

## N-channel 650 V, 0.42 $\Omega$ typ., 8 A MDmesh M2 Power MOSFET in a DPAK package

Datasheet - production data

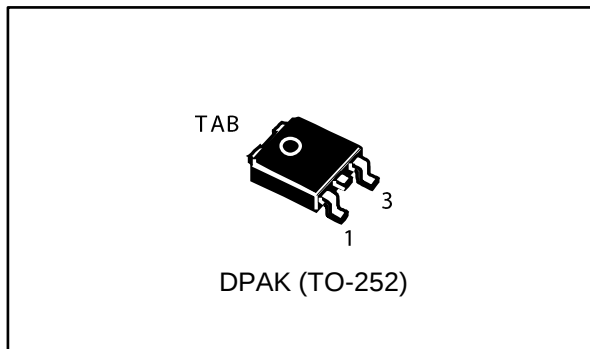
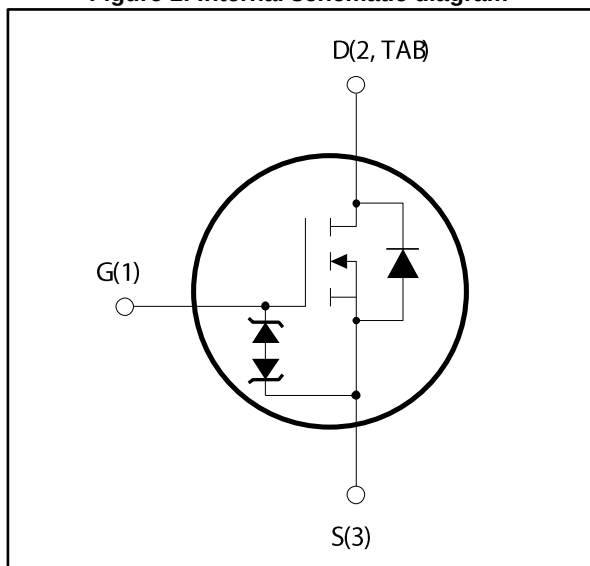


Figure 1: Internal schematic diagram



### Features

| Order code | V <sub>DS</sub> | R <sub>DS(on)</sub> max. | I <sub>D</sub> |
|------------|-----------------|--------------------------|----------------|
| STD12N65M2 | 650 V           | 0.5 $\Omega$             | 8 A            |

- Extremely low gate charge
- Excellent output capacitance (C<sub>oss</sub>) 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.

Table 1: Device summary

| Order code | Marking | Package | Packing       |
|------------|---------|---------|---------------|
| STD12N65M2 | 12N65M2 | DPAK    | Tape and reel |

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## Contents

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# 1 Electrical ratings

Table 2: Absolute maximum ratings

| Symbol         | Parameter                                                         | Value       | Unit               |
|----------------|-------------------------------------------------------------------|-------------|--------------------|
| $V_{GS}$       | Gate-source voltage                                               | $\pm 25$    | V                  |
| $I_D$          | Drain current (continuous) at $T_C = 25\text{ }^{\circ}\text{C}$  | 8           | A                  |
| $I_D$          | Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$ | 5           | A                  |
| $I_{DM}^{(1)}$ | Drain current (pulsed)                                            | 32          | A                  |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$           | 85          | 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                                               | - 55 to 150 | $^{\circ}\text{C}$ |
| $T_j$          | Operating junction temperature                                    |             |                    |

**Notes:**

<sup>(1)</sup> Pulse width limited by safe operating area.

<sup>(2)</sup>  $I_{SD} \leq 8\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ;  $V_{DS\text{ peak}} < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$ .

<sup>(3)</sup>  $V_{DS} \leq 520\text{ V}$

Table 3: Thermal data

| Symbol         | Parameter                                          | Value | Unit                        |
|----------------|----------------------------------------------------|-------|-----------------------------|
| $R_{thj-case}$ | Thermal resistance junction-case max               | 1.47  | $^{\circ}\text{C}/\text{W}$ |
| $R_{thj-pcb}$  | Thermal resistance junction-pcb max <sup>(1)</sup> | 50    | $^{\circ}\text{C}/\text{W}$ |

**Notes:**

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

Table 4: Avalanche characteristics

| Symbol   | Parameter                                                                                                              | Value | Unit |
|----------|------------------------------------------------------------------------------------------------------------------------|-------|------|
| $I_{AR}$ | Avalanche current, repetetive or not repetetive (pulse width limited by $T_{jmax}$ )                                   | 1.6   | A    |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_j = 25\text{ }^{\circ}\text{C}$ , $I_D = I_{AR}$ ; $V_{DD} = 50\text{ V}$ ) | 250   | mJ   |

## 2 Electrical characteristics

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

**Table 5: On/off states**

| Symbol        | Parameter                         | Test conditions                                                                            | Min. | Typ. | Max.     | Unit          |
|---------------|-----------------------------------|--------------------------------------------------------------------------------------------|------|------|----------|---------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage    | $V_{GS} = 0\text{ V}$ , $I_D = 1\text{ mA}$                                                | 650  |      |          | V             |
| $I_{DSS}$     | Zero gate voltage drain current   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 650\text{ V}$                                            |      |      | 1        | $\mu\text{A}$ |
|               |                                   | $V_{GS} = 0\text{ V}$ , $V_{GS(DS)} = 650\text{ V}$<br>$T_C = 125\text{ }^{\circ}\text{C}$ |      |      | 100      | $\mu\text{A}$ |
| $I_{GSS}$     | 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 | $V_{GS} = 10\text{ V}$ , $I_D = 4\text{ A}$                                                |      | 0.42 | 0.5      | $\Omega$      |

**Table 6: Dynamic**

| Symbol                     | Parameter                     | Test conditions                                                                                                                          | Min. | Typ. | Max. | Unit     |
|----------------------------|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|----------|
| $C_{iss}$                  | Input capacitance             | $V_{GS} = 0\text{ V}$ , $V_{DS} = 100\text{ V}$ ,<br>$f = 1\text{ MHz}$                                                                  | -    | 535  | -    | pF       |
| $C_{oss}$                  | Output capacitance            |                                                                                                                                          | -    | 25   | -    | pF       |
| $C_{rss}$                  | Reverse transfer capacitance  |                                                                                                                                          | -    | 1.1  | -    | pF       |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{GS} = 0\text{ V}$ , $V_{DS} = 0\text{ to }520\text{ V}$                                                                              | -    | 144  | -    | pF       |
| $R_G$                      | Intrinsic gate resistance     | $f = 1\text{ MHz}$ , open drain                                                                                                          | -    | 7    | -    | $\Omega$ |
| $Q_g$                      | Total gate charge             | $V_{DD} = 520\text{ V}$ , $I_D = 8\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$ (see <a href="#">Figure 15</a> :<br>"Gate charge test circuit") | -    | 16.5 | -    | nC       |
| $Q_{gs}$                   | Gate-source charge            |                                                                                                                                          | -    | 2.6  | -    | nC       |
| $Q_{gd}$                   | Gate-drain charge             |                                                                                                                                          | -    | 8.5  | -    | nC       |

**Notes:**

<sup>(1)</sup> $C_{oss\text{ eq.}}$  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 7: Switching times

| Symbol       | Parameter           | Test conditions                                                                                                                                                                                                                                   | Min. | Typ. | Max. | Unit |
|--------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 325\text{ V}$ , $I_D = 4\text{ A}$ , $R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 14: "Switching times test circuit for resistive load"</a> and <a href="#">Figure 19: "Switching time waveform"</a> ) | -    | 9    | -    | ns   |
| $t_r$        | Rise time           |                                                                                                                                                                                                                                                   | -    | 7    | -    | ns   |
| $t_{d(off)}$ | Turn-off delay time |                                                                                                                                                                                                                                                   | -    | 34   | -    | ns   |
| $t_f$        | Fall time           |                                                                                                                                                                                                                                                   | -    | 13.5 | -    | ns   |

Table 8: Source drain diode

| Symbol          | Parameter                     | Test conditions                                                                                                                                                                                                                   | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                                                                                                                   | -    |      | 8    | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                                                                                                                   | -    |      | 32   | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $V_{GS} = 0\text{ V}$ , $I_{SD} = 8\text{ A}$                                                                                                                                                                                     | -    |      | 1.6  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 8\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$<br>(see <a href="#">Figure 16: "Test circuit for inductive load switching and diode recovery times"</a> )                                     | -    | 313  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                                   | -    | 2.7  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                                   | -    | 17   |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 8\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$ ,<br>$T_j = 150\text{ }^\circ\text{C}$ (see <a href="#">Figure 16: "Test circuit for inductive load switching and diode recovery times"</a> ) | -    | 462  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                                   | -    | 4.1  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                                   | -    | 17.5 |      | A             |

**Notes:**

(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)

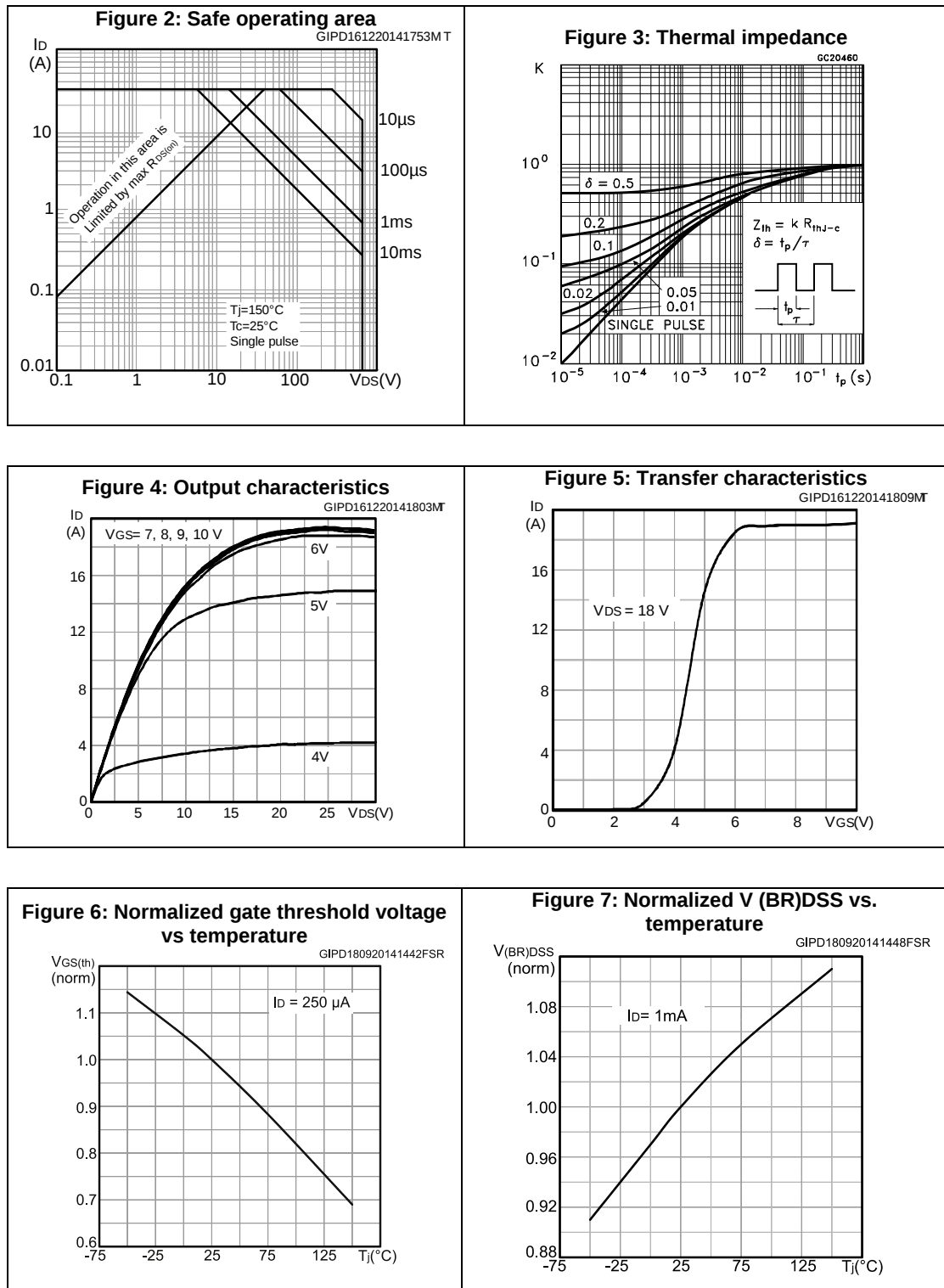


Figure 8: Static drain-source on-resistance

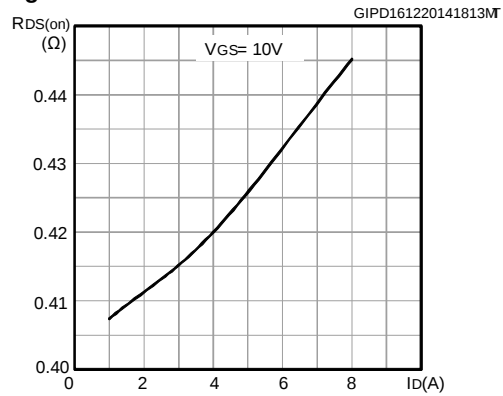


Figure 9: Normalized on-resistance vs temperature

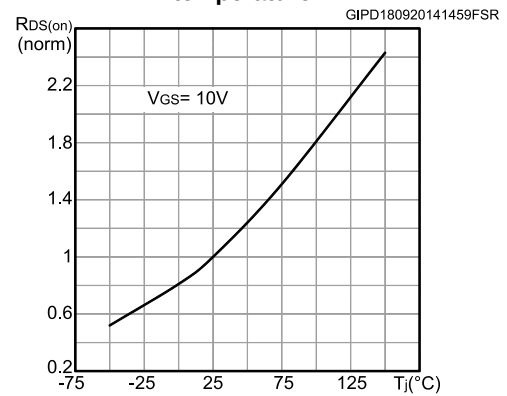


Figure 10: Gate charge vs. gate-source voltage

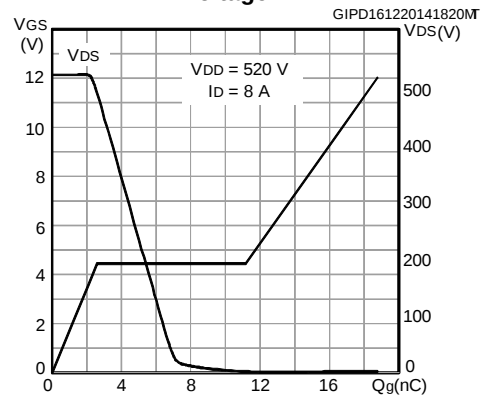


Figure 11: Capacitance variations

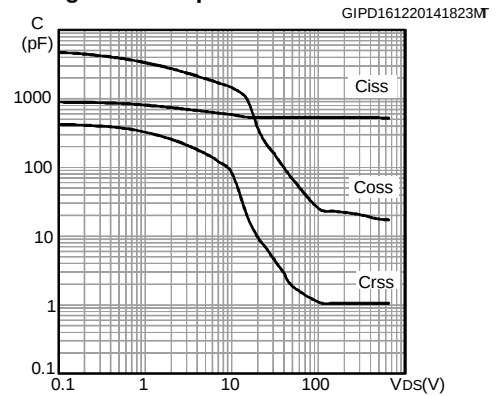


Figure 12: Turn-off switching loss vs drain current

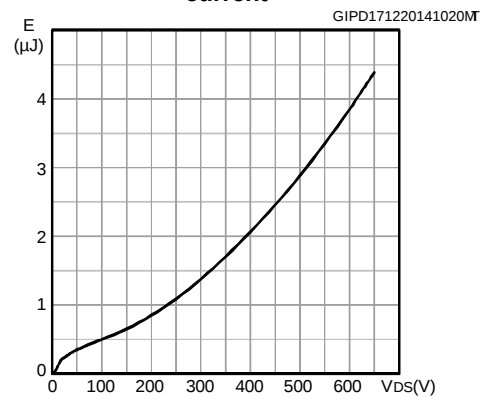
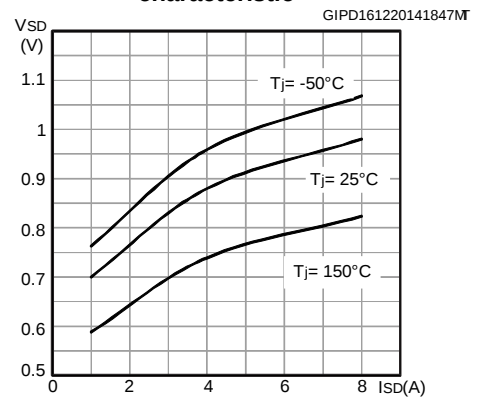


Figure 13: Source-drain diode forward characteristic



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AM01469v1

AM01470v1

AM01471v1

AM01472v1

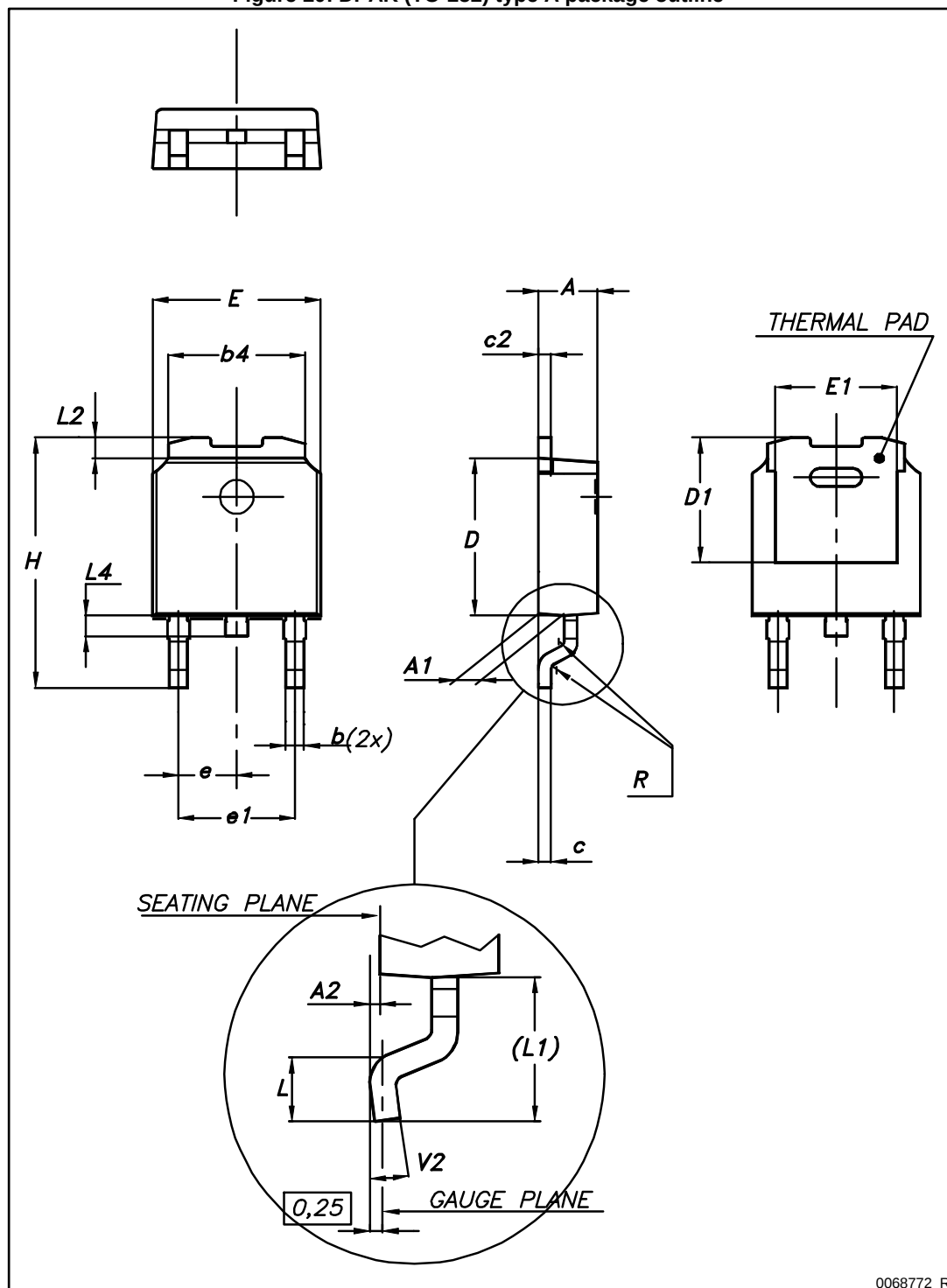
AM01473v1

## 4 Package information

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

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

Figure 20: DPAK (TO-252) type A package outline

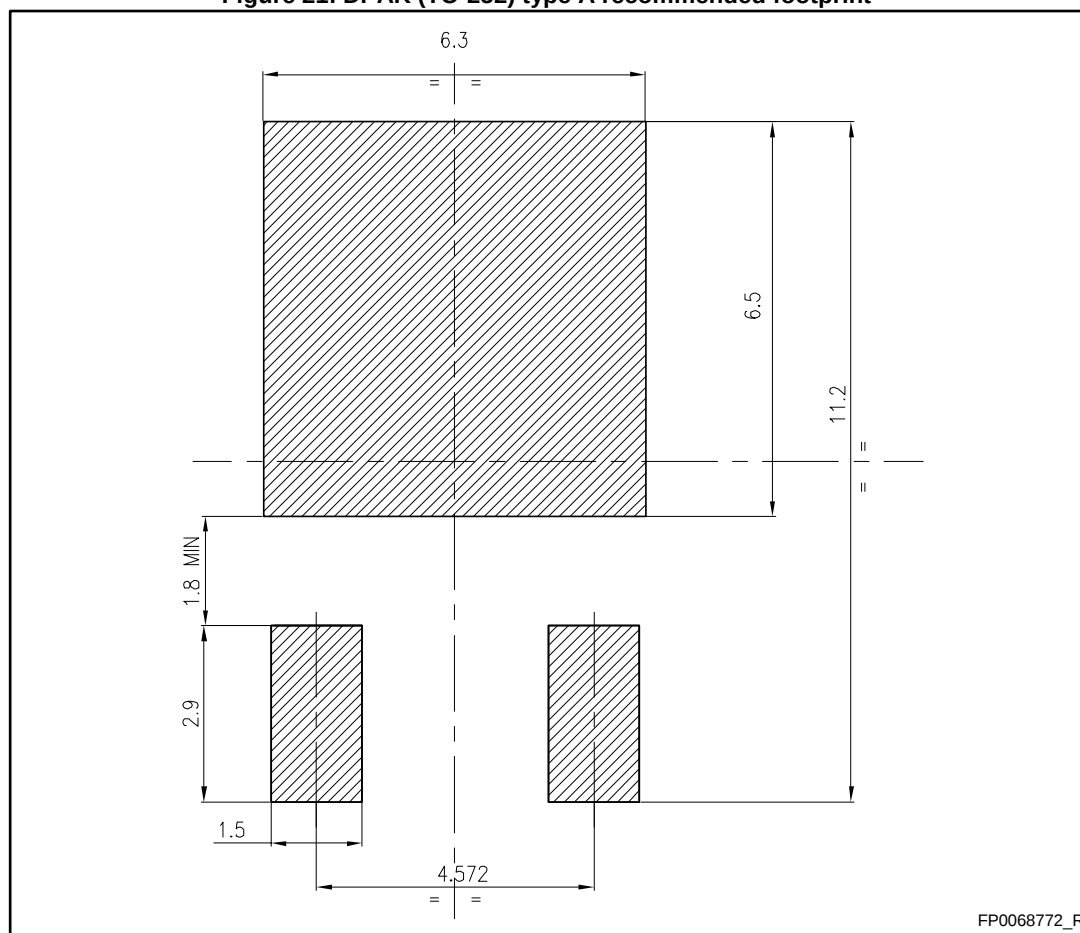


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Table 9: DPAK (TO-252) type A mechanical data

| 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   |      | 5.10 |       |
| E    | 6.40 |      | 6.60  |
| E1   |      | 4.70 |       |
| e    |      | 2.28 |       |
| e1   | 4.40 |      | 4.60  |
| H    | 9.35 |      | 10.10 |
| L    | 1.00 |      | 1.50  |
| L1   |      | 2.80 |       |
| L2   |      | 0.80 |       |
| L4   | 0.60 |      | 1.00  |
| R    |      | 0.20 |       |
| V2   | 0°   |      | 8°    |

Figure 21: DPAK (TO-252) type A recommended footprint



All dimensions are in mm

## 4.2 DPAK (TO-252) packing information

Figure 22: Tape for DPAK (TO-252)

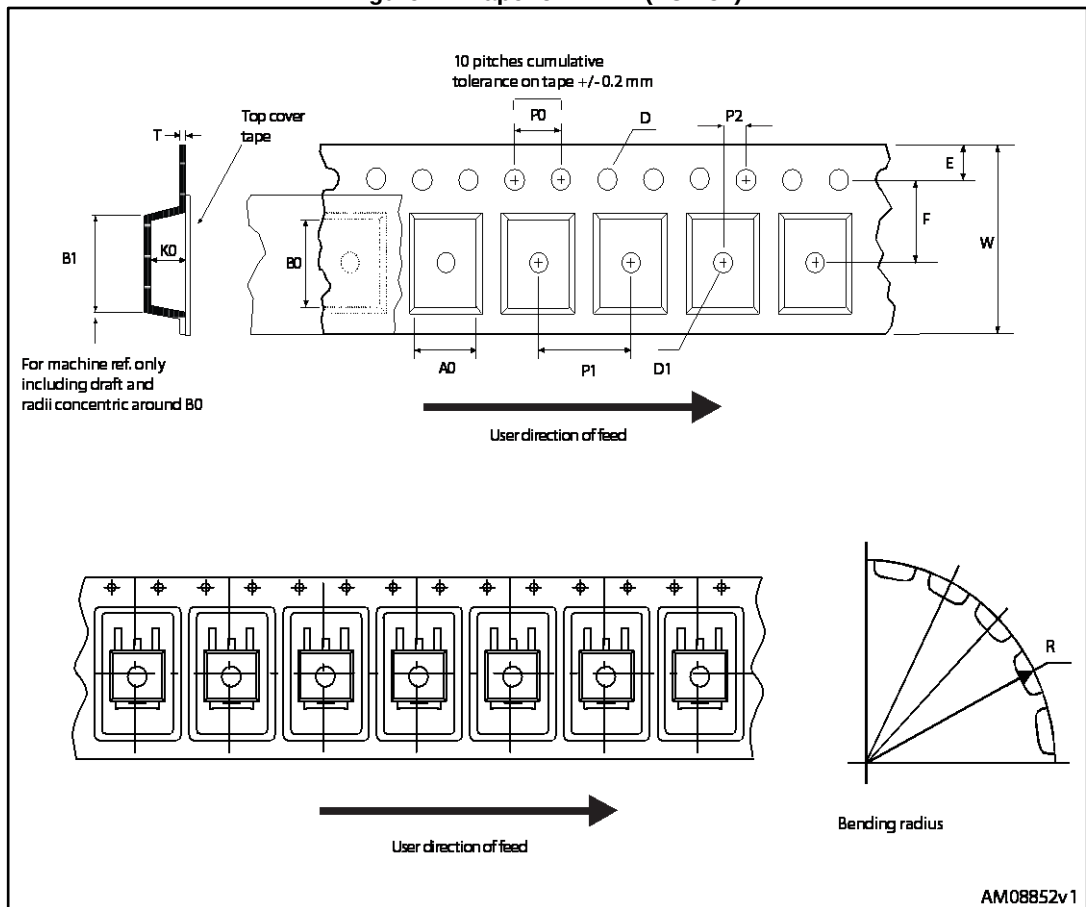


Figure 23: Reel for DPAK (TO-252)

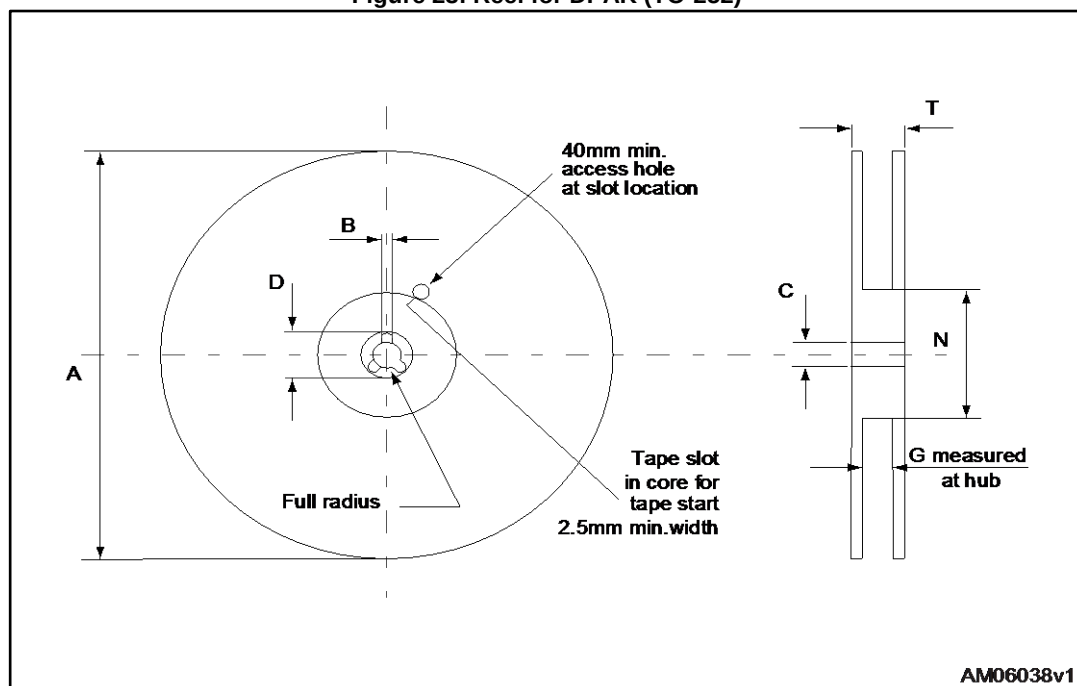


Table 10: DPAK (TO-252) tape and reel mechanical data

| 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 |           |      |      |

## 5 Revision history

**Table 11: Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                             |
|-------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 16-Dec-2014 | 1        | First release.                                                                                                                                                                                                                                                                                      |
| 12-Feb-2015 | 2        | Updated features in cover page.<br>Updated <a href="#">Table 4: "Avalanche characteristics"</a> , <a href="#">Table 7: "Switching times"</a> , <a href="#">Figure 2: "Safe operating area"</a> and <a href="#">Section 5.1: "DPAK (TO-252) type A package information"</a> .<br>Minor text changes. |

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