



# STD2LN60K3, STF2LN60K3, STU2LN60K3

N-channel 600 V, 4  $\Omega$  typ., 2 A SuperMESH3™ Power MOSFET  
in DPAK, TO-220FP and IPAK packages

Datasheet — production data

## Features

| Order codes | V <sub>DSS</sub> | R <sub>DS(on) max</sub> | I <sub>D</sub> | P <sub>TOT</sub> |
|-------------|------------------|-------------------------|----------------|------------------|
| STD2LN60K3  | 600 V            | < 4.5 $\Omega$          | 2 A            | 45 W             |
| STF2LN60K3  |                  |                         |                | 20 W             |
| STU2LN60K3  |                  |                         |                | 45 W             |

- 100% avalanche tested
- Extremely high dv/dt capability
- Very low intrinsic capacitance
- Improved diode reverse recovery characteristics
- Zener-protected

## Applications

- Switching applications

## Description

These SuperMESH3™ Power MOSFETs are the result of improvements applied to STMicroelectronics' SuperMESH™ technology, combined with a new optimized vertical structure. These devices boast an extremely low on-resistance, superior dynamic performance and high avalanche capability, rendering them suitable for the most demanding applications.

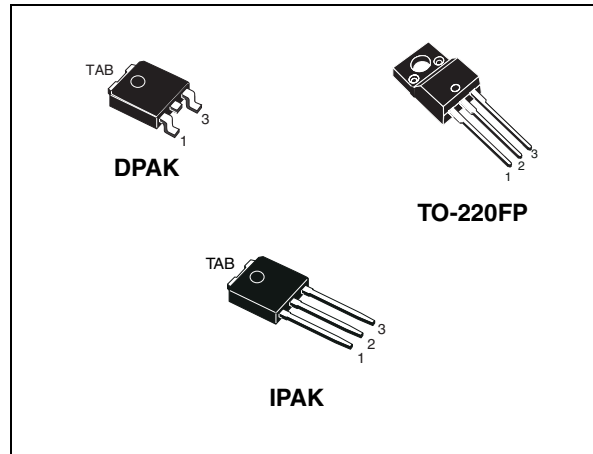


Figure 1. Internal schematic diagram

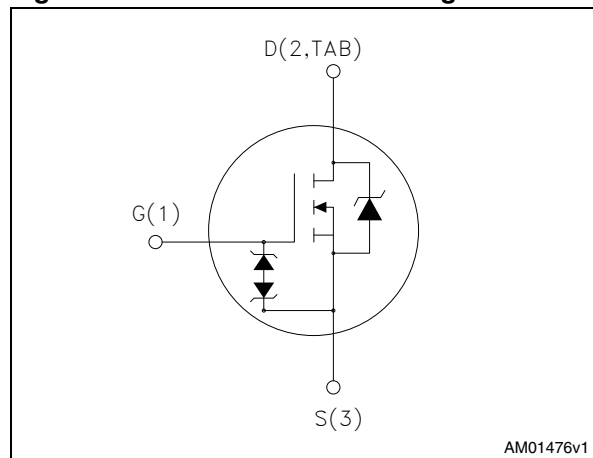


Table 1. Device summary

| Order codes | Marking | Package  | Packaging     |
|-------------|---------|----------|---------------|
| STD2LN60K3  | 2LN60K3 | DPAK     | Tape and reel |
| STF2LN60K3  |         | TO-220FP | Tube          |
| STU2LN60K3  |         | IPAK     |               |

## Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol                  | Parameter   | Value      |                     |      | Unit |
|-------------------------|---|------------|---------------------|------|------|
|                         |   | DPAK       | TO-220FP            | IPAK |      |
| $V_{DS}$                | Drain-source voltage  | 600        |                     |      | V    |
| $V_{GS}$                | Gate- source voltage  | ± 30       |                     |      | V    |
| $I_D$                   | Drain current (continuous) at $T_C = 25\text{ °C}$  | 2          | 2 <sup>(1)</sup>    | 2    | A    |
| $I_D$                   | Drain current (continuous) at $T_C = 100\text{ °C}$   | 1.26       | 1.26 <sup>(1)</sup> | 1.26 | A    |
| $I_{DM}$ <sup>(2)</sup> | Drain current (pulsed)  | 8          | 8 <sup>(1)</sup>    | 8    | A    |
| $P_{TOT}$               | Total dissipation at $T_C = 25\text{ °C}$   | 45         | 20                  | 45   | W    |
|                         | Derating factor   | 0.36       | 0.16                | 0.36 | W/°C |
| $V_{ESD(G-S)}$          | Gate source ESD<br>(HBM-C = 100 pF, R = 1.5 kΩ)   | 2500       |                     |      | V    |
| dv/dt <sup>(3)</sup>    | Peak diode recovery voltage slope   | 12         |                     |      | V/ns |
| $V_{ISO}$               | Insulation withstand voltage (RMS) from all three leads to external heat sink<br>(t = 1 s; $T_C = 25\text{ °C}$ ) |            | 2500                |      | V    |
| $T_{stg}$               | Storage temperature   | -55 to 150 |                     |      | °C   |
| $T_j$                   | Max. operating junction temperature   | 150        |                     |      | °C   |

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

**Table 3. Thermal data**

| Symbol         | Parameter                            | Value |          |      | Unit |
|----------------|--------------------------------------|-------|----------|------|------|
|                |                                      | DPAK  | TO-220FP | IPAK |      |
| $R_{thj-case}$ | Thermal resistance junction-case max | 2.78  | 6.25     | 2.78 | °C/W |
| $R_{thj-pcb}$  | Thermal resistance junction-pcb max  | 50    |          |      | °C/W |
| $R_{thj-amb}$  | Thermal resistance junction-amb max  |       | 62.5     | 100  | °C/W |

**Table 4. Avalanche characteristics**

| Symbol   | Parameter   | Max value | Unit |
|----------|---|-----------|------|
| $I_{AR}$ | Avalanche current, repetitive or not-repetitive<br>(pulse width limited by $T_j$ max)                       | 2         | A    |
| $E_{AS}$ | Single pulse avalanche energy<br>(starting $T_j = 25\text{ °C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ ) | 80        | 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 ( $V_{GS} = 0$ ) | $V_{DS} = 600\text{ V}$<br>$V_{DS} = 600\text{ V}$ , $T_C = 125\text{ °C}$ |      |      | 1<br>50  | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$     | Gate-body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 20\text{ V}$   |      |      | $\pm 10$ | $\mu\text{A}$                  |
| $V_{GS(th)}$  | Gate threshold voltage                           | $V_{DS} = V_{GS}$ , $I_D = 50\text{ }\mu\text{A}$                          | 3    | 3.75 | 4.5      | V                              |
| $R_{DS(on)}$  | Static drain-source on-resistance                | $V_{GS} = 10\text{ V}$ , $I_D = 1\text{ A}$                                |      | 4    | 4.5      | $\Omega$                       |

**Table 6. Dynamic**

| Symbol            | Parameter                      | Test conditions  | Min. | Typ. | Max. | Unit     |
|-------------------|--------------------------------|--|------|------|------|----------|
| $C_{iss}$         | Input capacitance              | $V_{DS} = 50\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$   | -    | 235  | -    | pF       |
| $C_{oss}$         | Output capacitance             |  |      | 22   |      | pF       |
| $C_{rss}$         | Reverse transfer capacitance   |  |      | 3.5  |      | pF       |
| $C_{o(tr)}^{(1)}$ | Eq. capacitance time related   | $V_{GS} = 0$ , $V_{DS} = 0\text{ to }480\text{ V}$   | -    | 14   | -    | pF       |
| $C_{o(er)}^{(2)}$ | Eq. capacitance energy related |  |      | 10   |      | pF       |
| $R_G$             | Intrinsic gate resistance      | $f = 1\text{ MHz}$ open drain  | -    | 7    | -    | $\Omega$ |
| $Q_g$             | Total gate charge              | $V_{DD} = 480\text{ V}$ , $I_D = 1\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 18</a> ) | -    | 12   | -    | nC       |
| $Q_{gs}$          | Gate-source charge             |  |      | 1.8  |      | nC       |
| $Q_{gd}$          | Gate-drain charge              |  |      | 7.7  |      | nC       |

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

2.  $C_{oss\text{ eq}}$ . energy related is defined as a constant equivalent capacitance giving the same stored energy 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  | $V_{DD} = 300\text{ V}$ , $I_D = 1\text{ A}$ ,<br>$R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 17</a> ) | -    | 10   | -    | ns   |
| $t_r$        | Rise time           |  | -    | 8.5  | -    | ns   |
| $t_{d(off)}$ | Turn-off-delay time |  | -    | 23.5 | -    | ns   |
| $t_f$        | Fall time           |  | -    | 21   | -    | ns   |

**Table 8. Source drain diode**

| Symbol          | Parameter                     | Test conditions  | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|--|------|------|------|------|
| $I_{SD}$        | Source-drain current          |  | -    |      | 2    | A    |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |  | -    |      | 8    | A    |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 2\text{ A}$ , $V_{GS} = 0$   | -    |      | 1.5  | V    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 2\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 60\text{ V}$ (see <a href="#">Figure 22</a> )  | -    | 200  |      | ns   |
| $Q_{rr}$        | Reverse recovery charge       |  | -    | 800  |      | nC   |
| $I_{RRM}$       | Reverse recovery current      |  | -    | 8    |      | A    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 2\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 22</a> ) | -    | 230  |      | ns   |
| $Q_{rr}$        | Reverse recovery charge       |  | -    | 950  |      | nC   |
| $I_{RRM}$       | Reverse recovery current      |  | -    | 8.5  |      | A    |

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

**Table 9. Gate-source Zener diode**

| Symbol           | Parameter                     | Test conditions                         | Min. | Typ. | Max. | Unit |
|------------------|-------------------------------|---|------|------|------|------|
| $BV_{GSO}^{(1)}$ | Gate-source breakdown voltage | $I_{gs} = \pm 1\text{ mA}$ (open drain) | 30   | -    | -    | V    |

1. The built-in back-to-back Zener diodes have specifically been designed to enhance not only the device's ESD capability, but also to make them safely absorb possible voltage transients that may occasionally be applied from gate to source. In this respect the Zener voltage is appropriate to achieve an efficient and cost-effective intervention to protect the device's integrity. These integrated Zener diodes thus avoid the usage of external components.

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for DPAK and IPAК

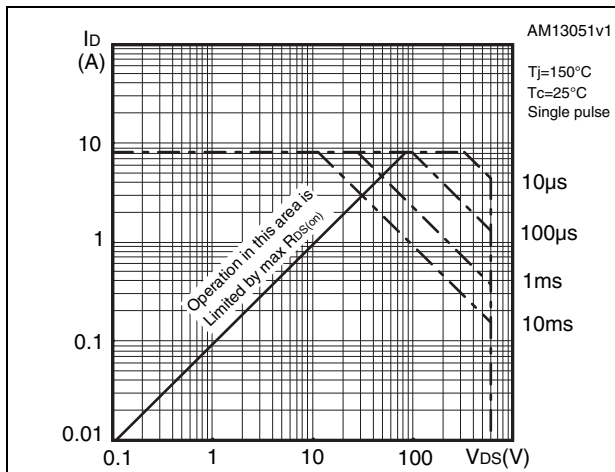


Figure 3. Thermal impedance for DPAK and IPAК

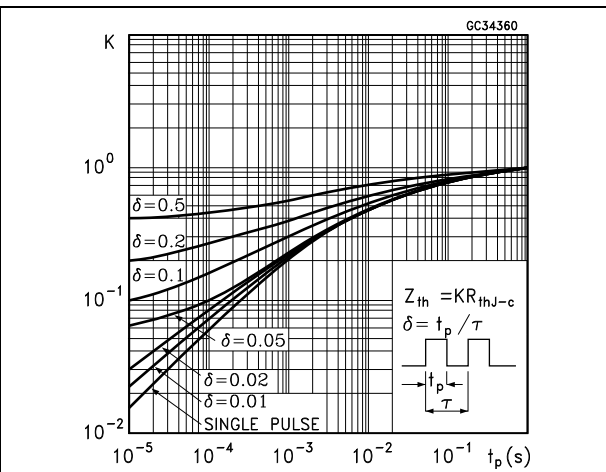


Figure 4. Safe operating area for TO-220FP

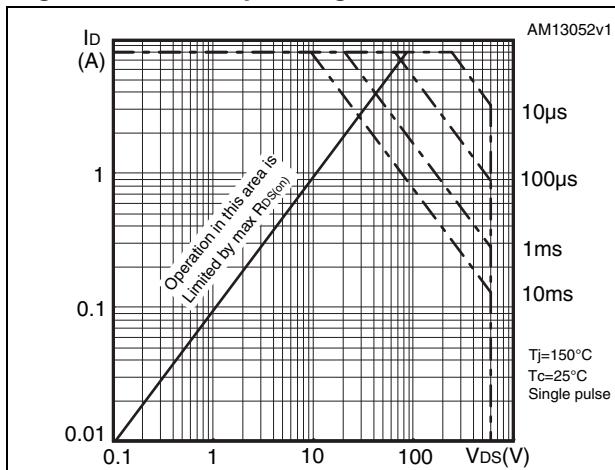


Figure 5. Thermal impedance for TO-220FP

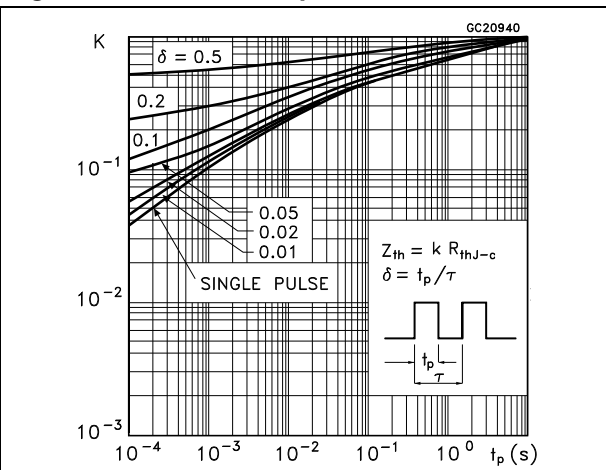


Figure 6. Output characteristics

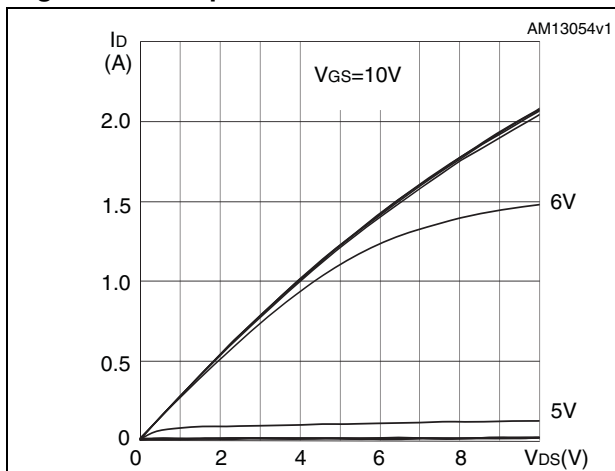
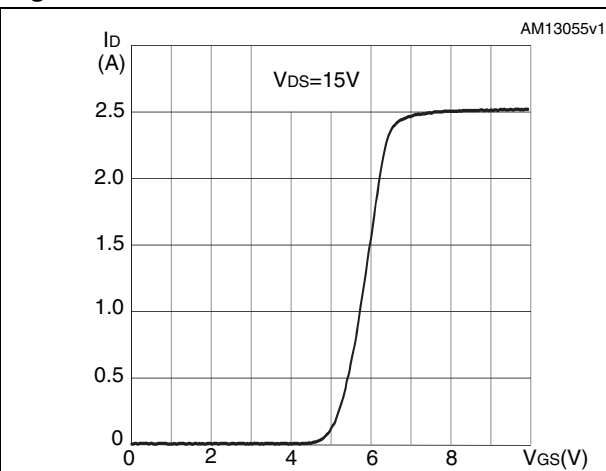
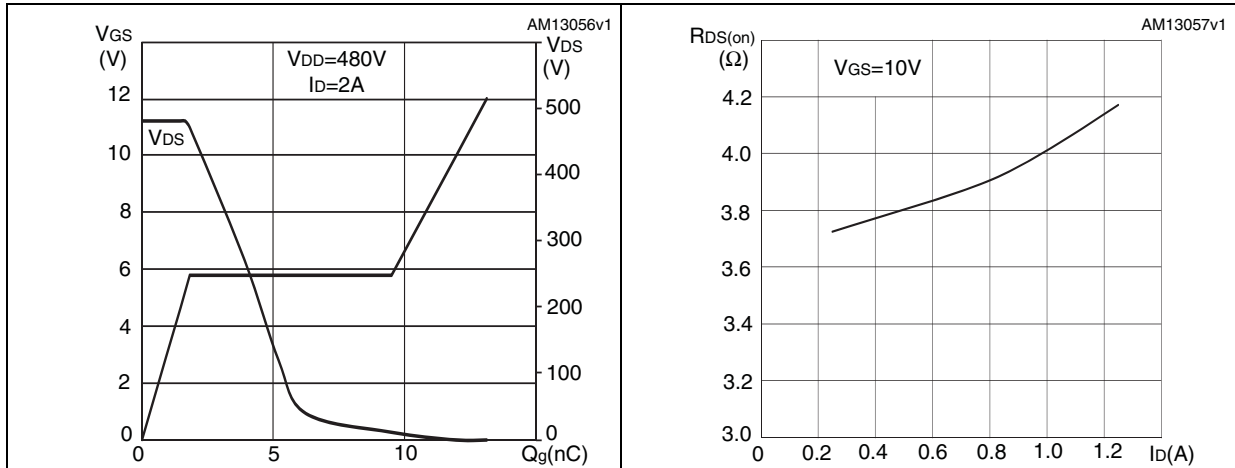


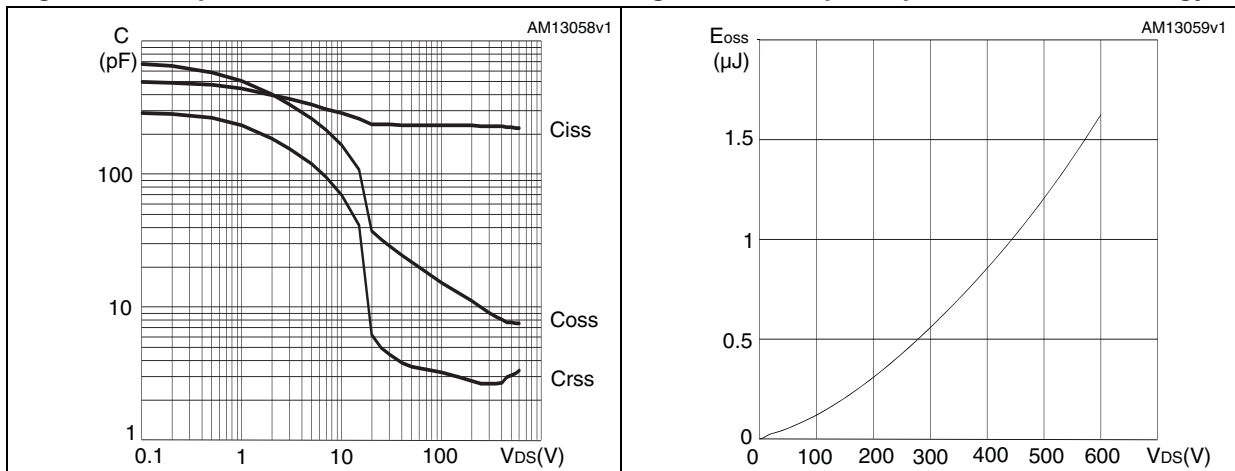
Figure 7. Transfer characteristics



**Figure 8. Gate charge vs gate-source voltage** **Figure 9. Static drain-source on-resistance**



**Figure 10. Capacitance variations** **Figure 11. Output capacitance stored energy**



**Figure 12. Normalized gate threshold voltage vs temperature** **Figure 13. Normalized on-resistance vs temperature**

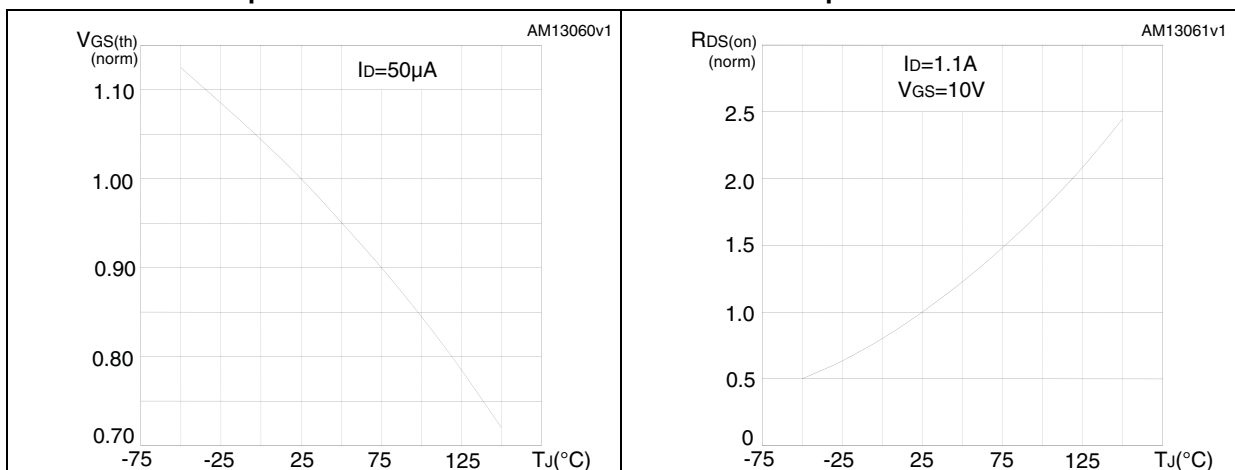


Figure 14. Normalized  $BV_{DSS}$  vs temperature

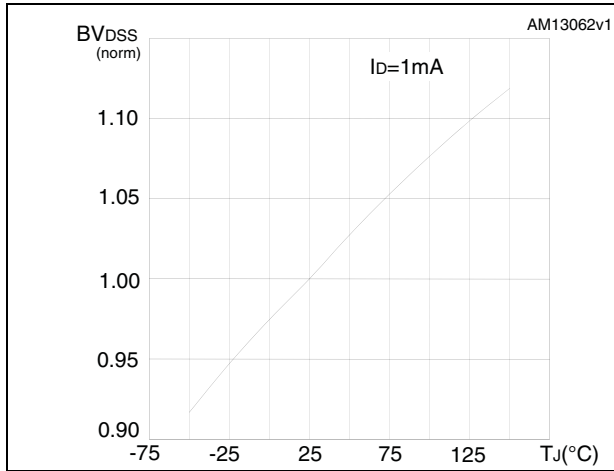


Figure 15. Source-drain diode forward characteristics

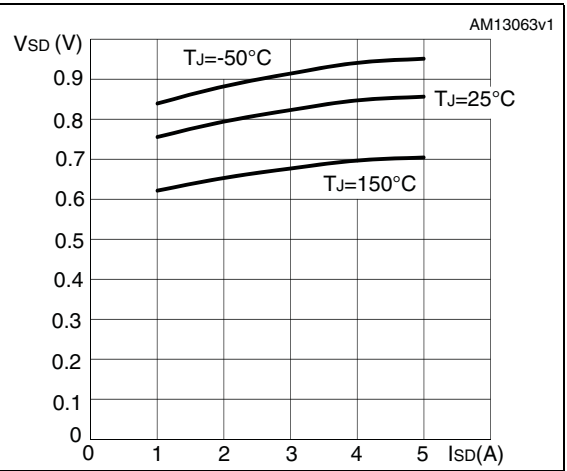
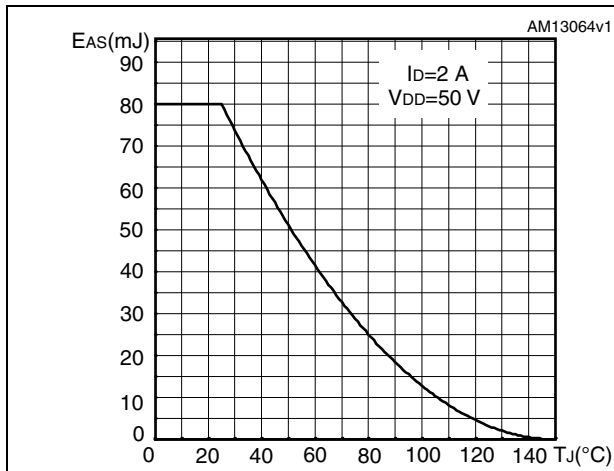


Figure 16. Maximum avalanche energy vs temperature





### 3 Test circuits

**Figure 17. Switching times test circuit for resistive load**



AM01468v1

**Figure 18. Gate charge test circuit**



AM01469v1

**Figure 19. Test circuit for inductive load switching and diode recovery times**



AM01470v1

**Figure 20. Unclamped Inductive load test circuit**



AM01471v1

**Figure 21. Unclamped inductive waveform**



AM01472v1

**Figure 22. Switching time waveform**



AM01473v1

## 4 Package mechanical data

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 is an ST trademark.

Table 10. DPAK (TO-252) 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    |      |       |
| L1   |      | 2.80 |       |
| L2   |      | 0.80 |       |
| L4   | 0.60 |      | 1     |
| R    |      | 0.20 |       |
| V2   | 0°   |      | 8°    |

Figure 23. DPAK (TO-252) drawing

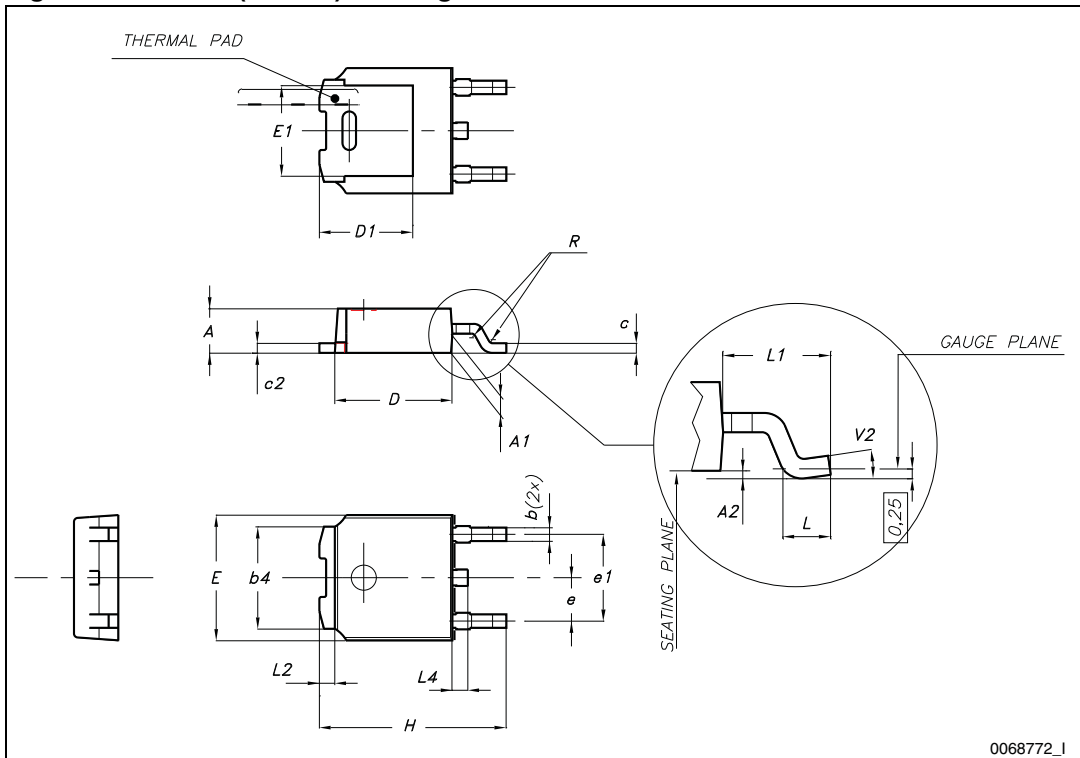
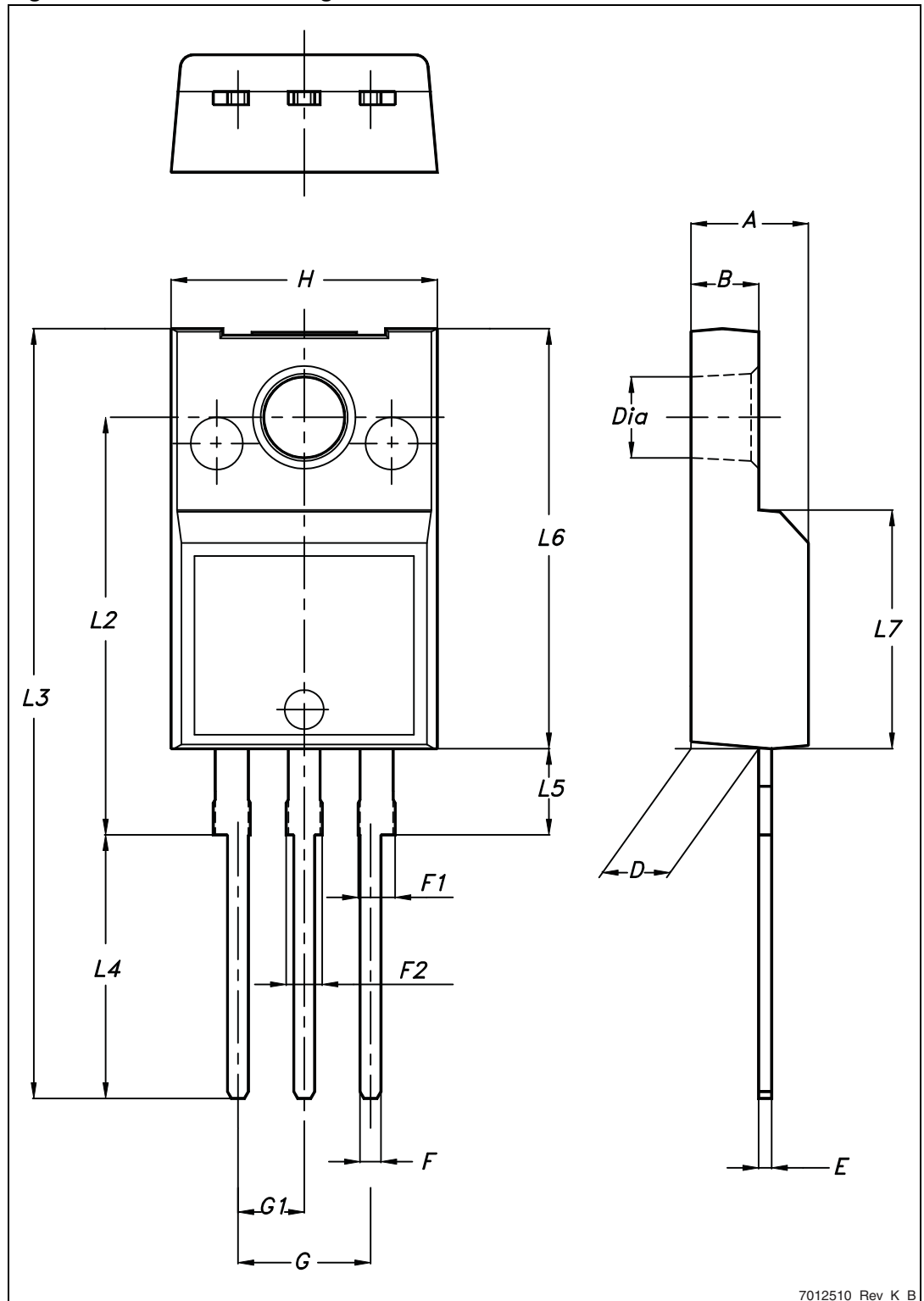


Table 11. TO-220FP mechanical data

| Dim. | mm   |      |      |
|------|------|------|------|
|      | Min. | Typ. | Max. |
| A    | 4.4  |      | 4.6  |
| B    | 2.5  |      | 2.7  |
| D    | 2.5  |      | 2.75 |
| E    | 0.45 |      | 0.7  |
| F    | 0.75 |      | 1    |
| F1   | 1.15 |      | 1.70 |
| F2   | 1.15 |      | 1.70 |
| G    | 4.95 |      | 5.2  |
| G1   | 2.4  |      | 2.7  |
| H    | 10   |      | 10.4 |
| L2   |      | 16   |      |
| L3   | 28.6 |      | 30.6 |
| L4   | 9.8  |      | 10.6 |
| L5   | 2.9  |      | 3.6  |
| L6   | 15.9 |      | 16.4 |
| L7   | 9    |      | 9.3  |
| Dia  | 3    |      | 3.2  |

Figure 24. TO-220FP drawing

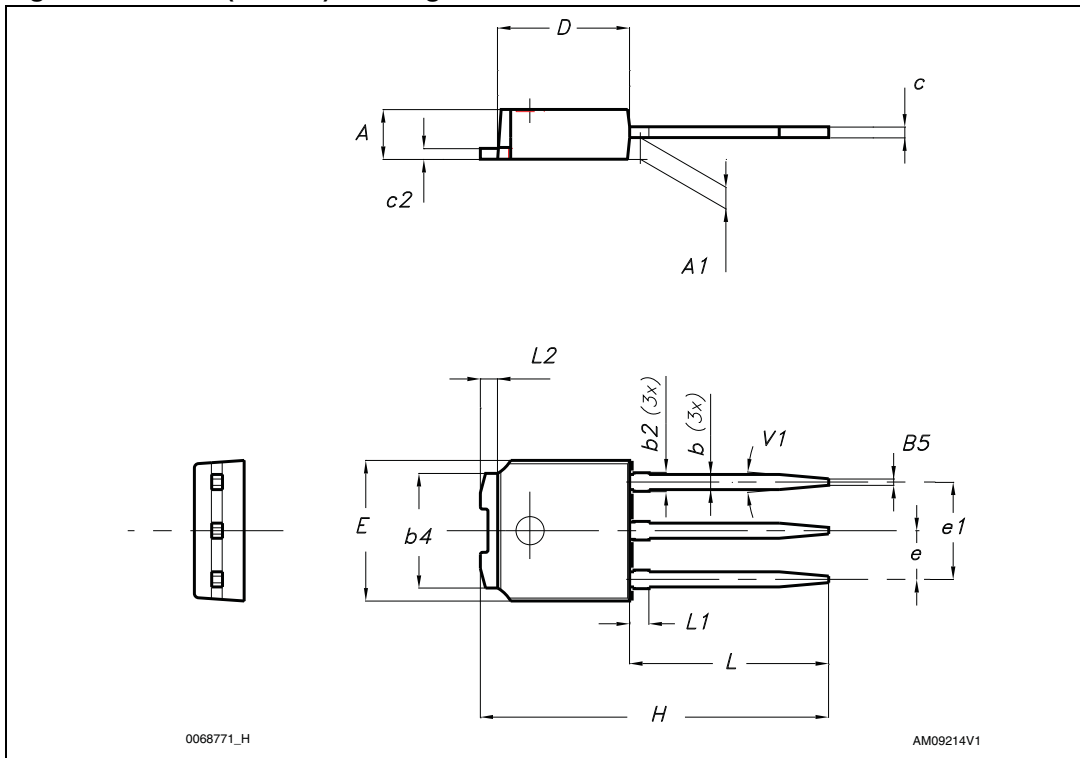


7012510\_Rev\_K\_B

Table 12. IPAK (TO-251) mechanical data

| DIM. | mm.  |       |      |
|------|------|-------|------|
|      | min. | typ   | max. |
| A    | 2.20 |       | 2.40 |
| A1   | 0.90 |       | 1.10 |
| b    | 0.64 |       | 0.90 |
| b2   |      |       | 0.95 |
| b4   | 5.20 |       | 5.40 |
| B5   |      | 0.3   |      |
| c    | 0.45 |       | 0.60 |
| c2   | 0.48 |       | 0.60 |
| D    | 6.00 |       | 6.20 |
| E    | 6.40 |       | 6.60 |
| e    |      | 2.28  |      |
| e1   | 4.40 |       | 4.60 |
| H    |      | 16.10 |      |
| L    | 9.00 |       | 9.40 |
| L1   | 0.80 |       | 1.20 |
| L2   |      | 0.80  | 1.00 |
| V1   |      | 10 °  |      |

Figure 25. IPAK (TO-251) drawing



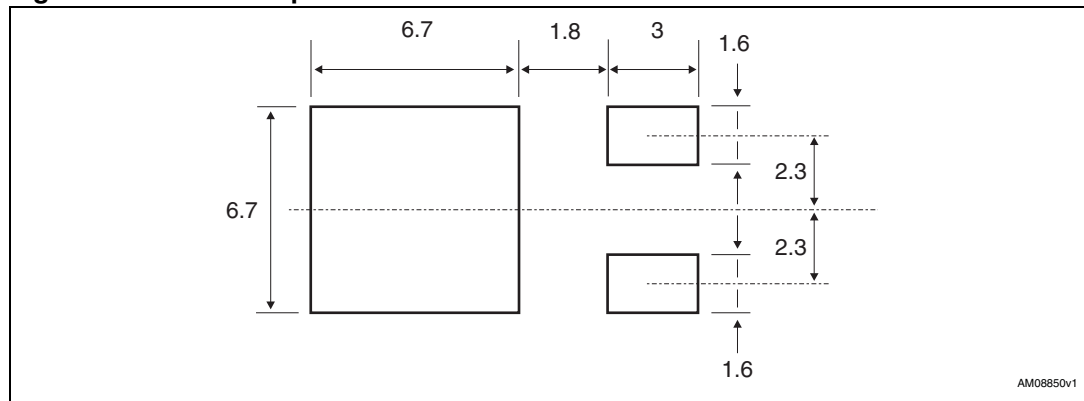


## 5 Packaging mechanical data

Table 13. 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 26. DPAK footprint<sup>(a)</sup>



a. All dimension are in millimeters

Figure 27. Tape for DPAK (TO-252)

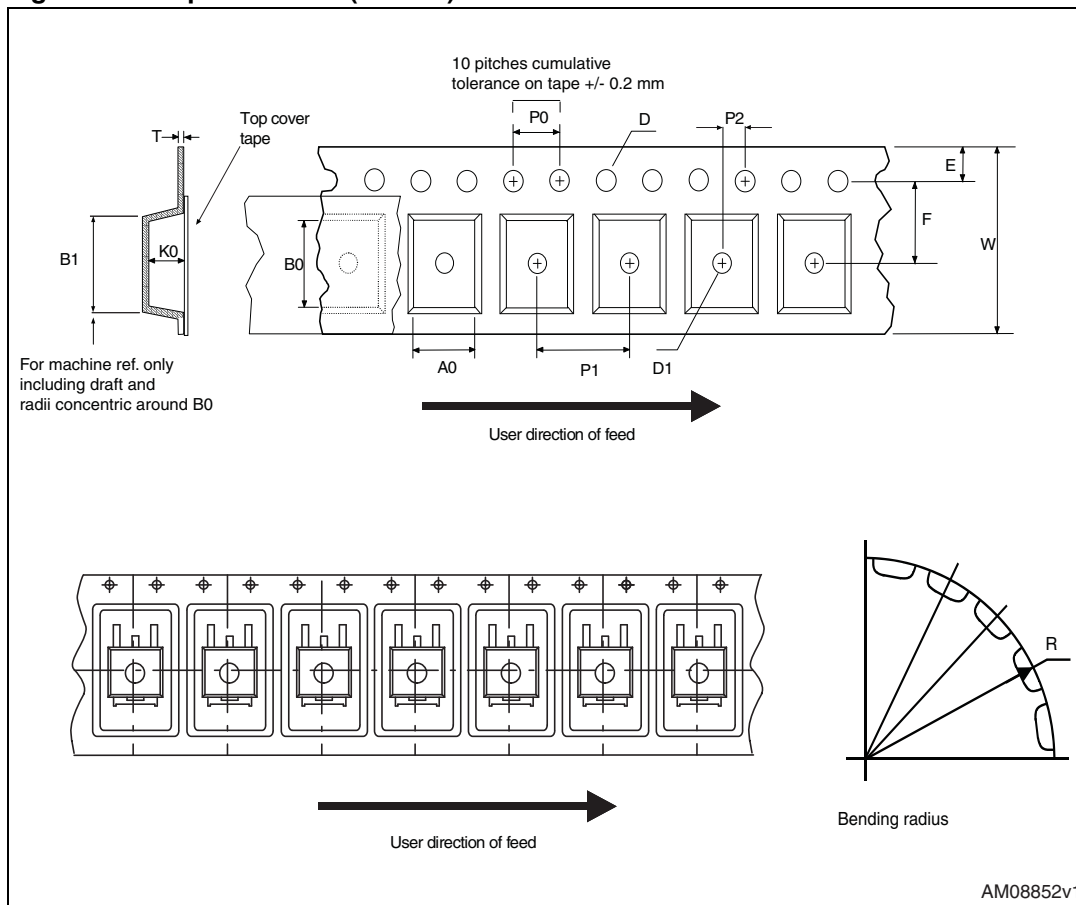
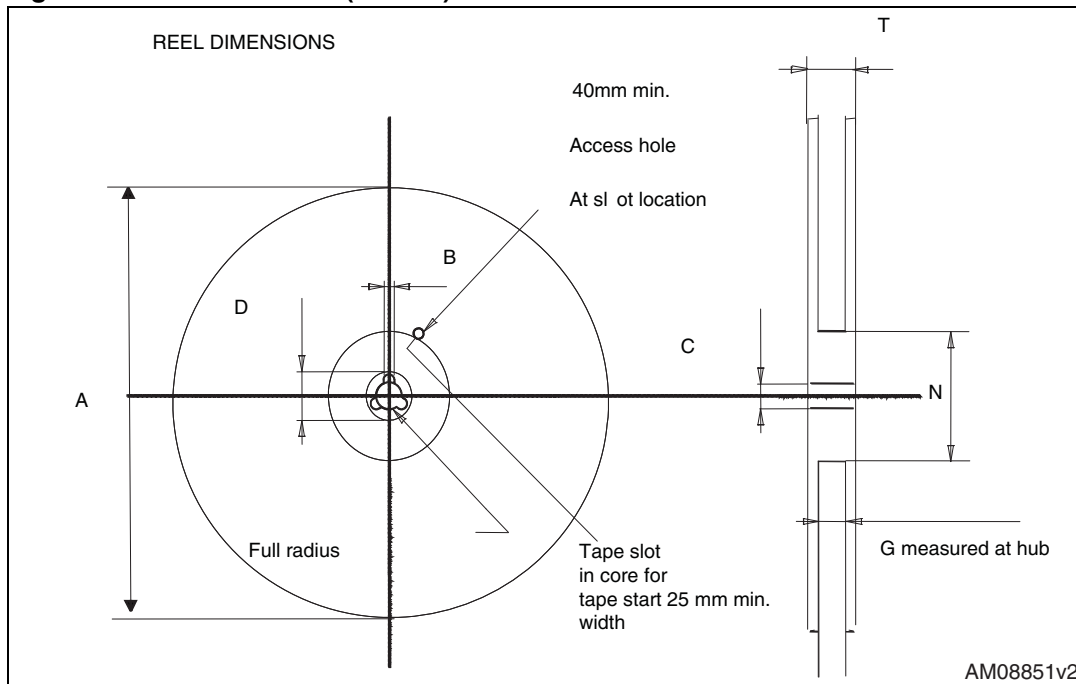


Figure 28. Reel for DPAK (TO-252)



## 6 Revision history

Table 14. Document revision history

| Date        | Revision | Changes        |
|-------------|----------|----------------|
| 05-Jul-2012 | 1        | First release. |

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