

## N-channel 600 V, 1.06 $\Omega$ typ., 4.5 A MDmesh™ M2 Power MOSFETs in D<sup>2</sup>PAK and DPAK packages

Datasheet - production data

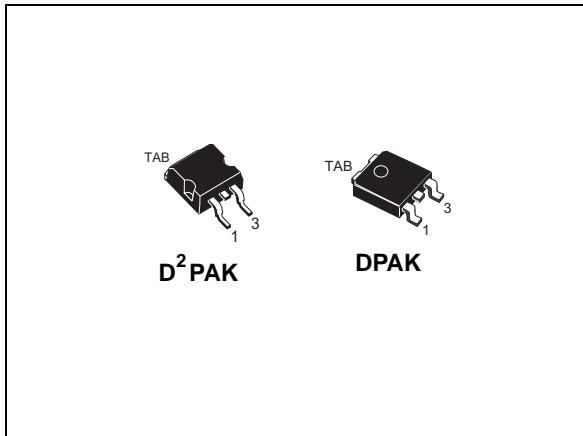
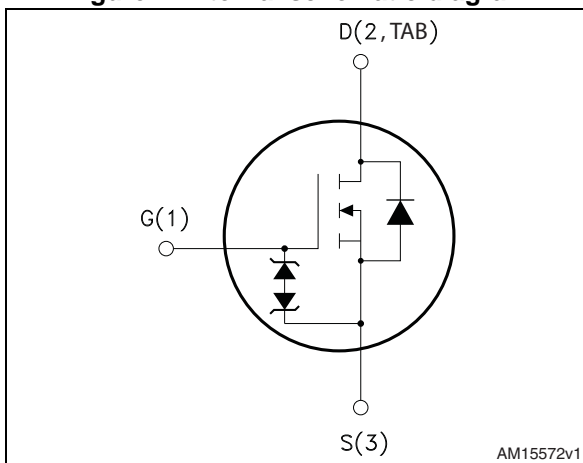


Figure 1. Internal schematic diagram



### Features

| Order code | $V_{DS} @ T_{Jmax}$ | $R_{DS(on) max}$ | $I_D$ |
|------------|---------------------|------------------|-------|
| STB6N60M2  | 650 V               | 1.2 $\Omega$     | 4.5 A |
| STD6N60M2  |                     |                  |       |

- Extremely low gate charge
- Excellent output capacitance ( $C_{oss}$ ) profile
- 100% avalanche tested
- Zener-protected

### Applications

- Switching applications

### Description

These devices are N-channel Power MOSFETs developed using MDmesh™ M2 technology. Thanks to their strip layout and improved vertical structure, the devices exhibit low on-resistance and optimized switching characteristics, rendering them suitable for the most demanding high efficiency converters.

Table 1. Device summary

| Order code | Marking | Package            | Packing       |
|------------|---------|--------------------|---------------|
| STB6N60M2  | 6N60M2  | D <sup>2</sup> PAK | Tape and reel |
| STD6N60M2  |         | DPAK               |               |

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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 $T_C = 25\text{ }^\circ\text{C}$  | 4.5        | A                |
| $I_D$          | Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$ | 2.9        | A                |
| $I_{DM}^{(1)}$ | Drain current (pulsed)  | 18         | A                |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ }^\circ\text{C}$           | 60         | W                |
| $dv/dt^{(2)}$  | Peak diode recovery voltage slope                               | 15         | V/ns             |
| $dv/dt^{(3)}$  | MOSFET $dv/dt$ ruggedness                                       | 50         |                  |
| $T_{stg}$      | Storage temperature range                                       | -55 to 150 | $^\circ\text{C}$ |
| $T_j$          | Operating junction temperature range                            |            |                  |

1. Pulse width limited by safe operating area
2.  $I_{SD} \leq 4.5\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ;  $V_{DS\text{ peak}} < V_{(BR)DSS}$ ,  $V_{DD}=400\text{ V}$
3.  $V_{DS} \leq 480\text{ V}$

**Table 3. Thermal data**

| Symbol         | Parameter  | Value              |      | Unit                      |
|----------------|--|--------------------|------|---------------------------|
|                |  | D <sup>2</sup> PAK | DPAK |                           |
| $R_{thj-case}$ | Thermal resistance junction-case max               | 2.08               |      | $^\circ\text{C}/\text{W}$ |
| $R_{thj-pcb}$  | Thermal resistance junction-pcb max <sup>(1)</sup> | 30                 | 50   | $^\circ\text{C}/\text{W}$ |

1. 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, repetitive or not repetitive (pulse width limited by $T_{jmax}$ )                           | 1     | A    |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_j=25\text{ }^\circ\text{C}$ , $I_D=I_{AR}$ ; $V_{DD}=50\text{ V}$ ) | 86    | mJ   |

## 2 Electrical characteristics

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

**Table 5. On /off states**

| Symbol        | Parameter  | Test conditions                                       | Min. | Typ. | Max.     | Unit          |
|---------------|--|---|------|------|----------|---------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage                   | $I_D = 1\text{ mA}$ , $V_{GS} = 0$                    | 600  |      |          | V             |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = 600\text{ V}$                               |      |      | 1        | $\mu\text{A}$ |
|               |  | $V_{DS} = 600\text{ V}$ , $T_C = 125\text{ °C}^{(1)}$ |      |      | 100      | $\mu\text{A}$ |
| $I_{GSS}$     | Gate-body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 25\text{ V}$                            |      |      | $\pm 10$ | $\mu\text{A}$ |
| $V_{GS(th)}$  | 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                | $V_{GS} = 10\text{ V}$ , $I_D = 2.25\text{ A}$        |      | 1.06 | 1.2      | $\Omega$      |

1. Defined by design, not subject to production test

**Table 6. Dynamic**

| Symbol                  | Parameter                     | Test conditions  | Min. | Typ. | Max. | Unit     |
|-------------------------|-------------------------------|--|------|------|------|----------|
| $C_{iss}$               | Input capacitance             | $V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ ,<br>$V_{GS} = 0$   | -    | 232  | -    | pF       |
| $C_{oss}$               | Output capacitance            |  | -    | 14   | -    | pF       |
| $C_{riss}$              | Reverse transfer capacitance  |  | -    | 0.7  | -    | pF       |
| $C_{oss\text{ eq.}(1)}$ | Equivalent output capacitance | $V_{DS} = 0\text{ to }480\text{ V}$ , $V_{GS} = 0$   | -    | 71   | -    | pF       |
| $R_G$                   | Intrinsic gate resistance     | $f = 1\text{ MHz}$ open drain  | -    | 6.5  | -    | $\Omega$ |
| $Q_g$                   | Total gate charge             | $V_{DD} = 480\text{ V}$ , $I_D = 4.5\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 16</a> ) | -    | 8.2  | -    | nC       |
| $Q_{gs}$                | Gate-source charge            |  | -    | 1.7  | -    | nC       |
| $Q_{gd}$                | Gate-drain charge             |  | -    | 4.2  | -    | nC       |

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

**Table 7. Switching times**

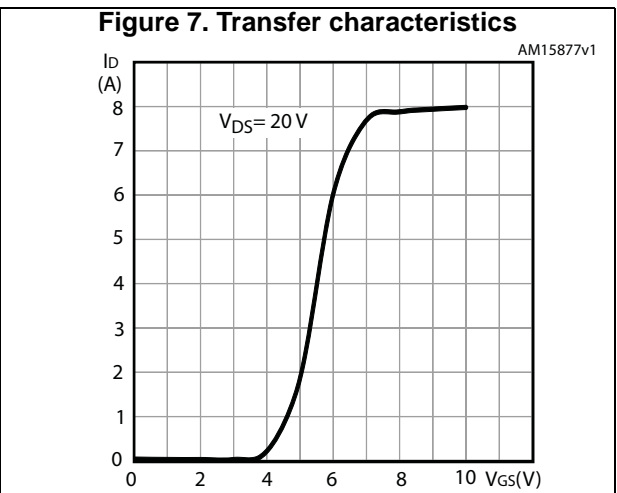
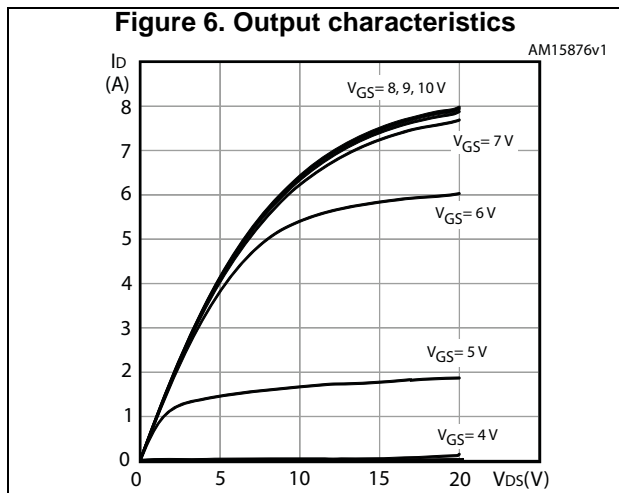
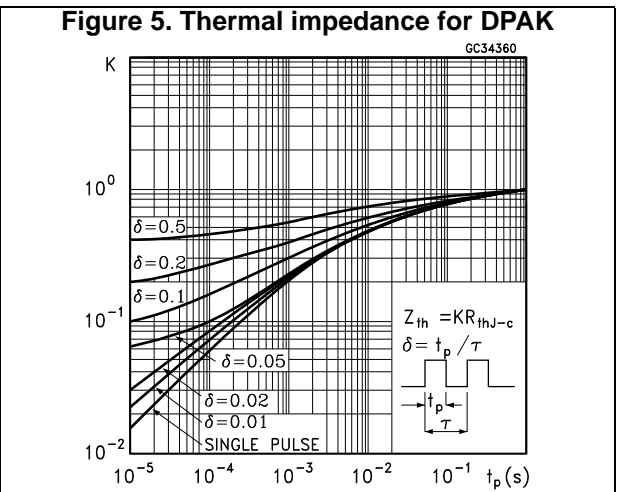
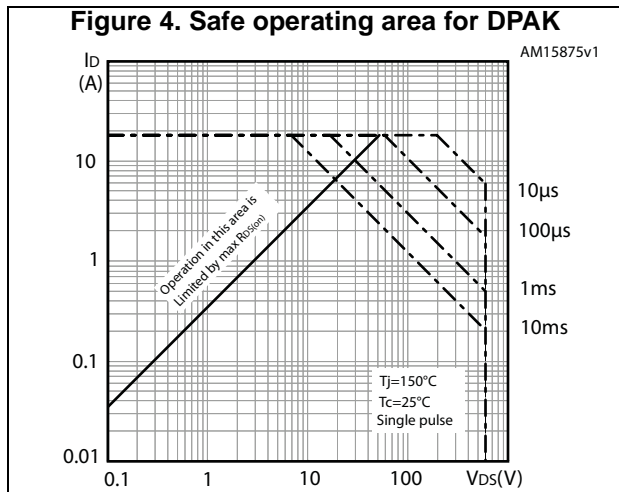
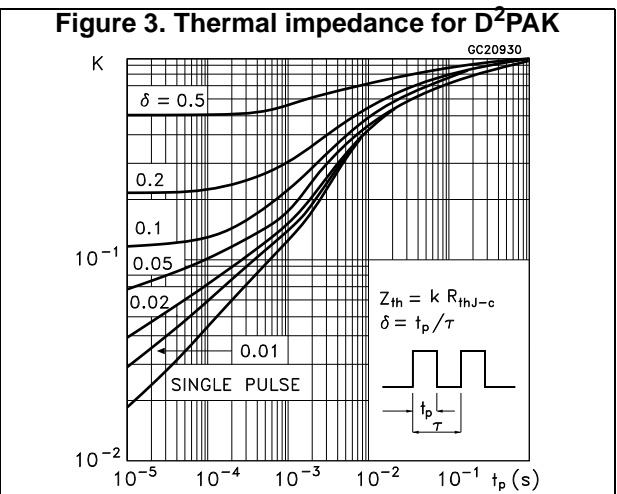
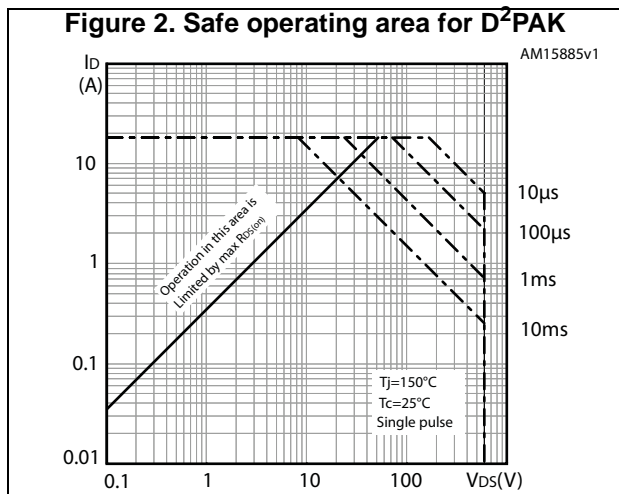
| Symbol       | Parameter           | Test conditions   | Min. | Typ. | Max. | Unit |
|--------------|---------------------|---|------|------|------|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 300\text{ V}$ , $I_D = 1.65\text{ A}$ ,<br>$R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 15</a> and <a href="#">Figure 20</a> ) | -    | 9.5  | -    | ns   |
| $t_r$        | Rise time           |   | -    | 7.4  | -    | ns   |
| $t_{d(off)}$ | Turn-off delay time |   | -    | 24   | -    | ns   |
| $t_f$        | Fall time           |   | -    | 22.5 | -    | ns   |

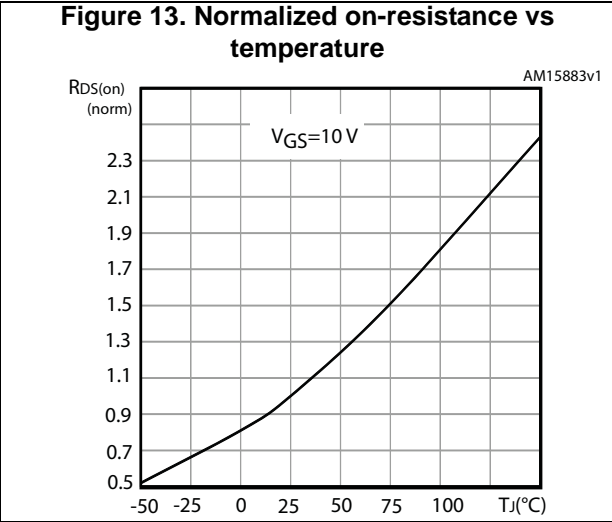
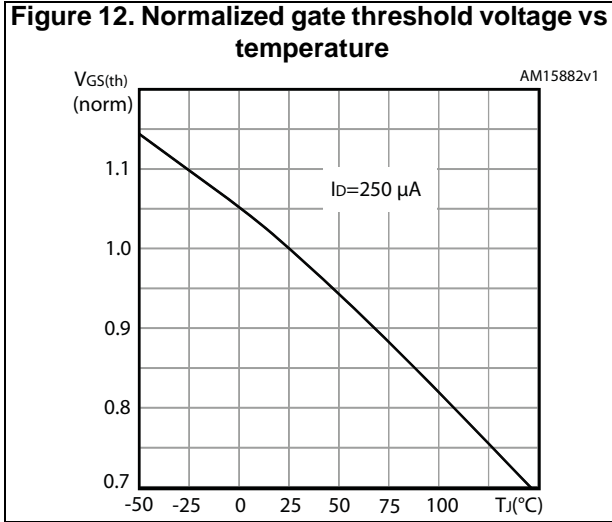
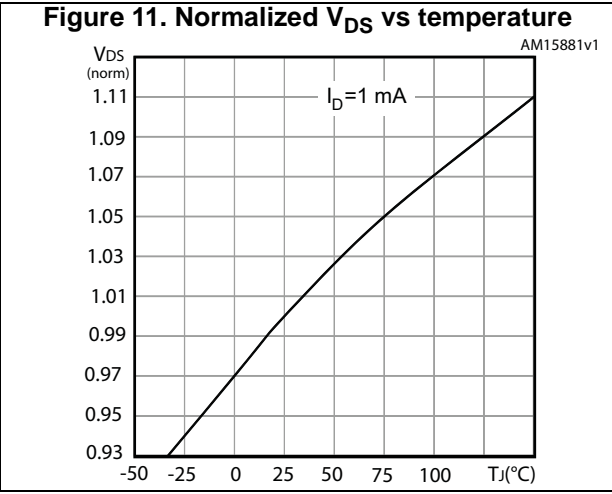
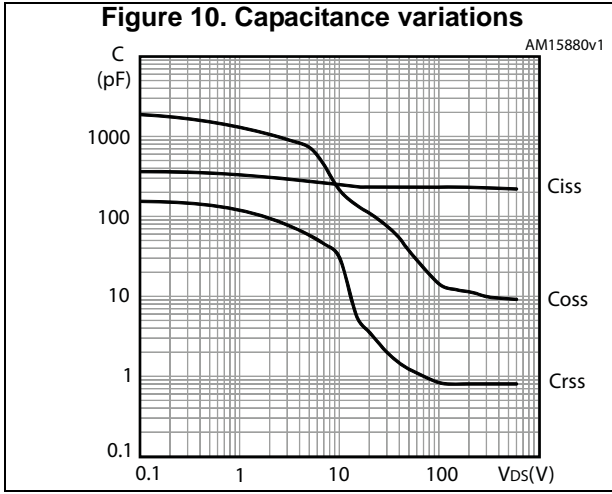
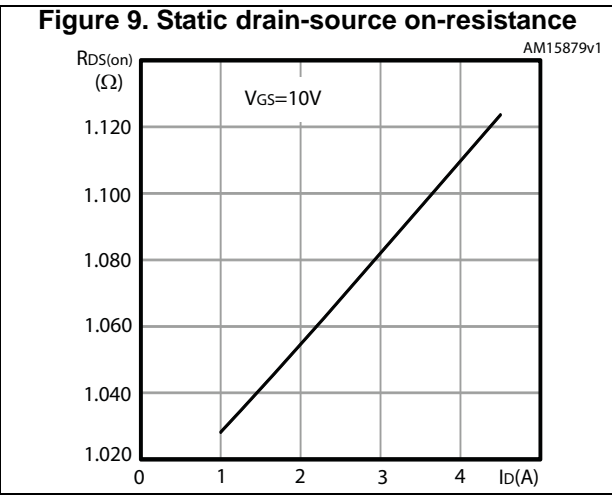
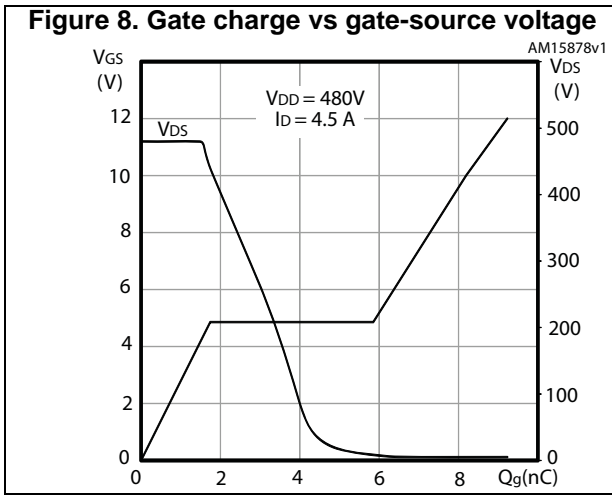
Table 8. Source drain diode

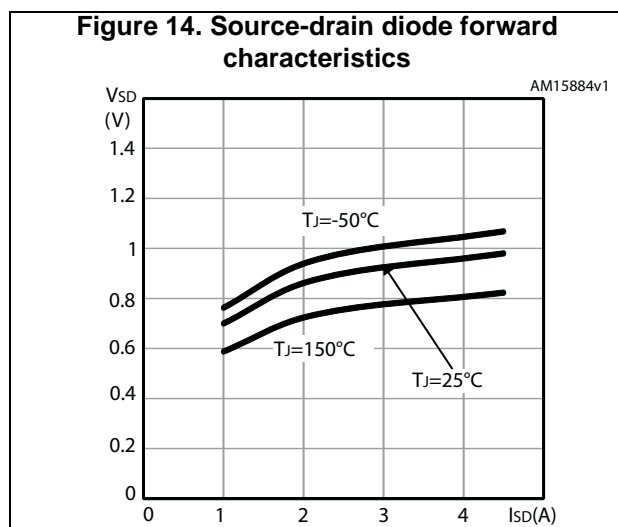
| Symbol          | Parameter                     | Test conditions  | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|--|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |  | -    |      | 4.5  | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |  | -    |      | 18   | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 4.5 \text{ A}$ , $V_{GS} = 0$  | -    |      | 1.6  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 4.5 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$<br>$V_{DD} = 60 \text{ V}$ (see <a href="#">Figure 17</a> )   | -    | 274  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |  | -    | 1.47 |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |  | -    | 10.7 |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 4.5 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$<br>$V_{DD} = 60 \text{ V}$ , $T_j = 150 \text{ }^\circ\text{C}$<br>(see <a href="#">Figure 17</a> ) | -    | 376  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |  | -    | 1.96 |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |  | -    | 10.5 |      | A             |

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

## 2.1 Electrical characteristics (curves)

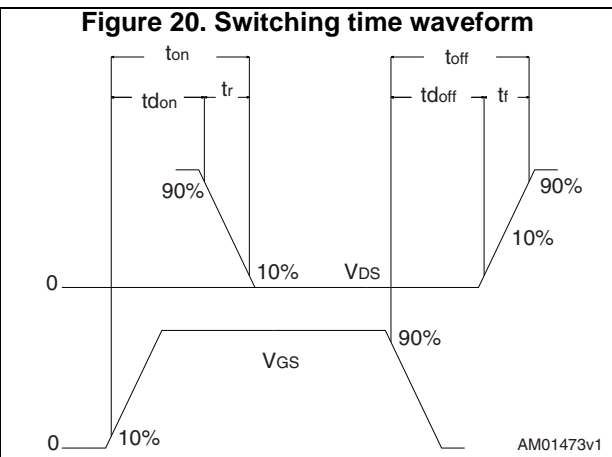
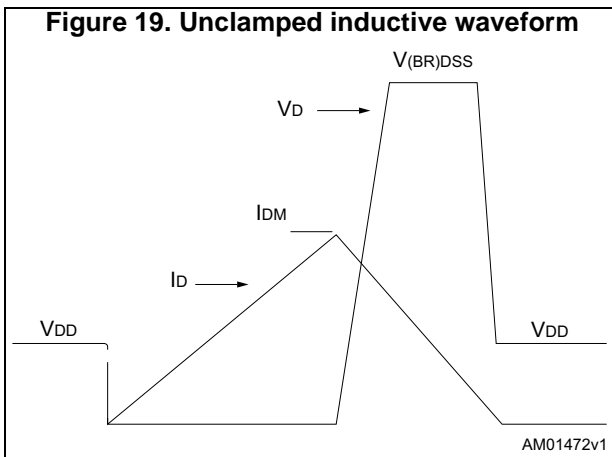
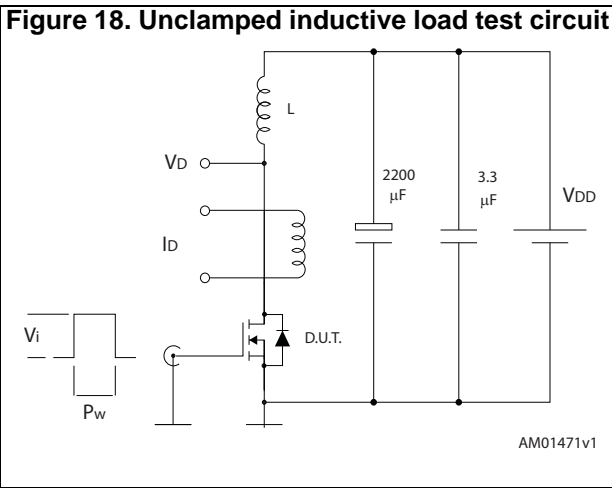
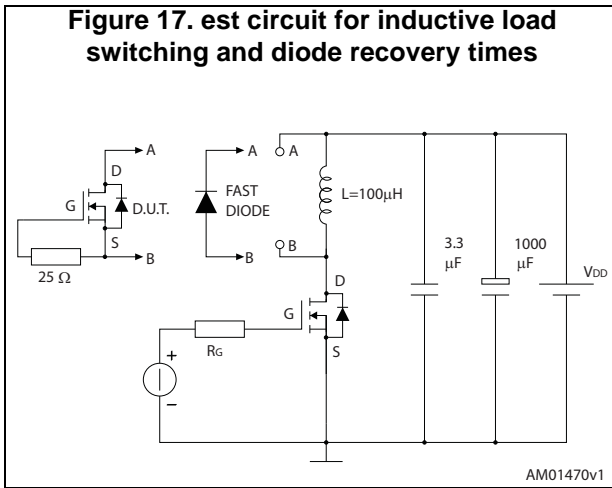
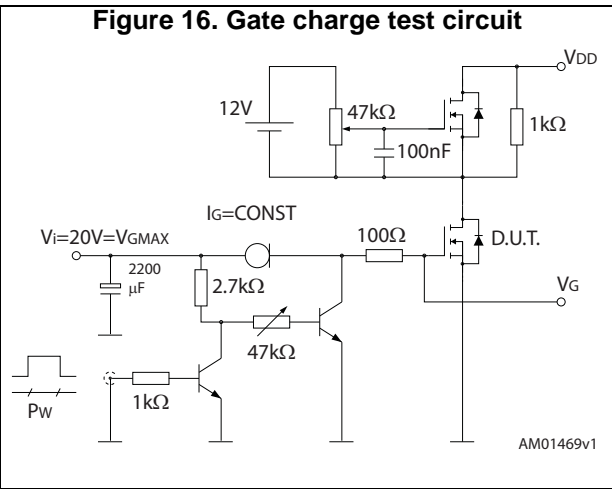
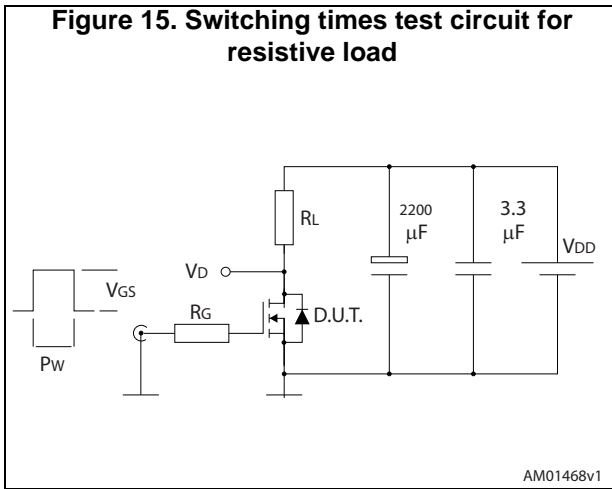








### 3 Test circuits



## 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 D<sup>2</sup>PAK(TO-263) package information

Figure 21. D<sup>2</sup>PAK (TO-263) type A package outline

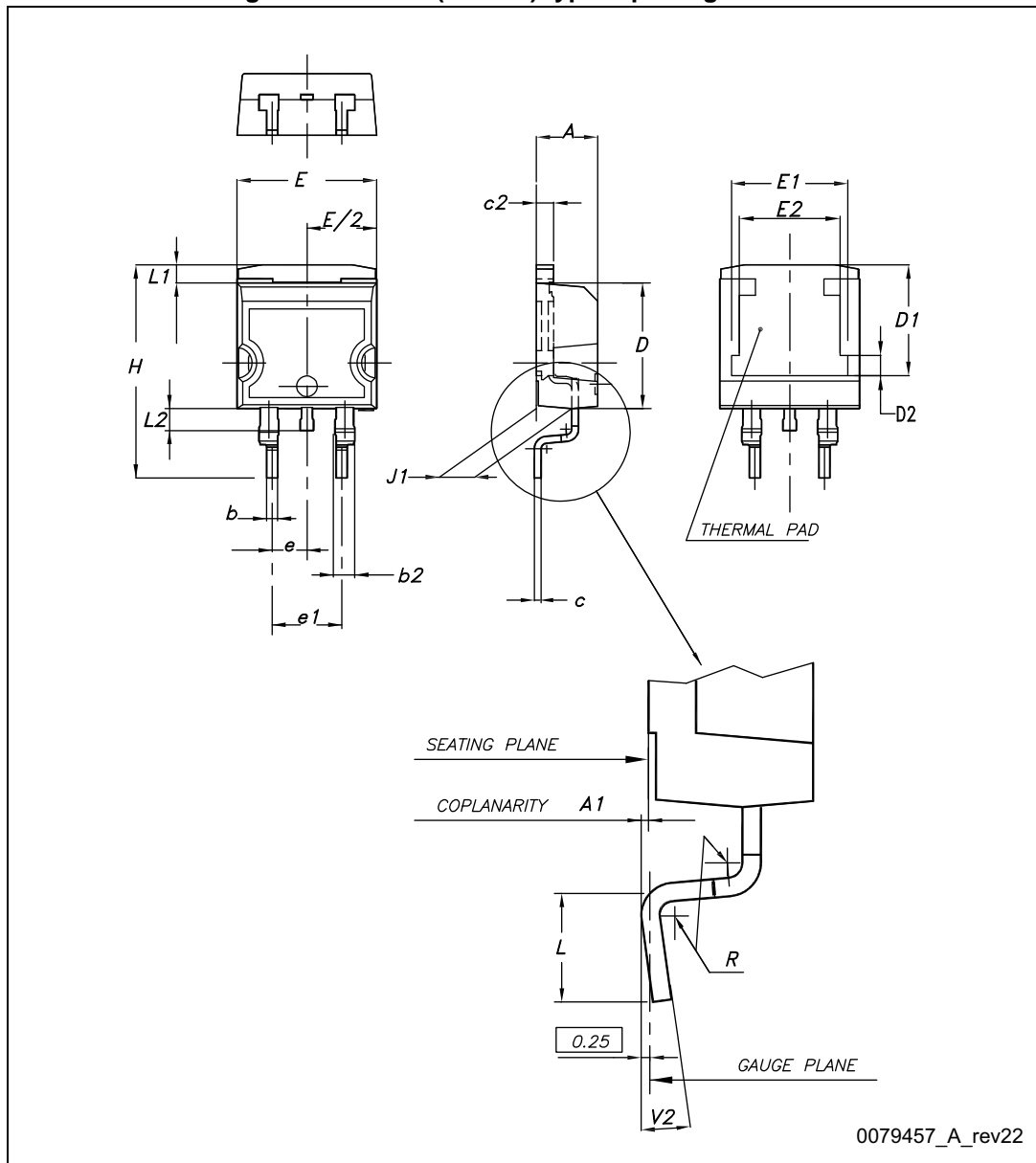
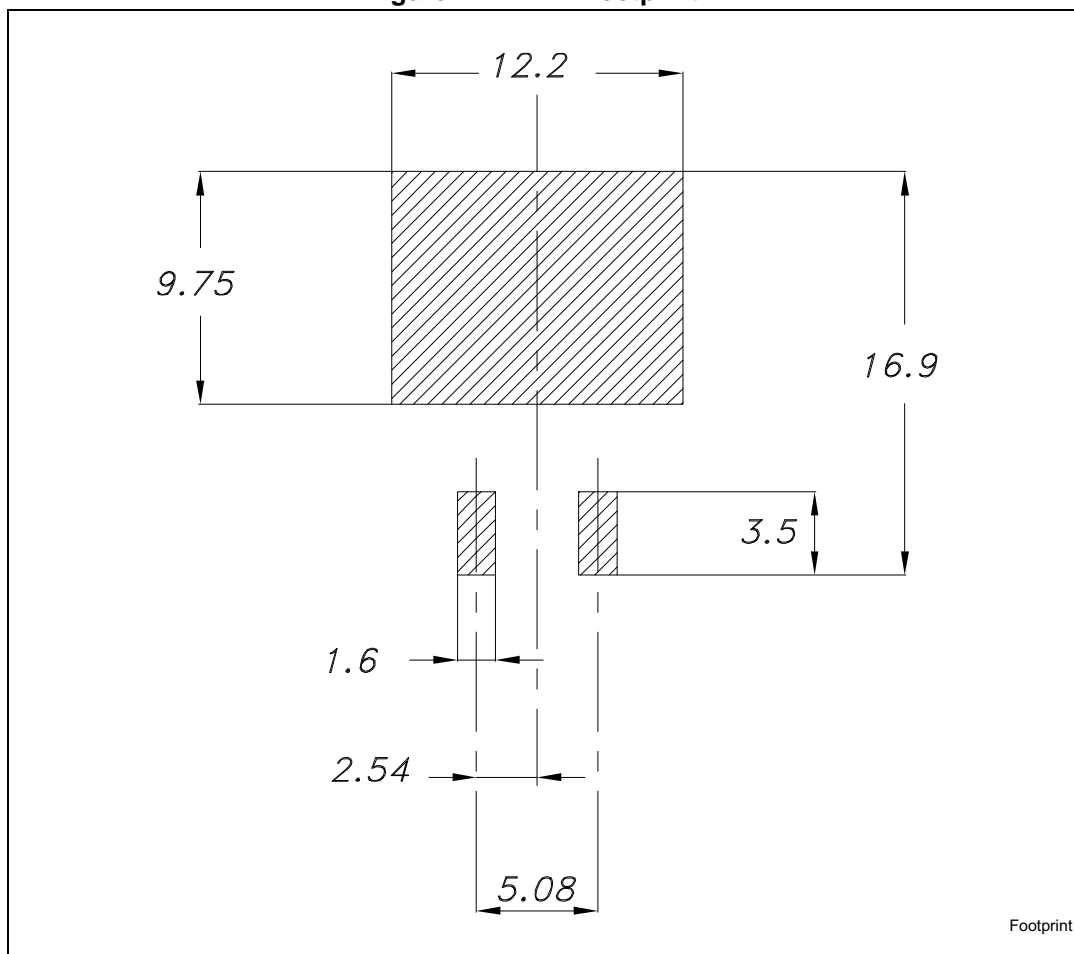


Table 9. D<sup>2</sup>PAK (TO-263) type A mechanical data

| Dim. | mm   |      |       |
|------|------|------|-------|
|      | Min. | Typ. | Max.  |
| A    | 4.40 |      | 4.60  |
| A1   | 0.03 |      | 0.23  |
| b    | 0.70 |      | 0.93  |
| b2   | 1.14 |      | 1.70  |
| c    | 0.45 |      | 0.60  |
| c2   | 1.23 |      | 1.36  |
| D    | 8.95 |      | 9.35  |
| D1   | 7.50 | 7.75 | 8.00  |
| D2   | 1.10 | 1.30 | 1.50  |
| E    | 10   |      | 10.40 |
| E1   | 8.50 | 8.70 | 8.90  |
| E2   | 6.85 | 7.05 | 7.25  |
| e    |      | 2.54 |       |
| e1   | 4.88 |      | 5.28  |
| H    | 15   |      | 15.85 |
| J1   | 2.49 |      | 2.69  |
| L    | 2.29 |      | 2.79  |
| L1   | 1.27 |      | 1.40  |
| L2   | 1.30 |      | 1.75  |
| R    |      | 0.4  |       |
| V2   | 0°   |      | 8°    |

Figure 22. D<sup>2</sup>PAK footprint<sup>(a)</sup>



a. All dimension are in millimeters

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

Figure 23. DPAK (TO-252) type C outline

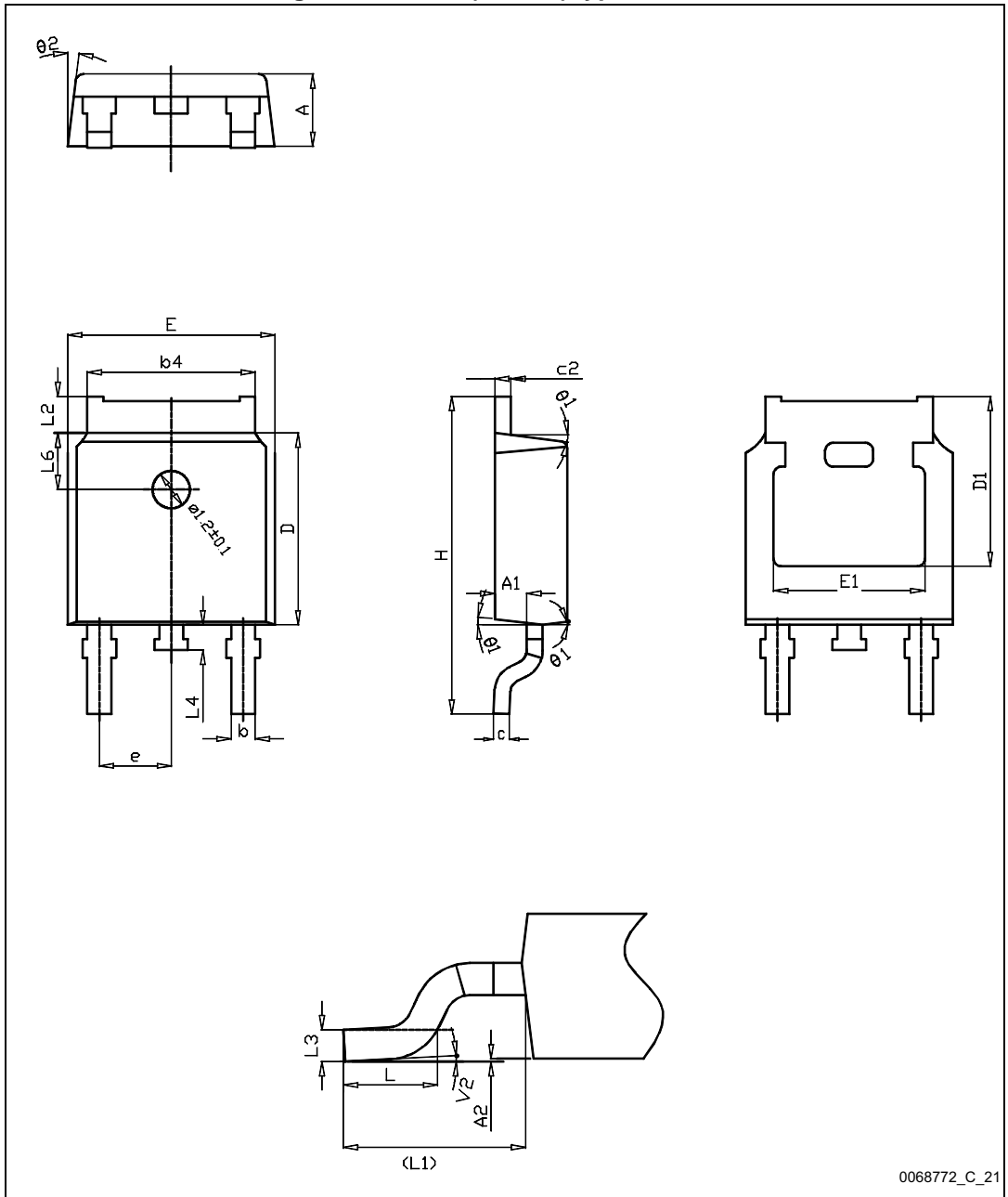
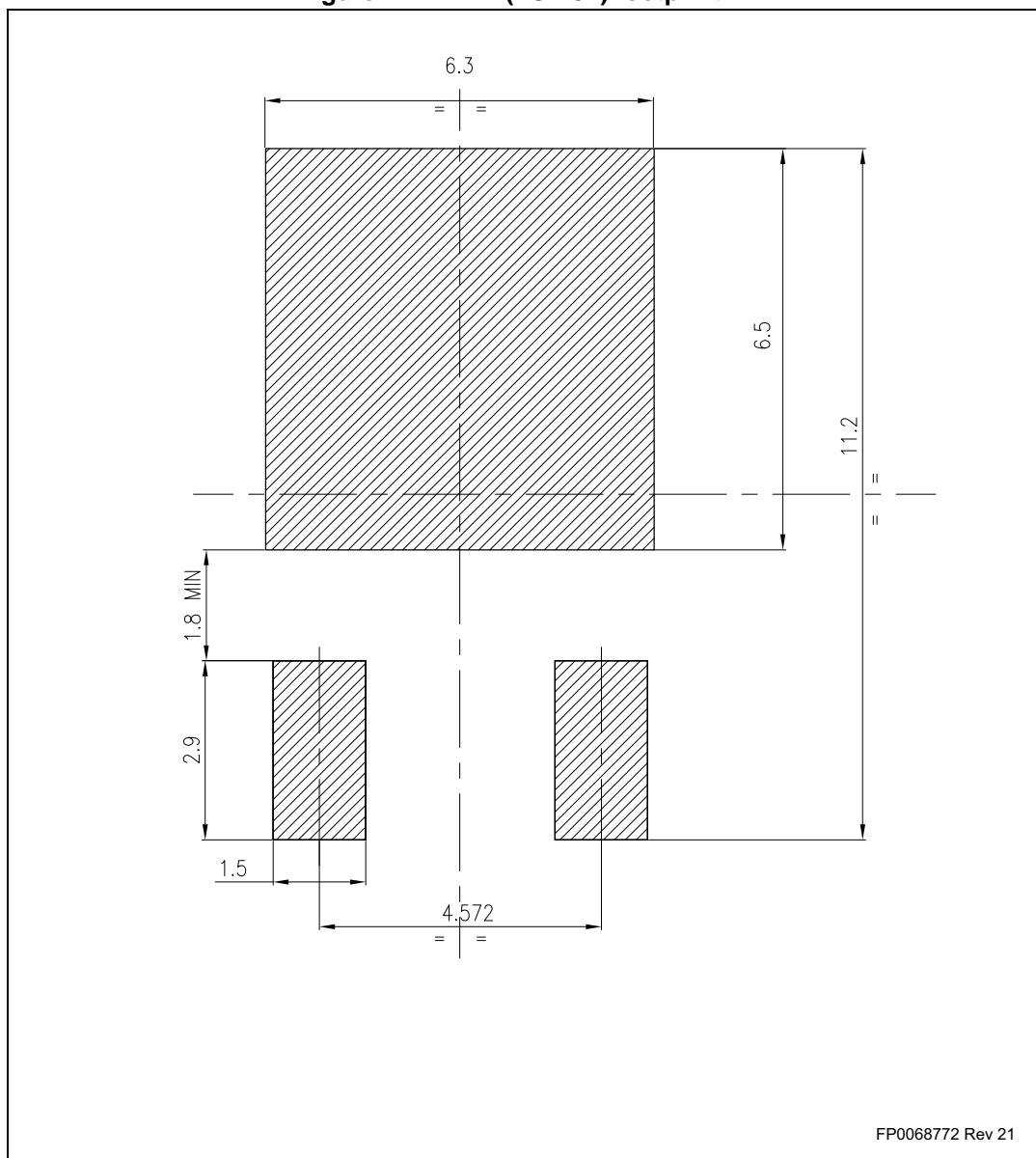


Table 10. DPAK (TO-252) type C package mechanical data

| 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   | 5.25     |       |       |
| E    | 6.50     | 6.60  | 6.70  |
| e    | 2.186    | 2.286 | 2.386 |
| E1   | 4.70     |       |       |
| 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 24. DPAK (TO-252) footprint (b)



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b. All dimensions are in millimeters



## 5 Packing information

Table 11. D<sup>2</sup>PAK (TO-263) tape and reel mechanical data

| Tape |      |      | Reel |          |      |
|------|------|------|------|----------|------|
| Dim. | mm   |      | Dim. | mm       |      |
|      | Min. | Max. |      | Min.     | Max. |
| A0   | 10.5 | 10.7 | A    |          | 330  |
| B0   | 15.7 | 15.9 | B    | 1.5      |      |
| D    | 1.5  | 1.6  | C    | 12.8     | 13.2 |
| D1   | 1.59 | 1.61 | D    | 20.2     |      |
| E    | 1.65 | 1.85 | G    | 24.4     | 26.4 |
| F    | 11.4 | 11.6 | N    | 100      |      |
| K0   | 4.8  | 5.0  | T    |          | 30.4 |
| P0   | 3.9  | 4.1  |      |          |      |
| P1   | 11.9 | 12.1 |      | Base qty | 1000 |
| P2   | 1.9  | 2.1  |      | Bulk qty | 1000 |
| R    | 50   |      |      |          |      |
| T    | 0.25 | 0.35 |      |          |      |
| W    | 23.7 | 24.3 |      |          |      |

Table 12. 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 |           |      |      |

Figure 25. Tape

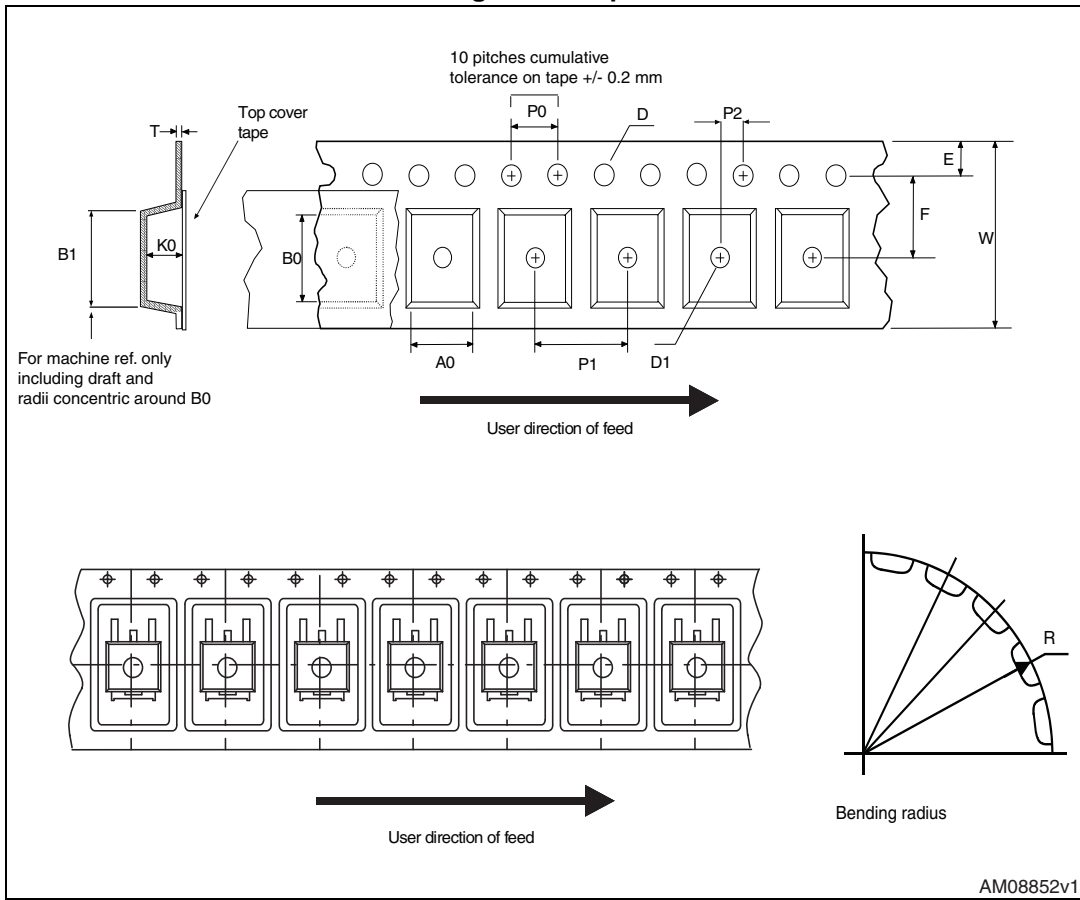
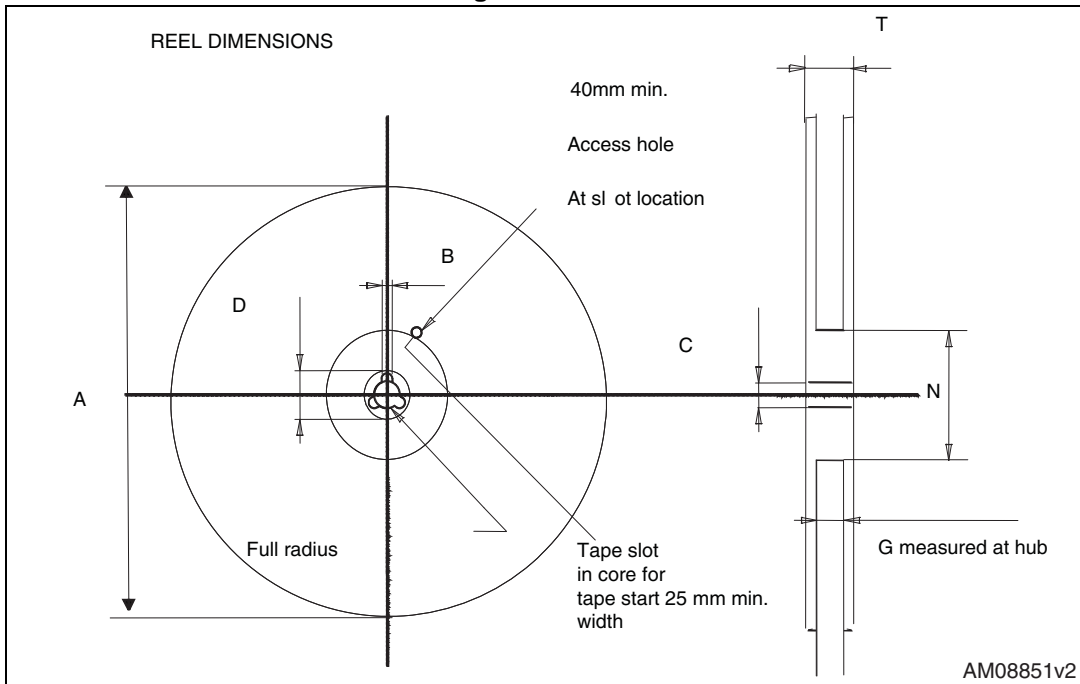


Figure 26. Reel



## 6 Revision history

Table 13. Document revision history

| Date        | Revision | Changes  |
|-------------|----------|--|
| 11-Jun-2013 | 1        | First release.   |
| 09-Jul-2013 | 2        | – Minor text changes<br>– Modified: $R_{thj-case}$ value for D <sup>2</sup> PAK in table 3   |
| 30-May-2016 | 3        | Updated title, features and description.<br>Updated <a href="#">Table 6: Dynamic</a> and <a href="#">Table 8: Source drain diode</a> .<br>Updated <a href="#">Section 4: Package information</a> and <a href="#">Section 5: Packing information</a> .<br>Minor text changes. |

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