



# STB11N52K3, STF11N52K3 STP11N52K3

N-channel 525 V, 0.41  $\Omega$ , 10 A SuperMESH3™ Power MOSFET  
in D<sup>2</sup>PAK, TO-220FP and TO-220 packages

Datasheet — production data

## Features

| Order codes | V <sub>DSS</sub> | R <sub>DS(on)</sub><br>max. | I <sub>D</sub> | P <sub>w</sub> |
|-------------|------------------|-----------------------------|----------------|----------------|
| STB11N52K3  | 525 V            | < 0.51 $\Omega$             | 10 A           | 125 W          |
| STF11N52K3  |                  |                             |                | 30 W           |
| STP11N52K3  |                  |                             |                | 125 W          |

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

## Applications

- Switching applications

## Description

These devices are N-channel Power MOSFETs made using the SuperMESH3™ technology that is obtained via improvements applied to STMicroelectronics' SuperMESH™ technology combined with a new optimized vertical structure. The resulting transistor has an extremely low on resistance, superior dynamic performance and high avalanche capability, making it especially suitable for the most demanding applications.

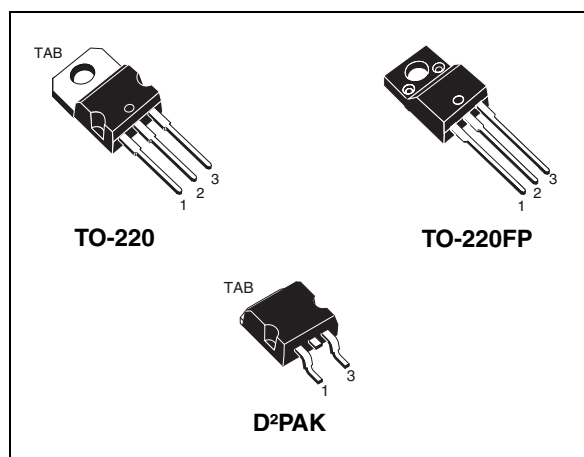


Figure 1. Internal schematic diagram

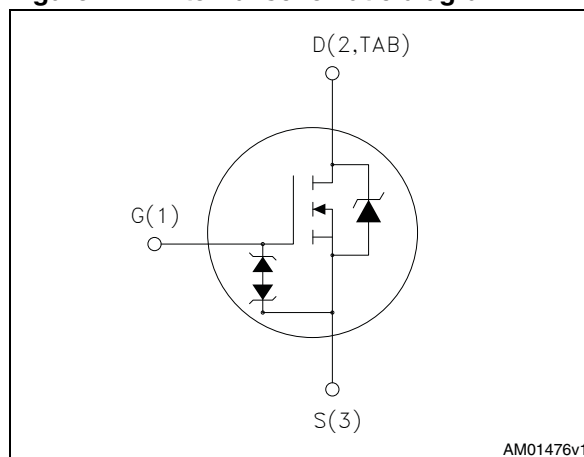


Table 1. Device summary

| Order codes                            | Marking | Packages                                 | Packaging                     |
|----------------------------------------|---------|------------------------------------------|-------------------------------|
| STB11N52K3<br>STF11N52K3<br>STP11N52K3 | 11N52K3 | D <sup>2</sup> PAK<br>TO-220FP<br>TO-220 | Tape and reel<br>Tube<br>Tube |

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol                  | Parameter                                                                                                                    | Value                      |                   | Unit               |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------|----------------------------|-------------------|--------------------|
|                         |                                                                                                                              | TO-220, D <sup>2</sup> PAK | TO-220FP          |                    |
| $V_{DS}$                | Drain- source voltage                                                                                                        | 525                        |                   | V                  |
| $V_{GS}$                | Gate- source voltage                                                                                                         | $\pm 30$                   |                   | V                  |
| $I_D$                   | Drain current (continuous) at $T_C = 25\text{ }^{\circ}\text{C}$                                                             | 10                         | 10 <sup>(1)</sup> | A                  |
| $I_D$                   | Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$                                                            | 6                          | 6 <sup>(1)</sup>  | A                  |
| $I_{DM}$ <sup>(2)</sup> | Drain current (pulsed)                                                                                                       | 40                         | 40 <sup>(1)</sup> | A                  |
| $P_{TOT}$               | Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$                                                                      | 125                        | 30                | W                  |
| $I_{AR}$                | Avalanche current, repetitive or not-repetitive (pulse width limited by $T_J$ max)                                           | 5                          |                   | A                  |
| $E_{AS}$                | Single pulse avalanche energy (starting $T_J = 25\text{ }^{\circ}\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ )       | 170                        |                   | mJ                 |
| $V_{ESD(G-S)}$          | Gate source ESD(HBM-C = 100 pF, R = 1.5 k $\Omega$ )                                                                         | 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 (t = 1 s; $T_C = 25\text{ }^{\circ}\text{C}$ ) | 2500                       |                   |                    |
| $T_J$<br>$T_{stg}$      | Operating junction temperature<br>Storage temperature                                                                        | - 55 to 150                |                   | $^{\circ}\text{C}$ |

1. Limited only by maximum temperature allowed
2. Pulse width limited by safe operating area
3.  $I_{SD} \leq 10\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$

**Table 3. Thermal data**

| Symbol         | Parameter                                      | Value  |          |                    | Unit                        |
|----------------|------------------------------------------------|--------|----------|--------------------|-----------------------------|
|                |                                                | TO-220 | TO-220FP | D <sup>2</sup> PAK |                             |
| $R_{thj-case}$ | Thermal resistance junction-case max           | 1      | 4.17     | 1                  | $^{\circ}\text{C}/\text{W}$ |
| $R_{thj-amb}$  | Thermal resistance junction-amb max            | 62.50  |          |                    | $^{\circ}\text{C}/\text{W}$ |
| $R_{thj-pcb}$  | Thermal resistance junction-pcb max            | 30     |          |                    | $^{\circ}\text{C}/\text{W}$ |
| $T_J$          | Maximum lead temperature for soldering purpose | 300    |          |                    | $^{\circ}\text{C}/\text{W}$ |

## 2 Electrical characteristics

(T<sub>case</sub> = 25 °C unless otherwise specified)

**Table 4. On /off states**

| Symbol        | Parameter                                        | Test conditions                                                               | Min. | Typ. | Max.     | Unit                           |
|---------------|--------------------------------------------------|-------------------------------------------------------------------------------|------|------|----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage                   | $I_D = 1 \text{ mA}$ , $V_{GS} = 0$                                           | 525  |      |          | V                              |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = 525 \text{ V}$<br>$V_{DS} = 525 \text{ V}$ , $T_C = 125 \text{ °C}$ |      |      | 1<br>50  | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$     | Gate-body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 20 \text{ V}$ ; $V_{DS} = 0$                                    |      |      | $\pm 10$ | $\mu\text{A}$                  |
| $V_{GS(th)}$  | 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                | $V_{GS} = 10 \text{ V}$ , $I_D = 5 \text{ A}$                                 |      | 0.41 | 0.51     | $\Omega$                       |

**Table 5. Dynamic**

| Symbol                              | Parameter                                                               | Test conditions                                                                                 | Min. | Typ.              | Max. | Unit           |
|-------------------------------------|-------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|------|-------------------|------|----------------|
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$ | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{DS} = 50 \text{ V}$ , $f = 1 \text{ MHz}$ ,<br>$V_{GS} = 0$                                 | -    | 1400<br>110<br>22 | -    | pF<br>pF<br>pF |
| $C_{oss \text{ eq.}}^{(1)}$         | Equivalent output capacitance                                           | $V_{DS} = 0$ to $420 \text{ V}$ , $V_{GS} = 0$                                                  | -    | 83                | -    | pF             |
| $R_g$                               | Gate input resistance                                                   | $f = 1 \text{ MHz}$ open drain                                                                  | 1    | 3                 | 7    | $\Omega$       |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$       | Total gate charge<br>Gate-source charge<br>Gate-drain charge            | $V_{DD} = 420 \text{ V}$ , $I_D = 10 \text{ A}$ ,<br>$V_{GS} = 10 \text{ V}$<br>(see Figure 18) | -    | 51<br>8<br>32     | -    | nC<br>nC<br>nC |

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%  $V_{DS}$

**Table 6. Switching times**

| Symbol                                        | Parameter                                                           | Test conditions                                                                                                             | Min. | Typ.                 | Max | Unit                 |
|-----------------------------------------------|---------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|------|----------------------|-----|----------------------|
| $t_{d(on)}$<br>$t_r$<br>$t_{d(off)}$<br>$t_f$ | Turn-on delay time<br>Rise time<br>Turn-off-delay time<br>Fall time | $V_{DD} = 210 \text{ V}$ , $I_D = 5 \text{ A}$ ,<br>$R_G = 4.7 \text{ }\Omega$ , $V_{GS} = 10 \text{ V}$<br>(see Figure 17) | -    | 7<br>18<br>281<br>42 | -   | ns<br>ns<br>ns<br>ns |

**Table 7. 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) |                                                             | -    |      | 40  | A    |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 10\text{ A}$ , $V_{GS} = 0$                       | -    |      | 1.5 | V    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 10\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ | -    | 270  |     | ns   |
| $Q_{rr}$        | Reverse recovery charge       | $V_{DD} = 60\text{ V}$                                      | -    | 2700 |     | nC   |
| $I_{RRM}$       | Reverse recovery current      | (see Figure 19)                                             |      | 20   |     | A    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 10\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ | -    | 320  |     | ns   |
| $Q_{rr}$        | Reverse recovery charge       | $V_{DD} = 60\text{ V}$ $T_J = 150\text{ }^\circ\text{C}$    | -    | 3400 |     | nC   |
| $I_{RRM}$       | Reverse recovery current      | (see Figure 19)                                             |      | 22   |     | A    |

1. Pulse width limited by safe operating area

2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

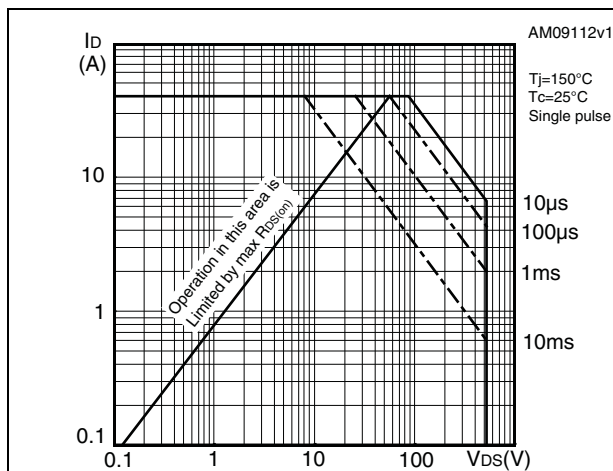
**Table 8. Gate-source Zener diode**

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

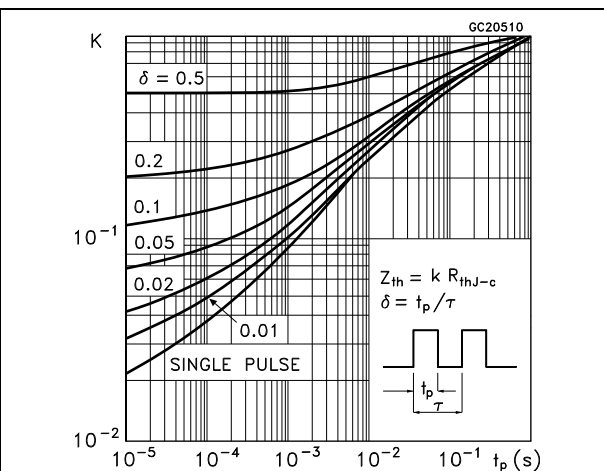
The built-in back-to-back Zener diodes have specifically been designed to enhance not only the device's ESD capability, but also to make them safely absorb possible voltage transients that may occasionally be applied from gate to source. In this respect the Zener voltage is appropriate to achieve an 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)

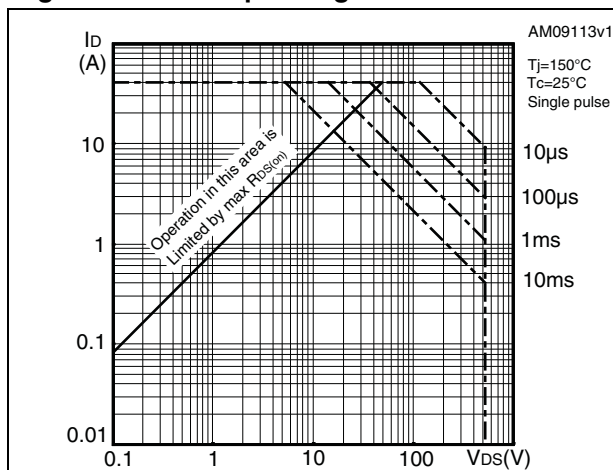
**Figure 2. Safe operating area for TO-220, D<sup>2</sup>PAK**



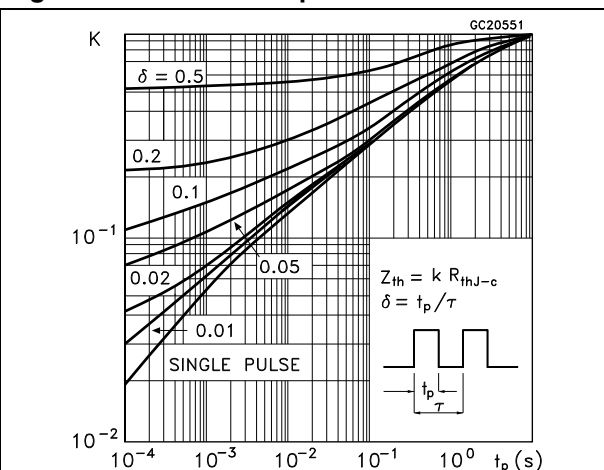
**Figure 3. Thermal impedance for TO-220, D<sup>2</sup>PAK**



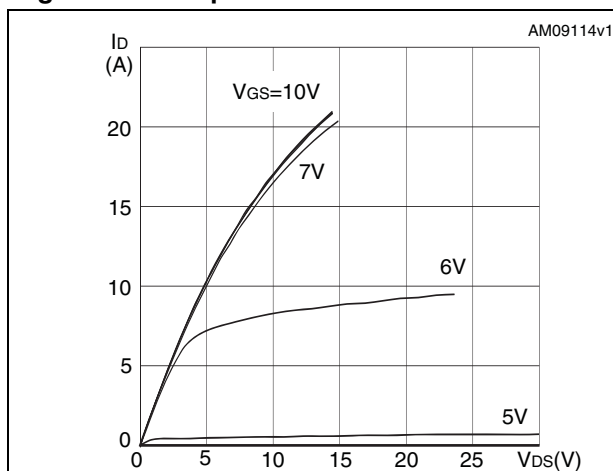
**Figure 4. Safe operating area for TO-220FP**



**Figure 5. Thermal impedance for TO-220FP**



**Figure 6. Output characteristics**



**Figure 7. Transfer characteristics**

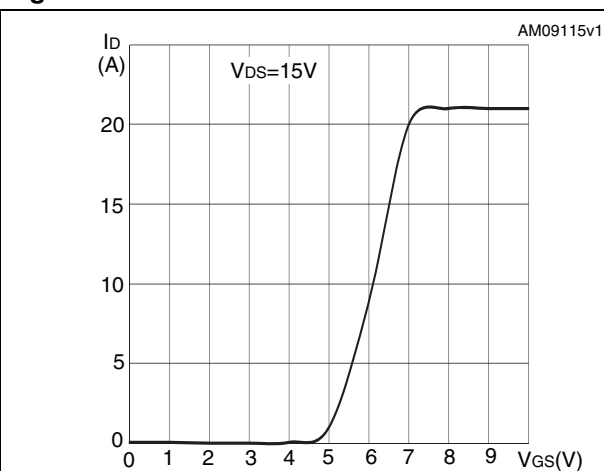


Figure 8. Gate charge vs gate-source voltage

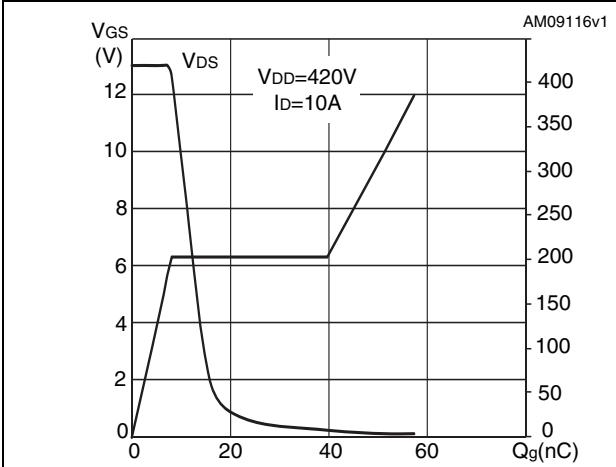


Figure 9. Static drain-source on resistance

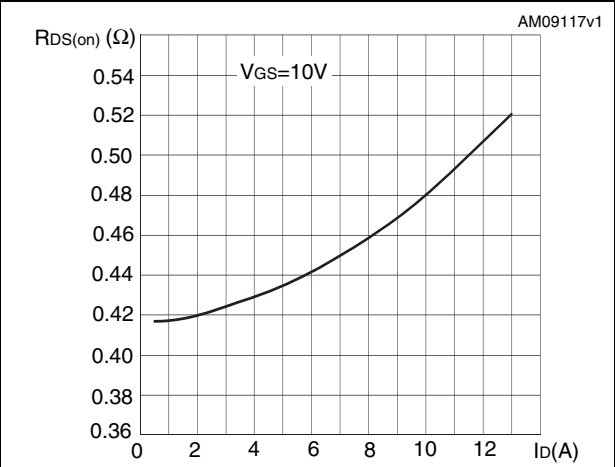


Figure 10. Capacitance variations

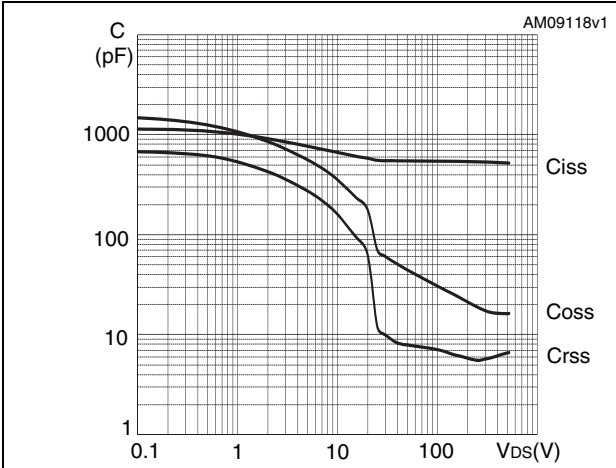


Figure 11. Output capacitance stored energy

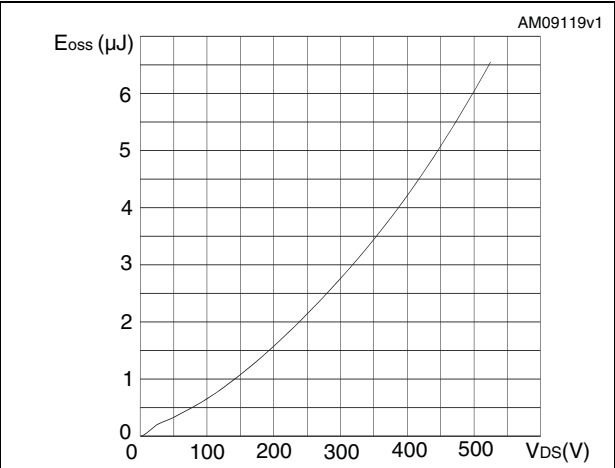


Figure 12. Normalized gate threshold voltage vs temperature

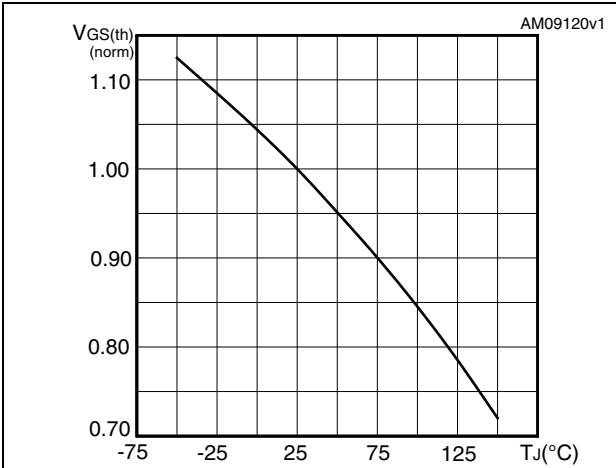


Figure 13. Normalized on resistance vs temperature

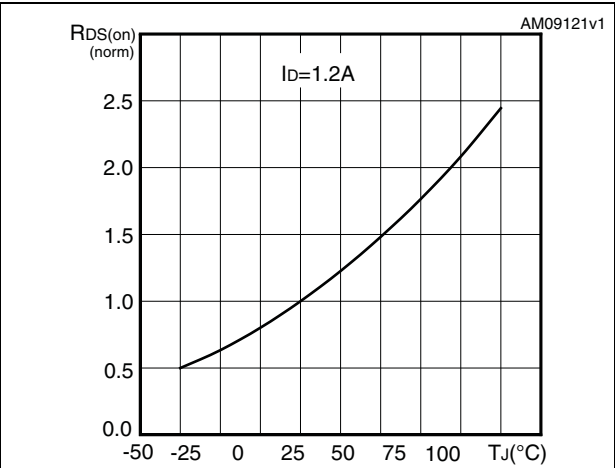


Figure 14. Source-drain diode forward characteristics

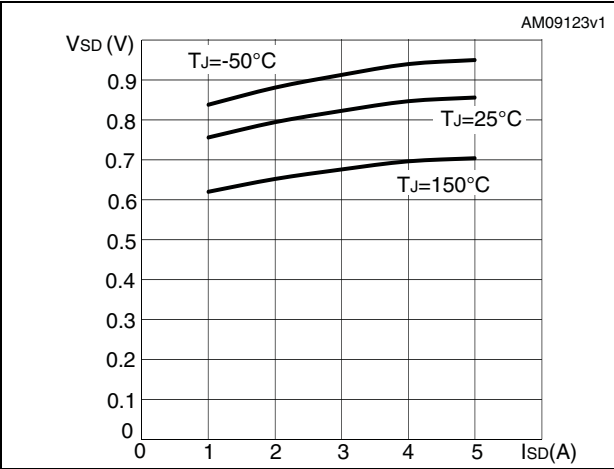


Figure 15. Normalized  $B_{VDSS}$  vs temperature

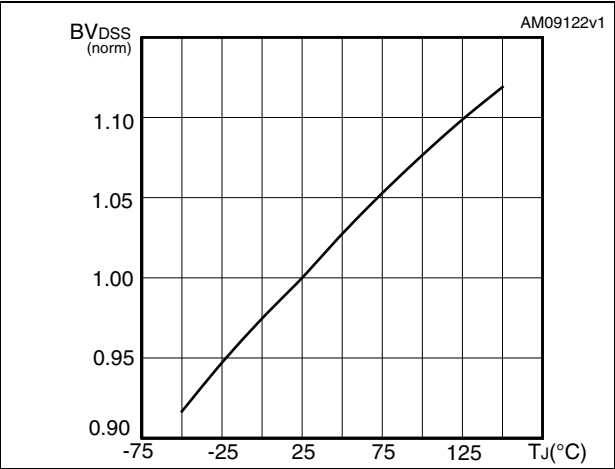
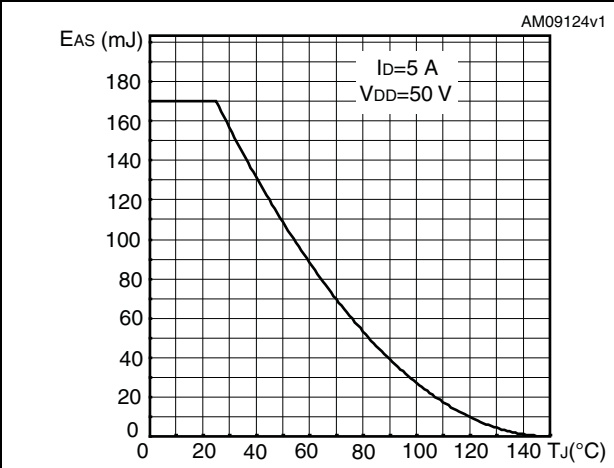
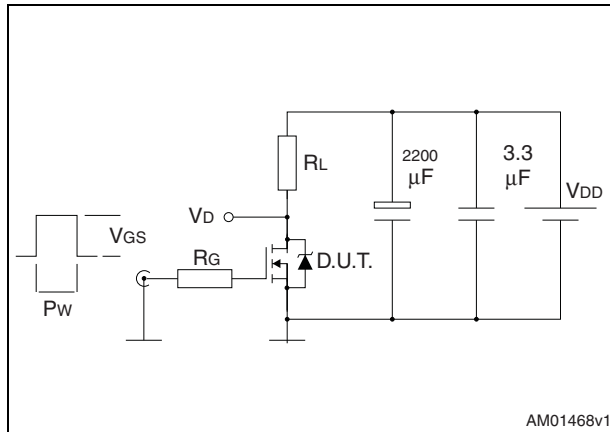


Figure 16. Maximum avalanche energy vs starting  $T_J$

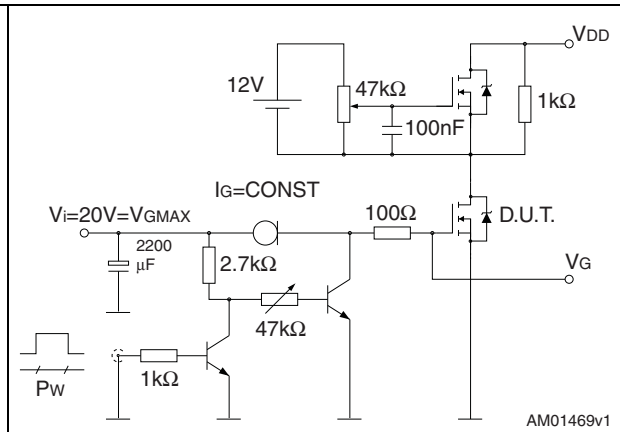


### 3 Test circuits

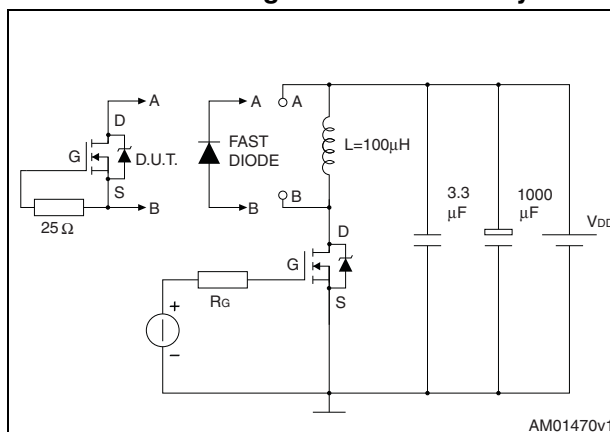
**Figure 17. Switching times test circuit for resistive load**



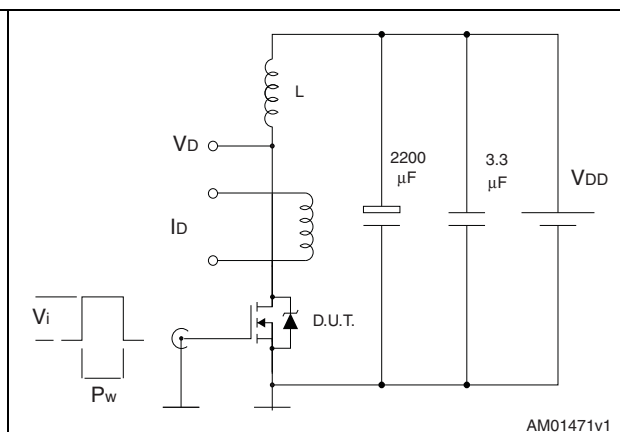
**Figure 18. Gate charge test circuit**



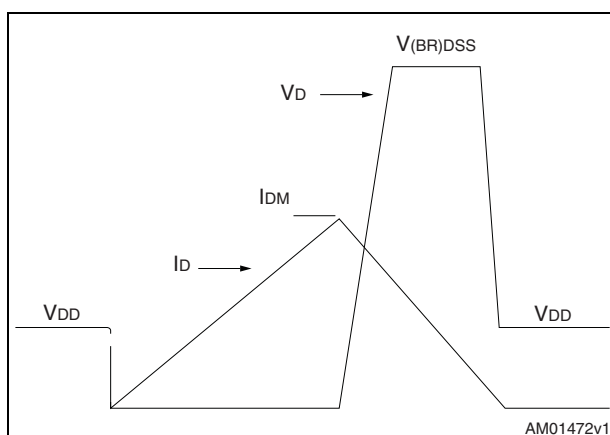
**Figure 19. Test circuit for inductive load switching and diode recovery times**



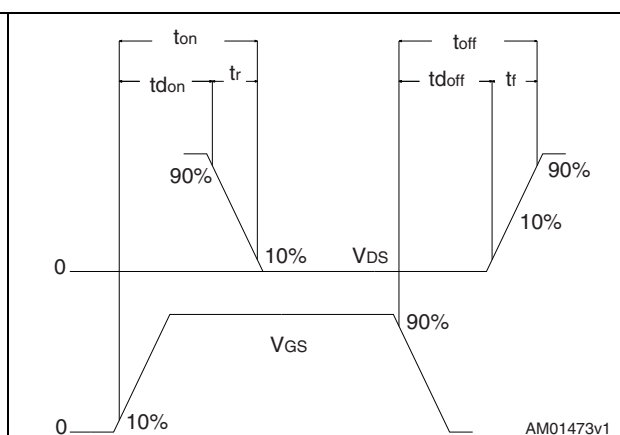
**Figure 20. Unclamped inductive load test circuit**



**Figure 21. Unclamped inductive waveform**



**Figure 22. Switching time waveform**



## 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 9. 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 23. TO-220FP drawing

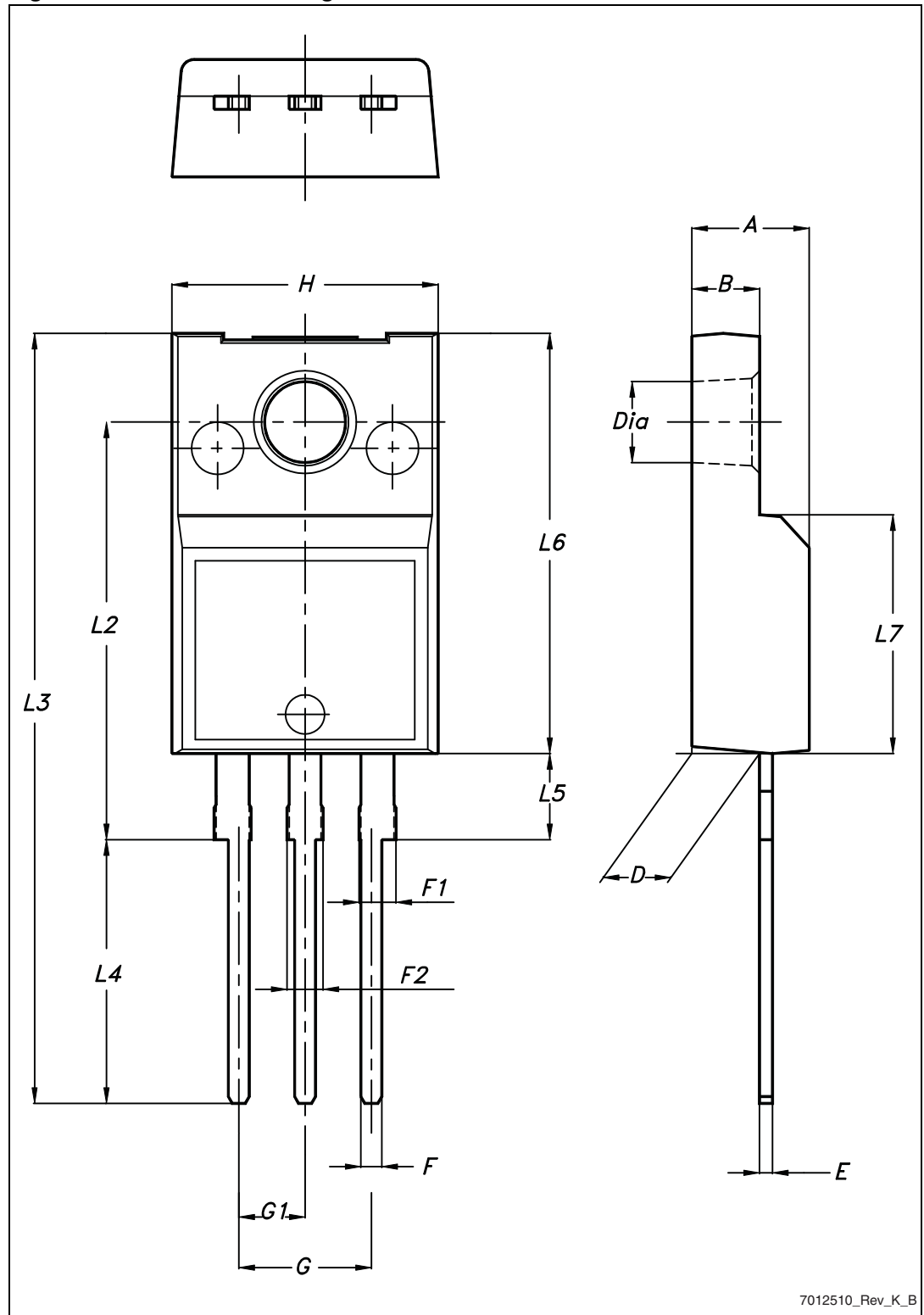


Table 10. TO-220 type A mechanical data

| Dim. | mm    |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.40  |       | 4.60  |
| b    | 0.61  |       | 0.88  |
| b1   | 1.14  |       | 1.70  |
| c    | 0.48  |       | 0.70  |
| D    | 15.25 |       | 15.75 |
| D1   |       | 1.27  |       |
| E    | 10    |       | 10.40 |
| e    | 2.40  |       | 2.70  |
| e1   | 4.95  |       | 5.15  |
| F    | 1.23  |       | 1.32  |
| H1   | 6.20  |       | 6.60  |
| J1   | 2.40  |       | 2.72  |
| L    | 13    |       | 14    |
| L1   | 3.50  |       | 3.93  |
| L20  |       | 16.40 |       |
| L30  |       | 28.90 |       |
| ØP   | 3.75  |       | 3.85  |
| Q    | 2.65  |       | 2.95  |

Figure 24. TO-220 type A drawing

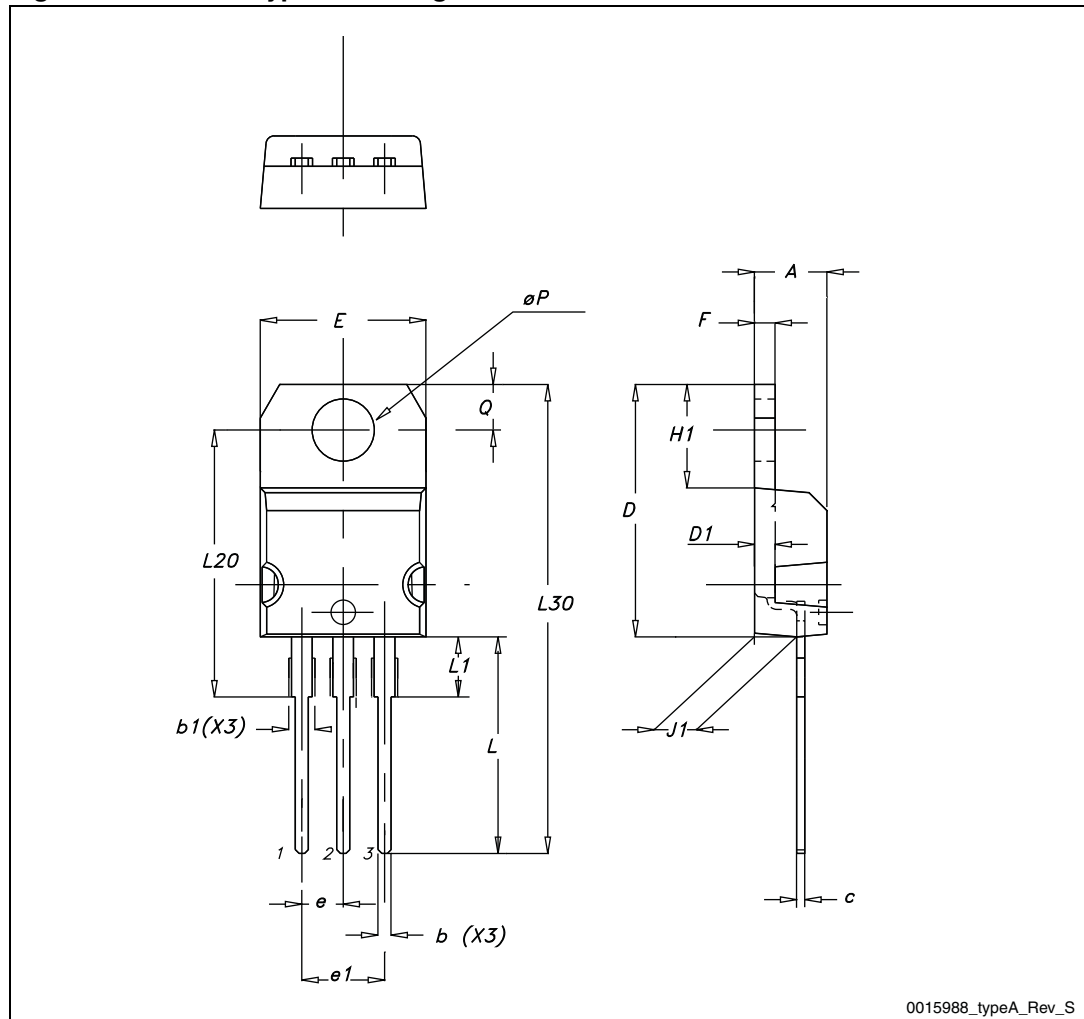
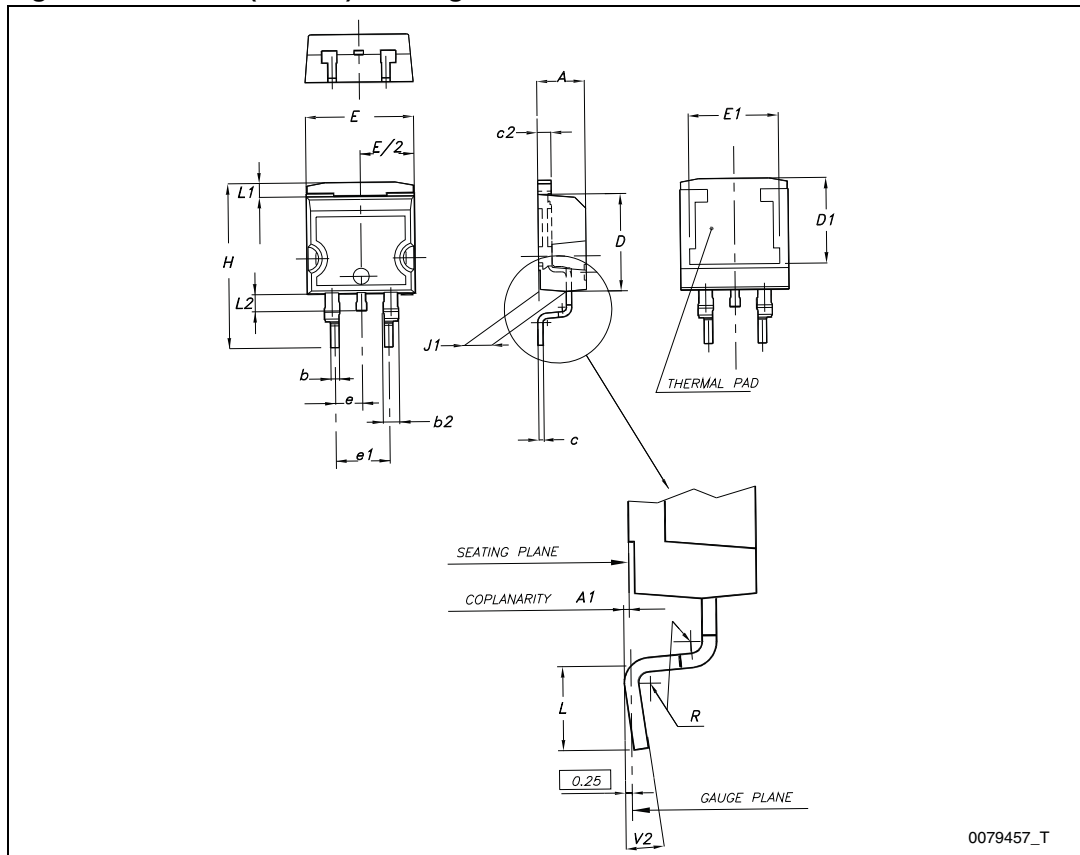
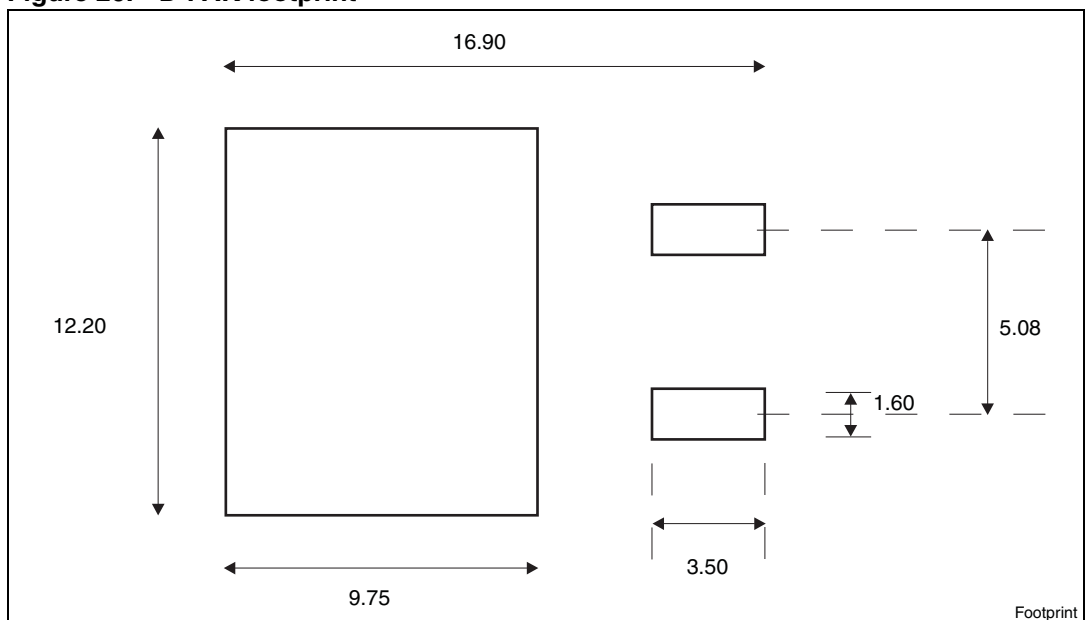


Table 11. D<sup>2</sup>PAK (TO-263) mechanical data

| 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 |      |       |
| E    | 10   |      | 10.40 |
| E1   | 8.50 |      |       |
| 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°    |

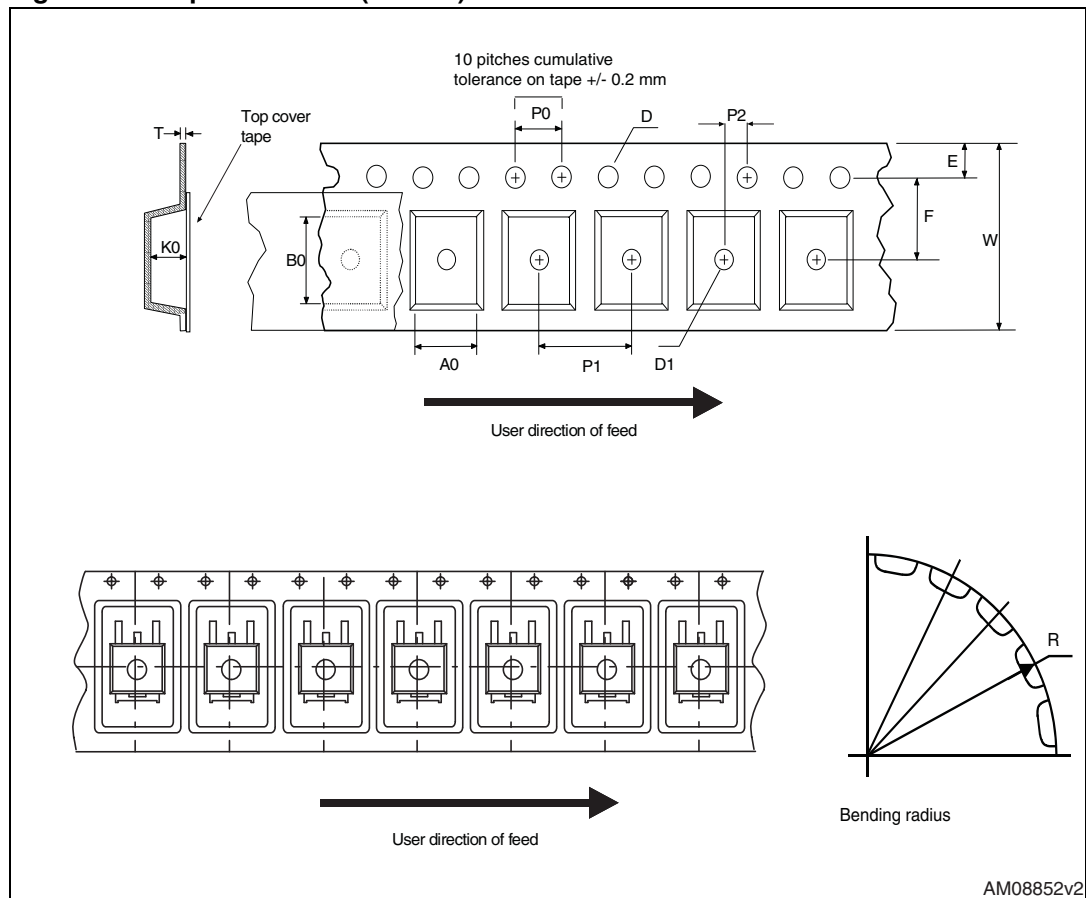
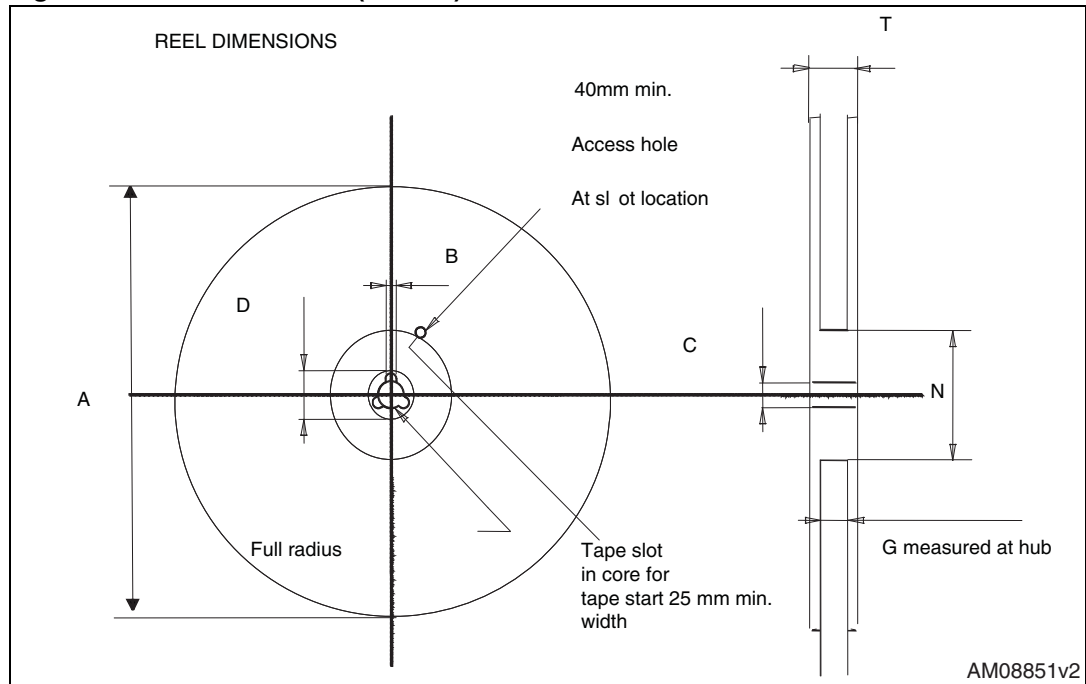
Figure 25. D<sup>2</sup>PAK (TO-263) drawingFigure 26. D<sup>2</sup>PAK footprint<sup>(a)</sup>

a. All dimension are in millimeters

## 5 Package mechanical data

Table 12. 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 |          |      |      |

Figure 27. Tape for D<sup>2</sup>PAK (TO-263)Figure 28. Reel for D<sup>2</sup>PAK (TO-263)

## 6 Revision history

**Table 13. Document revision history**

| Date        | Revision | Changes                                                                                                                             |
|-------------|----------|-------------------------------------------------------------------------------------------------------------------------------------|
| 20-May-2011 | 1        | First release.                                                                                                                      |
| 27-Mar-2012 | 2        | Inserted max and min. values for $R_G$ in <a href="#">Table 5</a> .<br>Updated <a href="#">Section 4: Package mechanical data</a> . |

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