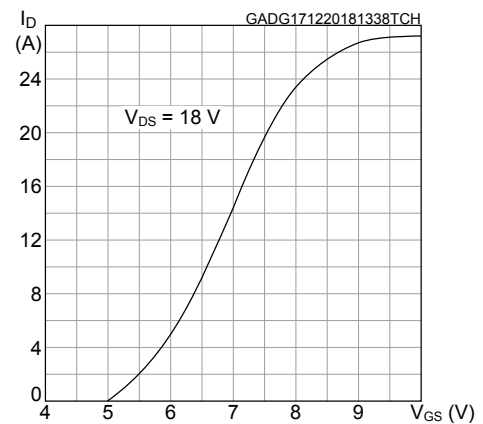
**Figure 2. Maximum transient thermal impedance**



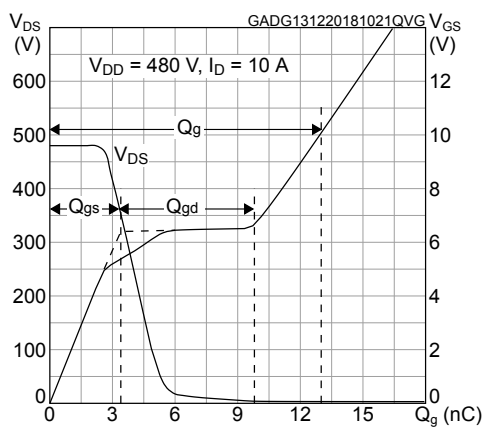
**Figure 3. Typical output characteristics**



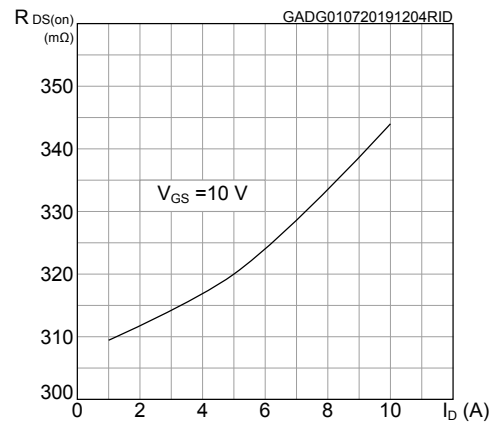
**Figure 4. Typical transfer characteristics**



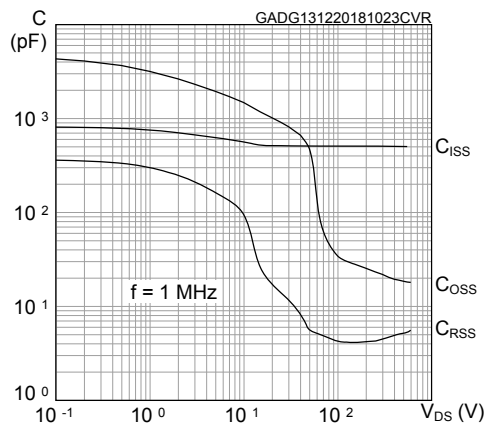
**Figure 5. Typical gate charge characteristics**



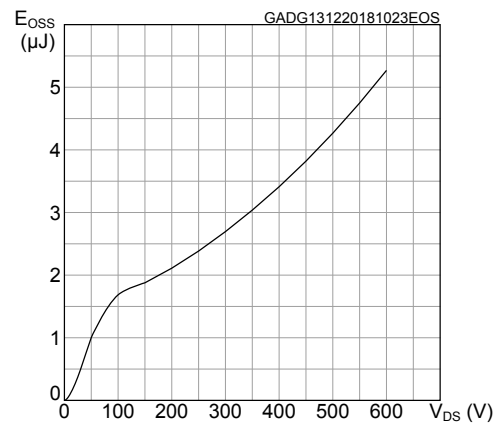
**Figure 6. Typical drain-source on-resistance**



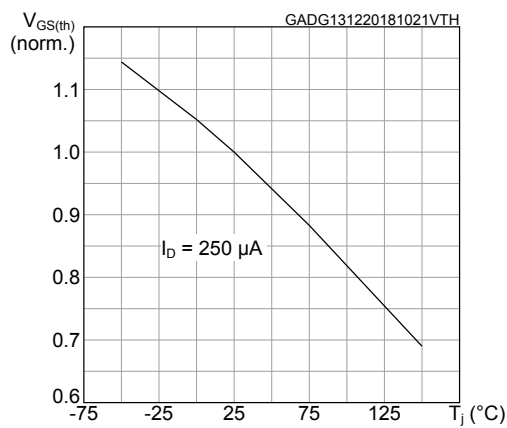
**Figure 7. Typical capacitance characteristics**



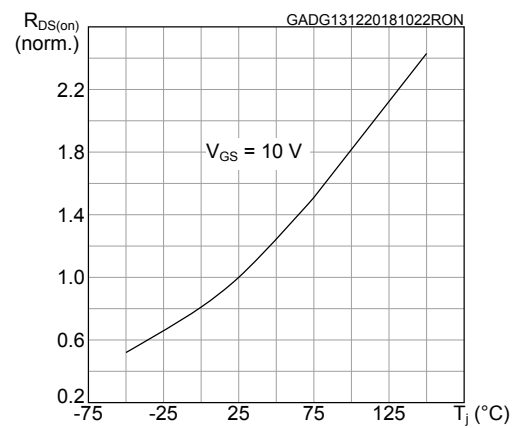
**Figure 8. Typical output capacitance stored energy**



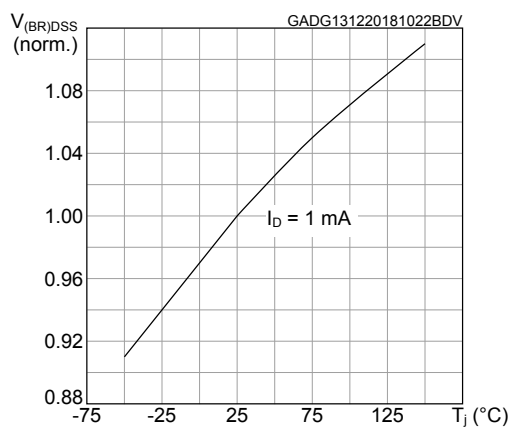
**Figure 9. Normalized gate threshold vs temperature**



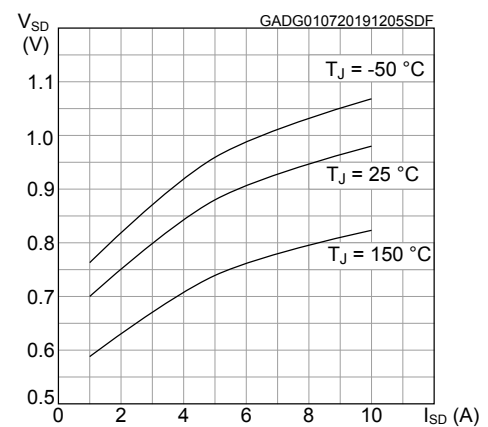
**Figure 10. Normalized on-resistance vs temperature**



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

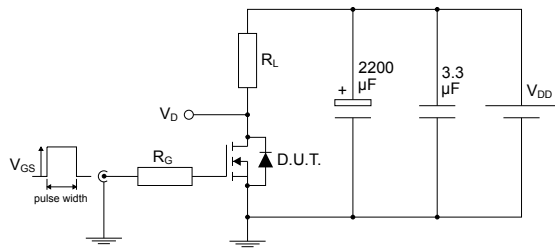


**Figure 12. Typical reverse diode forward characteristics**



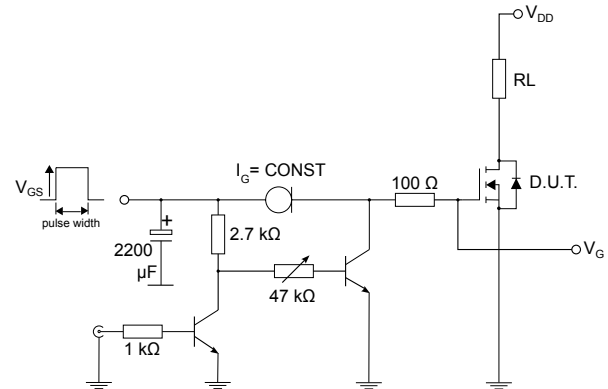
### 3 Test circuits

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



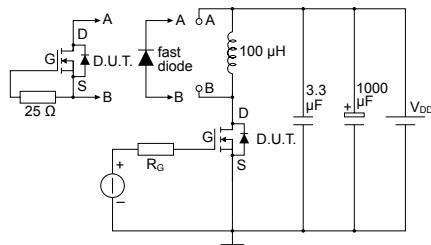
AM01468v1

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



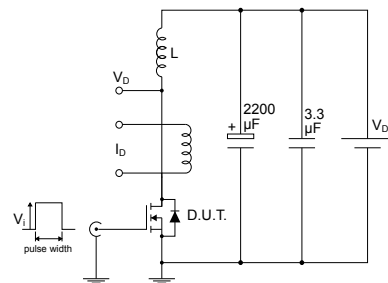
AM01469v10

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



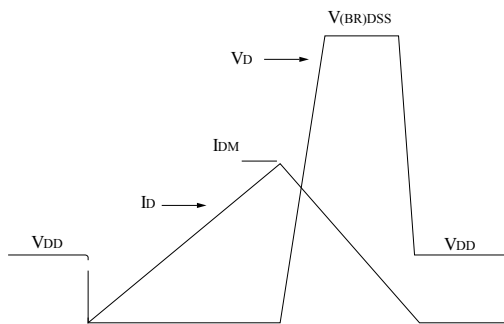
AM01470v1

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



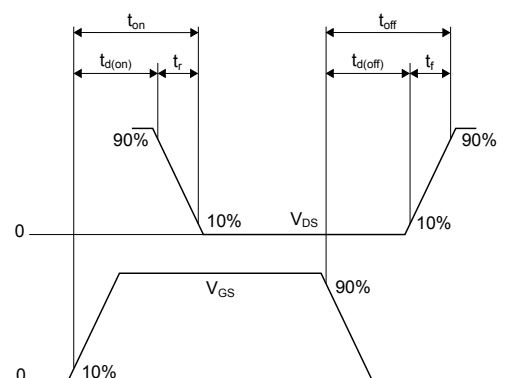
AM01471v1

**Figure 17. Unclamped inductive waveform**



AM01472v1

**Figure 18. Switching time waveform**



AM01473v1

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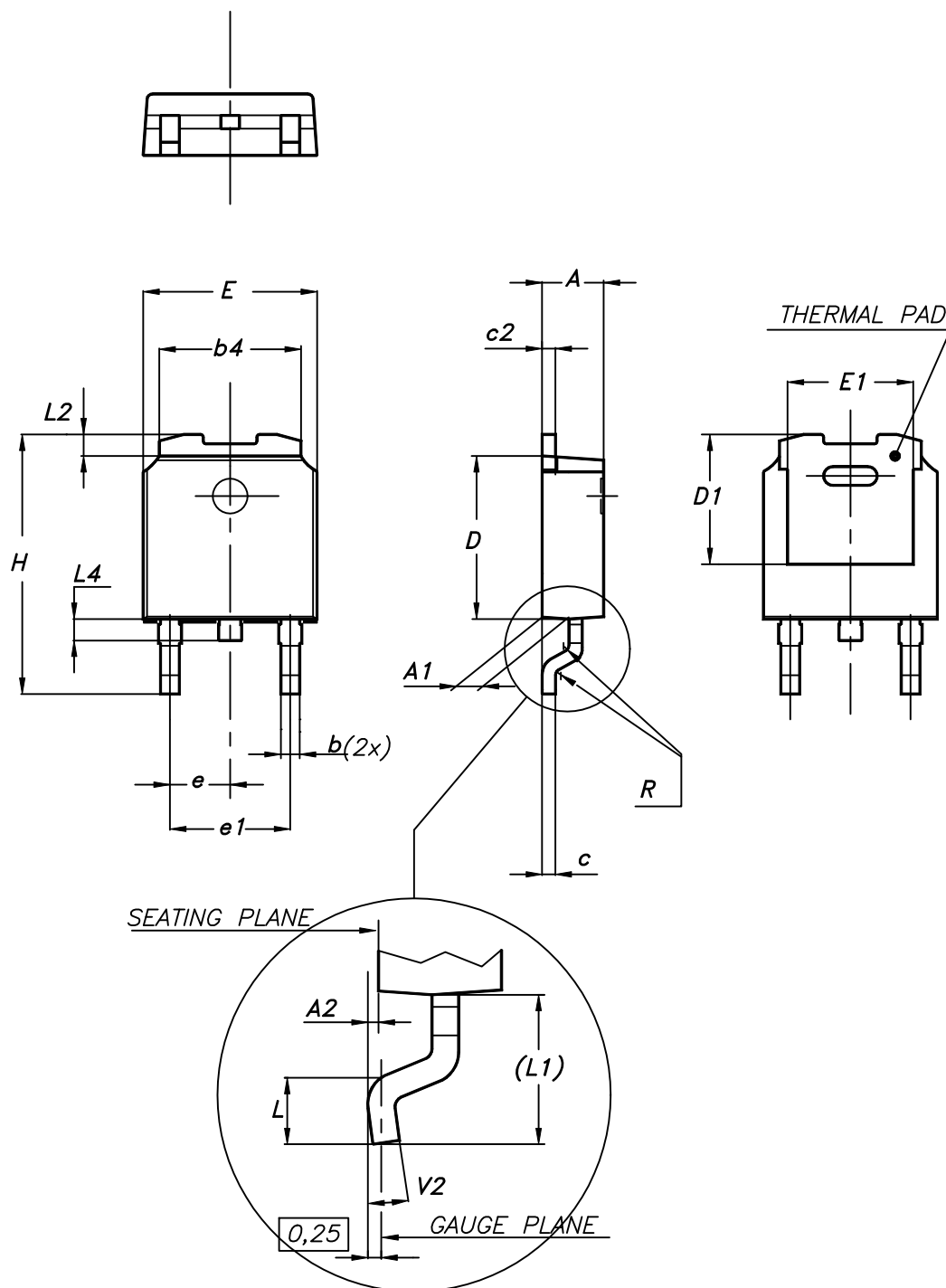
## 4 Package information

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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 DPAK (TO-252) type A2 package information

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

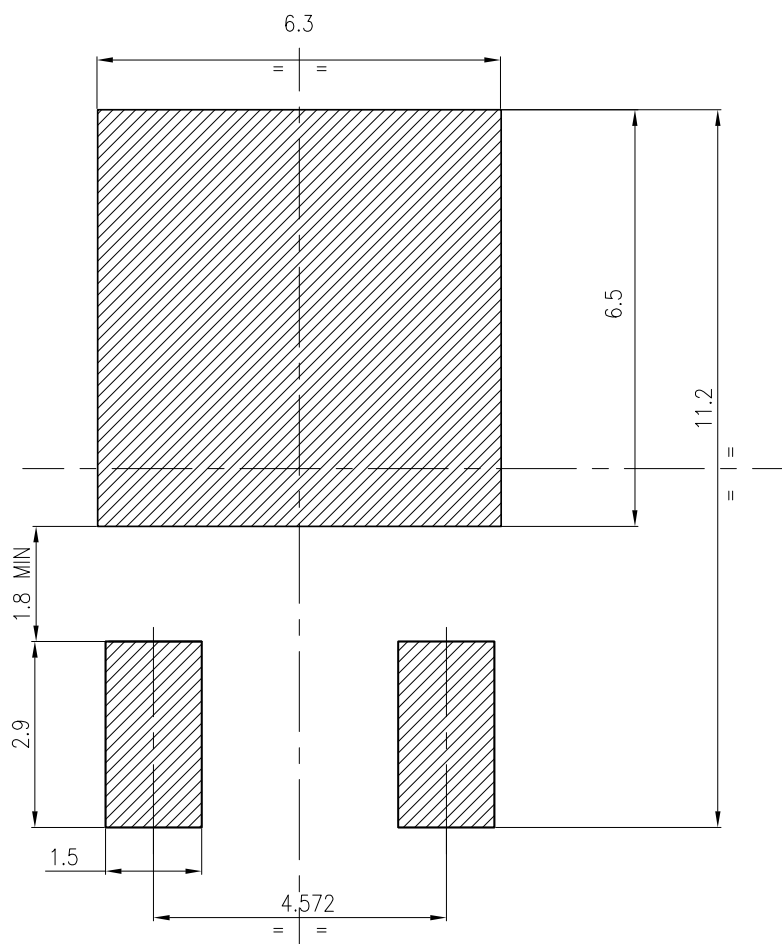


0068772\_type-A2\_rev26

**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°    |

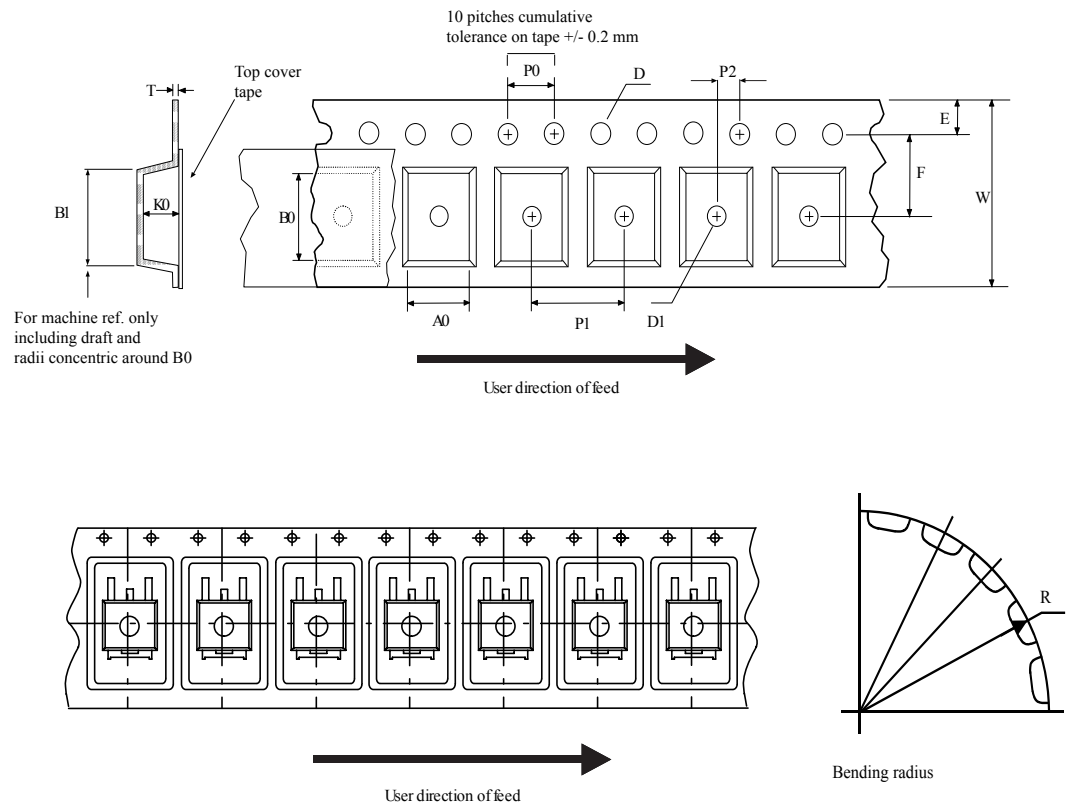
**Figure 20. DPAK (TO-252) recommended footprint (dimensions are in mm)**

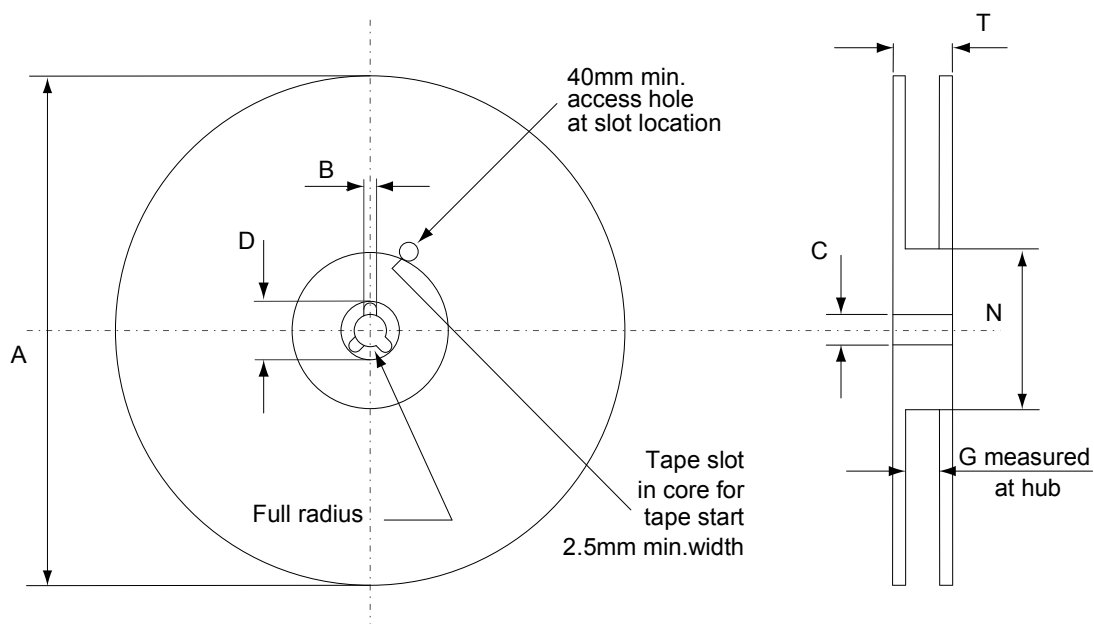


FP\_0068772\_26

## 4.2 DPAK (TO-252) packing information

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



**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        |
|-------------|---------|----------------|
| 17-Oct-2019 | 1       | First release. |

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