



# STD7N52DK3 STF7N52DK3, STP7N52DK3

N-channel 525 V, 0.95  $\Omega$ , 6 A, DPAK, TO-220FP, TO-220  
SuperFREDmesh3™ Power MOSFET

## Features

| Order codes | V <sub>DSS</sub> | R <sub>DS(on)</sub><br>max. | I <sub>D</sub>     | P <sub>w</sub> |
|-------------|------------------|-----------------------------|--------------------|----------------|
| STD7N52DK3  | 525 V            | < 1.15 $\Omega$             | 6 A                | 90 W           |
| STF7N52DK3  |                  |                             | 6 A <sup>(1)</sup> | 25 W           |
| STP7N52DK3  |                  |                             | 6 A                | 90 W           |

1. Limited by package

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

## Application

Switching applications

## Description

These devices are N-channel SuperFREDmesh3™, a new Power MOSFET technology that is obtained via improvements applied to STMicroelectronics' SuperMESH3™ technology. The resulting product has an extremely low on resistance, superior dynamic performance, high avalanche capability and a fast body-drain recovery diode, making it especially suitable for the most demanding applications.

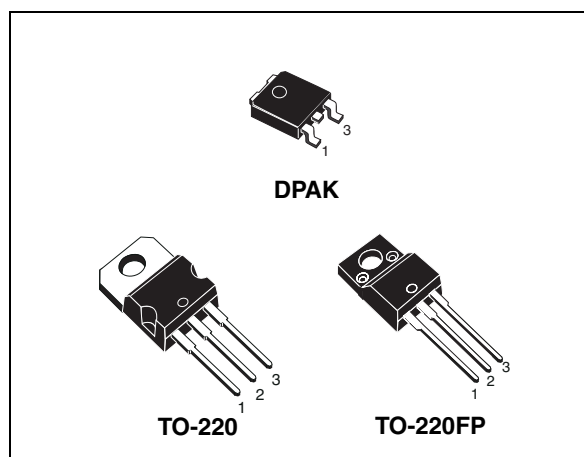


Figure 1. Internal schematic diagram

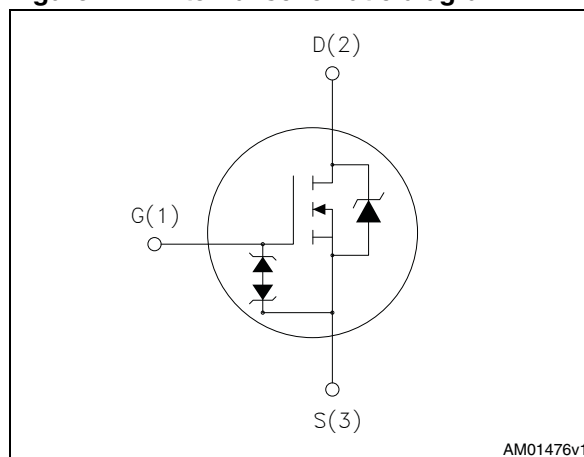


Table 1. Device summary

| Order codes | Marking | Package  | Packaging     |
|-------------|---------|----------|---------------|
| STD7N52DK3  | 7N52DK3 | DPAK     | Tape and reel |
| STF7N52DK3  | 7N52DK3 | TO-220FP | Tube          |
| STP7N52DK3  | 7N52DK3 | TO-220   | Tube          |

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol         | Parameter                                                                                                                    | Value      |      |                   | Unit               |
|----------------|------------------------------------------------------------------------------------------------------------------------------|------------|------|-------------------|--------------------|
|                |                                                                                                                              | TO-220     | DPAK | TO-220FP          |                    |
| $V_{DS}$       | Drain-source voltage ( $V_{GS} = 0$ )                                                                                        | 525        |      |                   | V                  |
| $V_{GS}$       | Gate- source voltage                                                                                                         | $\pm 30$   |      |                   | V                  |
| $I_D$          | Drain current (continuous) at $T_C = 25\text{ }^{\circ}\text{C}$                                                             | 6          |      | 6 <sup>(1)</sup>  | A                  |
| $I_D$          | Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$                                                            | 4          |      | 4 <sup>(1)</sup>  | A                  |
| $I_{DM}^{(2)}$ | Drain current (pulsed)                                                                                                       | 24         |      | 24 <sup>(1)</sup> | A                  |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$                                                                      | 90         |      | 25                | W                  |
| $I_{AR}$       | Avalanche current, repetitive or not-repetitive (pulse width limited by $T_j$ max)                                           | 3          |      |                   | A                  |
| $E_{AS}$       | Single pulse avalanche energy (starting $T_j = 25\text{ }^{\circ}\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ )       | 100        |      |                   | mJ                 |
| $V_{ESD(G-S)}$ | Gate source ESD(HBM-C = 100 pF, R = 1.5 k $\Omega$ )                                                                         | 2500       |      |                   | V                  |
| $dv/dt^{(3)}$  | Peak diode recovery voltage slope                                                                                            | 20         |      |                   | V/ns               |
| $di/dt$        | Diode reverse recovery current slope                                                                                         | 400        |      |                   | A/ $\mu$ s         |
| $V_{ISO}$      | Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; $T_C = 25\text{ }^{\circ}\text{C}$ ) | 2500       |      |                   | V                  |
| $T_{stg}$      | Storage temperature                                                                                                          | -55 to 150 |      |                   | $^{\circ}\text{C}$ |
| $T_j$          | Max. operating junction temperature                                                                                          | 150        |      |                   | $^{\circ}\text{C}$ |

1. Limited by package

2. Pulse width limited by safe operating area

3.  $I_{SD} \leq 6\text{ A}$ , peak  $V_{DS} < V_{(BR)DSS}$ .
**Table 3. Thermal data**

| Symbol              | Parameter                                      | Value  |      |          | Unit                 |
|---------------------|------------------------------------------------|--------|------|----------|----------------------|
|                     |                                                | TO-220 | DPAK | TO-220FP |                      |
| $R_{thj-case}$      | Thermal resistance junction-case max           | 1.39   |      | 5        | $^{\circ}\text{C/W}$ |
| $R_{thj-pcb}^{(1)}$ | Thermal resistance junction-pcb max            |        | 50   |          | $^{\circ}\text{C/W}$ |
| $R_{thj-amb}$       | Thermal resistance junction-ambient max        | 62.5   |      | 62.5     | $^{\circ}\text{C/W}$ |
| $T_l$               | Maximum lead temperature for soldering purpose | 300    |      | 300      | $^{\circ}\text{C}$   |

1. When mounted on 1inch<sup>2</sup> FR-4 board, 2 oz Cu

## 2 Electrical characteristics

( $T_C = 25\text{ }^{\circ}\text{C}$  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 ( $V_{GS} = 0$ ) | $V_{DS} = \text{Max rating}$<br>$V_{DS} = \text{Max rating}$ , $T_C = 125\text{ }^{\circ}\text{C}$ |      |      | 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                | $V_{GS} = 10\text{ V}$ , $I_D = 3\text{ A}$                                                        |      | 0.95 | 1.15     | $\Omega$                       |

**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>$V_{GS} = 0$                                                | -    | 870<br>70<br>13 | -    | pF<br>pF<br>pF |
| $C_{o(tr)}^{(1)}$                   | Equivalent capacitance time related                                     | $V_{DS} = 0\text{ to }525\text{ V}$ , $V_{GS} = 0$                                                           | -    | 53              | -    | pF             |
| $C_{o(er)}^{(2)}$                   | Equivalent capacitance energy related                                   |                                                                                                              | -    | 74              | -    | pF             |
| $R_G$                               | Intrinsic gate resistance                                               | $f = 1\text{ MHz}$ open drain                                                                                | -    | 3.5             | -    | $\Omega$       |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$       | Total gate charge<br>Gate-source charge<br>Gate-drain charge            | $V_{DD} = 420\text{ V}$ , $I_D = 6\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 20</a> ) | -    | 33<br>5<br>19   | -    | nC<br>nC<br>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 6. Switching times**

| Symbol       | Parameter           | Test conditions                                                                                                                    | Min. | Typ. | Max | Unit |
|--------------|---------------------|------------------------------------------------------------------------------------------------------------------------------------|------|------|-----|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 260\text{ V}$ , $I_D = 3\text{ A}$ ,<br>$R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 19</a> ) | -    | 12   | -   | ns   |
| $t_r$        | Rise time           |                                                                                                                                    |      | 12   |     | ns   |
| $t_{d(off)}$ | Turn-off-delay time |                                                                                                                                    |      | 37   |     | ns   |
| $t_f$        | Fall time           |                                                                                                                                    |      | 19   |     | ns   |

**Table 7. Source drain diode**

| Symbol          | Parameter                     | Test conditions                                                                                                                                              | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                                              | -    |      | 6    | A    |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                                              |      |      | 24   | A    |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 6\text{ A}$ , $V_{GS} = 0$                                                                                                                         | -    |      | 1.5  | V    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 6\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 60\text{ V}$ (see <a href="#">Figure 24</a> )                                        | -    | 110  |      | ns   |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                              |      | 440  |      | nC   |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                              |      | 8    |      | A    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 6\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 24</a> ) | -    | 140  |      | ns   |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                              |      | 680  |      | nC   |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                              |      | 10   |      | 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 DPAK

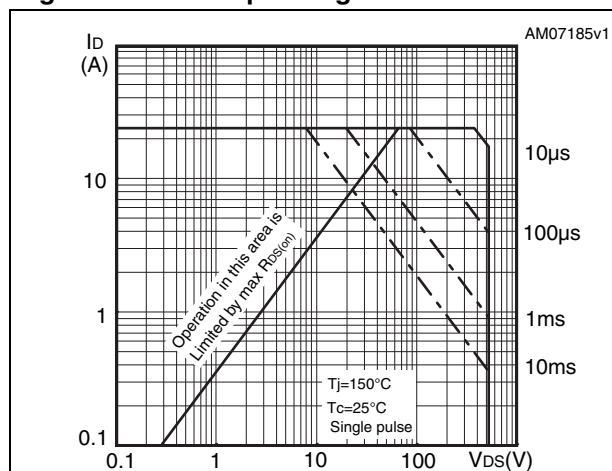


Figure 3. Thermal impedance for DPAK

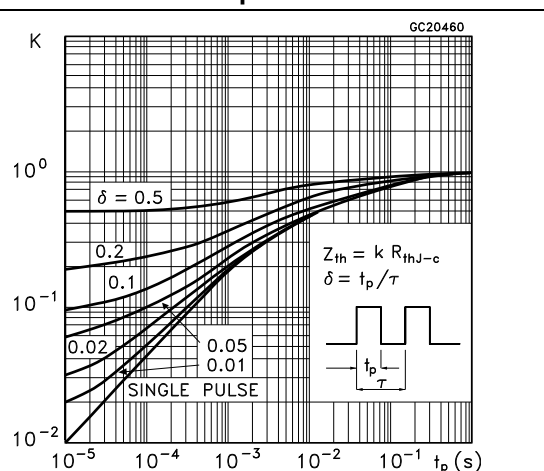


Figure 4. Safe operating area for TO-220FP

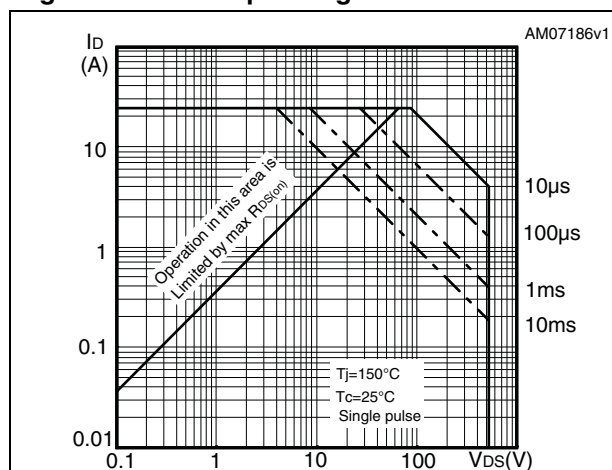


Figure 5. Thermal impedance for TO-220FP

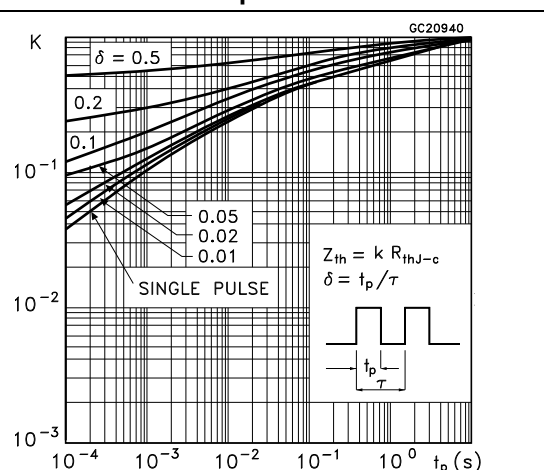


Figure 6. Safe operating area for TO-220

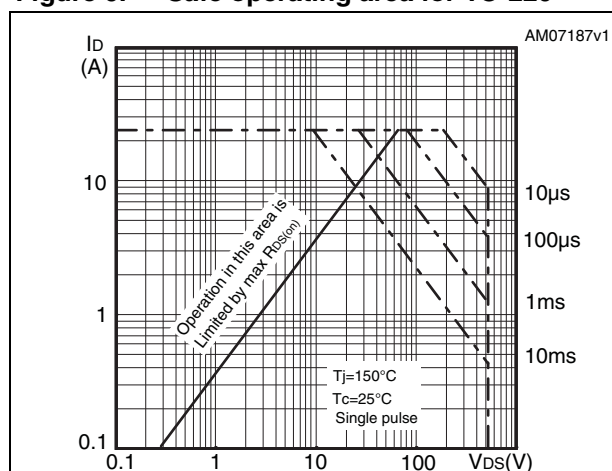


Figure 7. Thermal impedance for TO-220

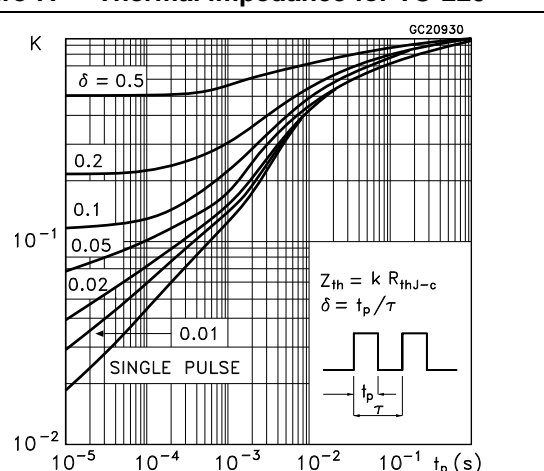


Figure 8. Output characteristics

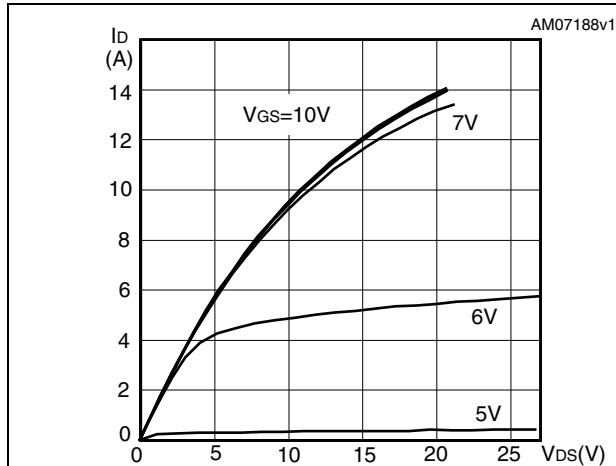


Figure 9. Transfer characteristics

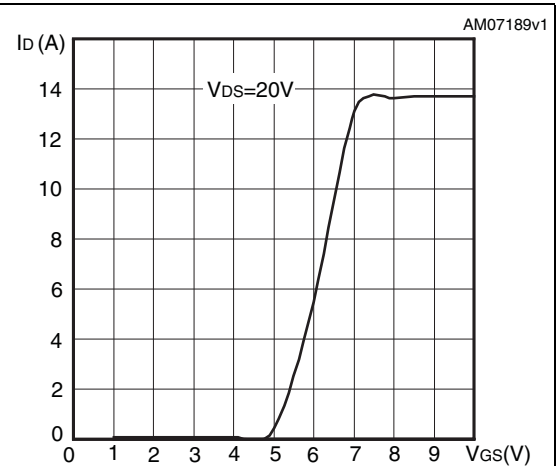


Figure 10. Gate charge vs gate-source voltage

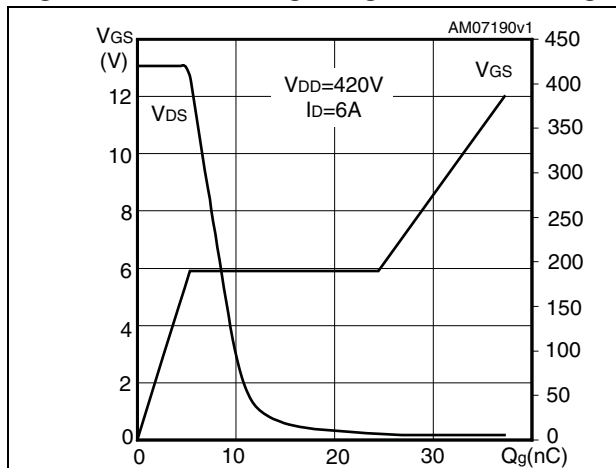


Figure 11. Static drain-source on resistance

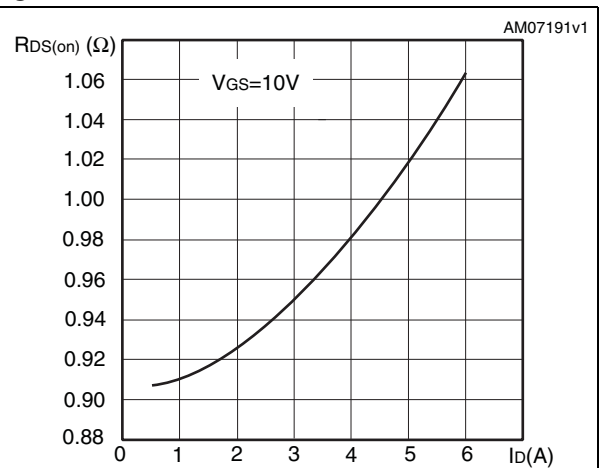


Figure 12. Capacitance variations

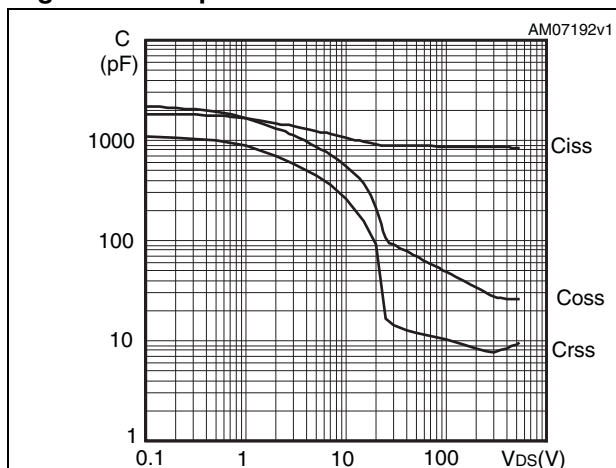


Figure 13. Output capacitance stored energy

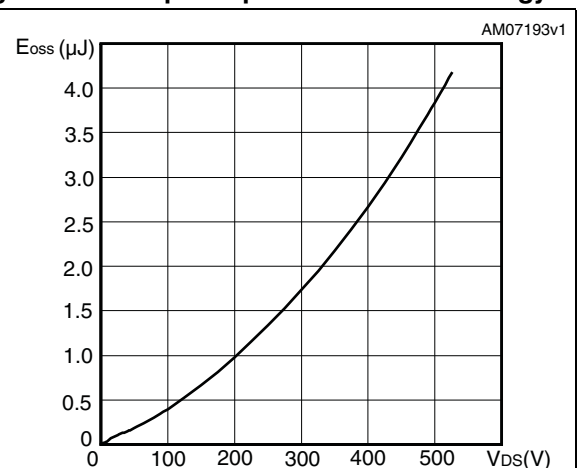


Figure 14. Normalized gate threshold voltage vs temperature

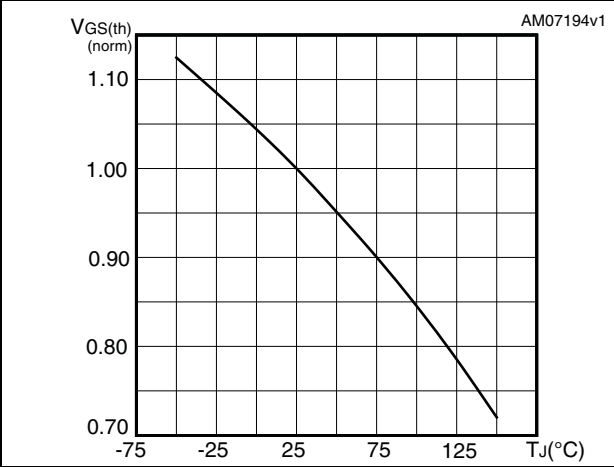


Figure 15. Normalized on resistance vs temperature

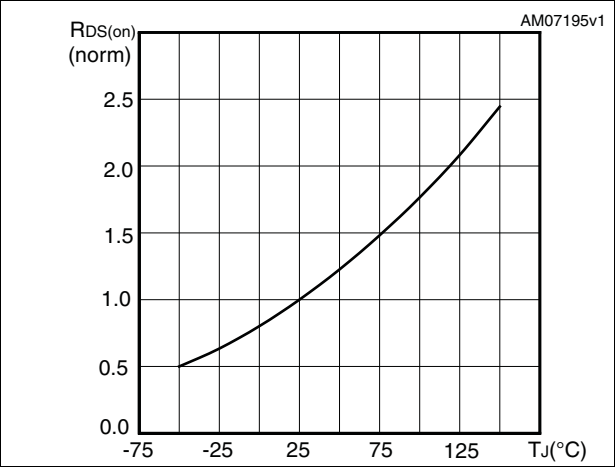


Figure 16. Source-drain diode forward characteristics

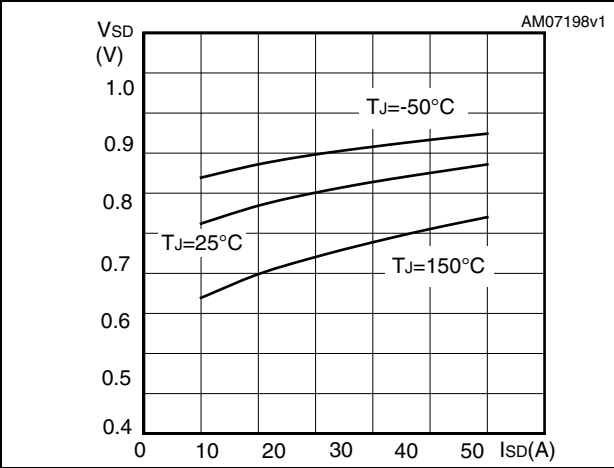


Figure 17. Normalized  $B_{VDSS}$  vs temperature

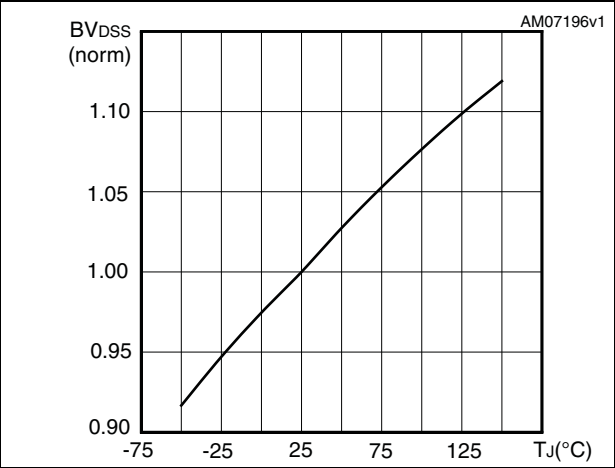
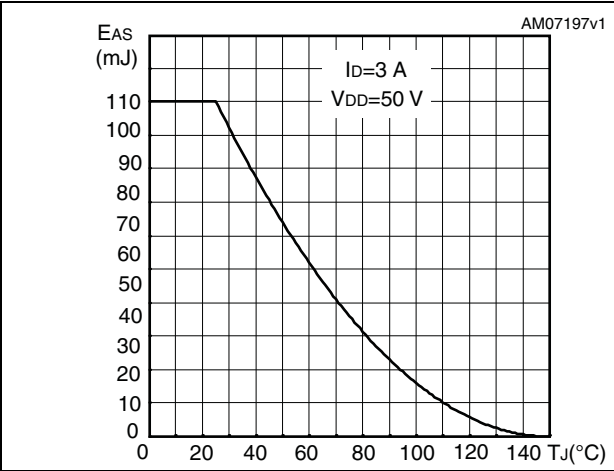
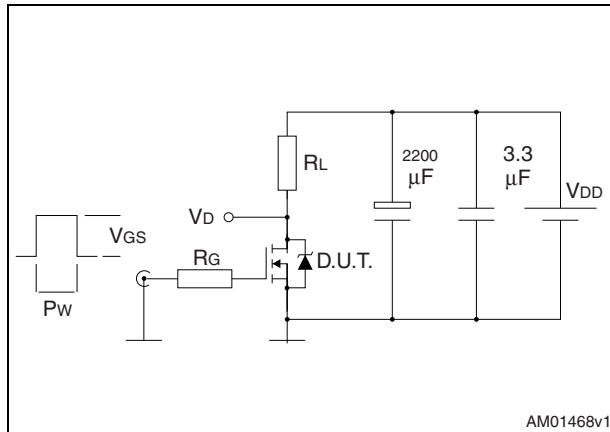


Figure 18. Maximum avalanche energy vs starting  $T_J$

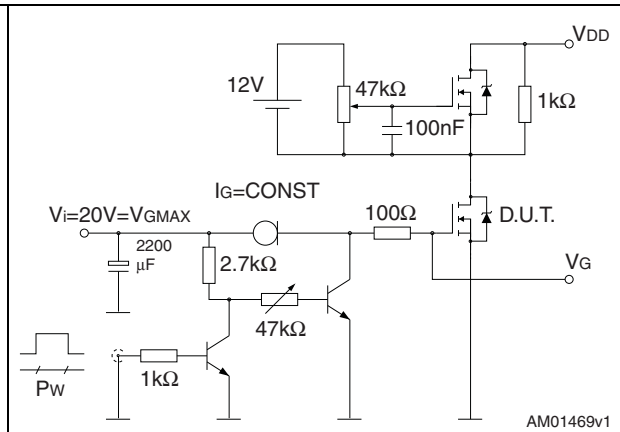


### 3 Test circuits

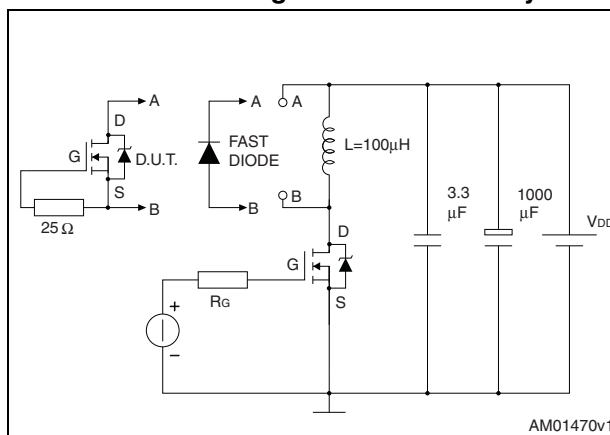
**Figure 19. Switching times test circuit for resistive load**



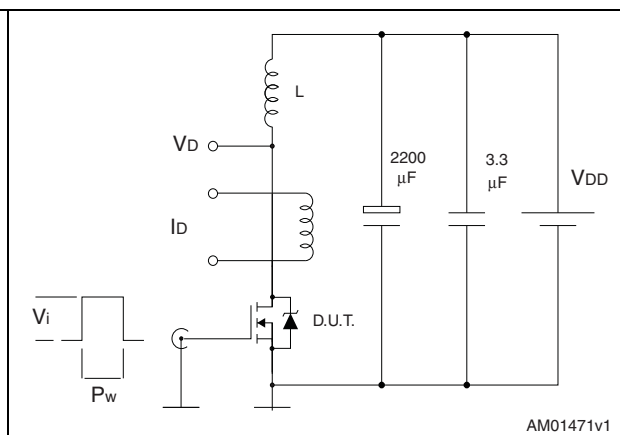
**Figure 20. Gate charge test circuit**



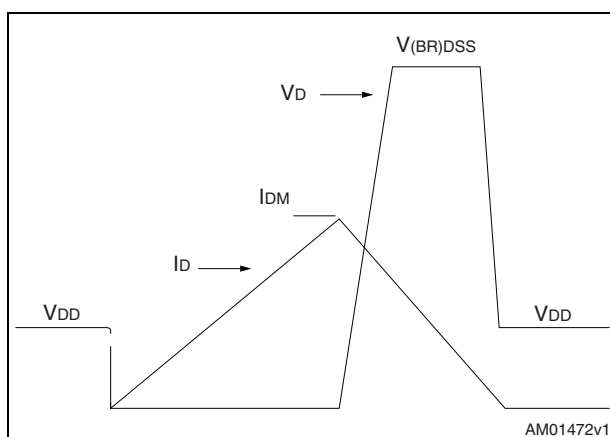
**Figure 21. Test circuit for inductive load switching and diode recovery times**



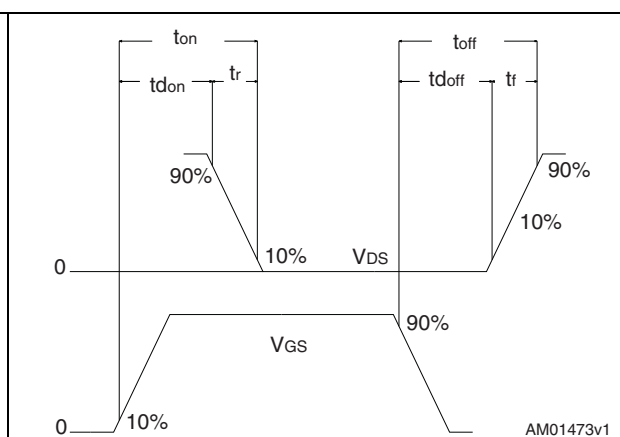
**Figure 22. Unclamped inductive load test circuit**



**Figure 23. Unclamped inductive waveform**



**Figure 24. Switching time waveform**



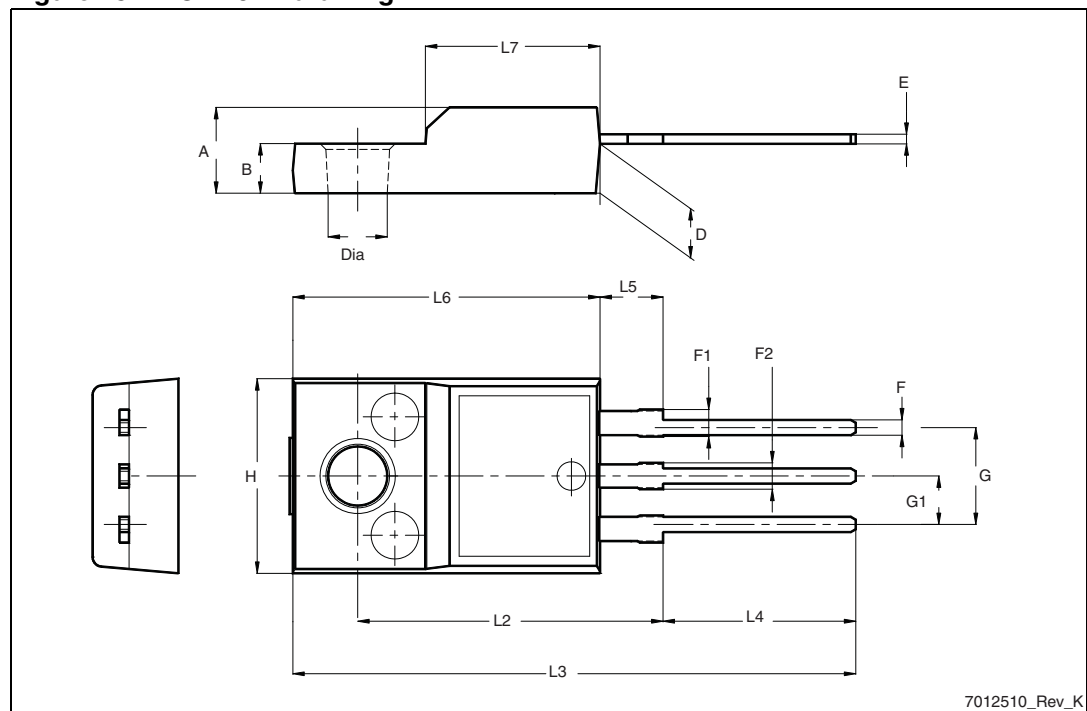
## 4 Package mechanical data

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  |

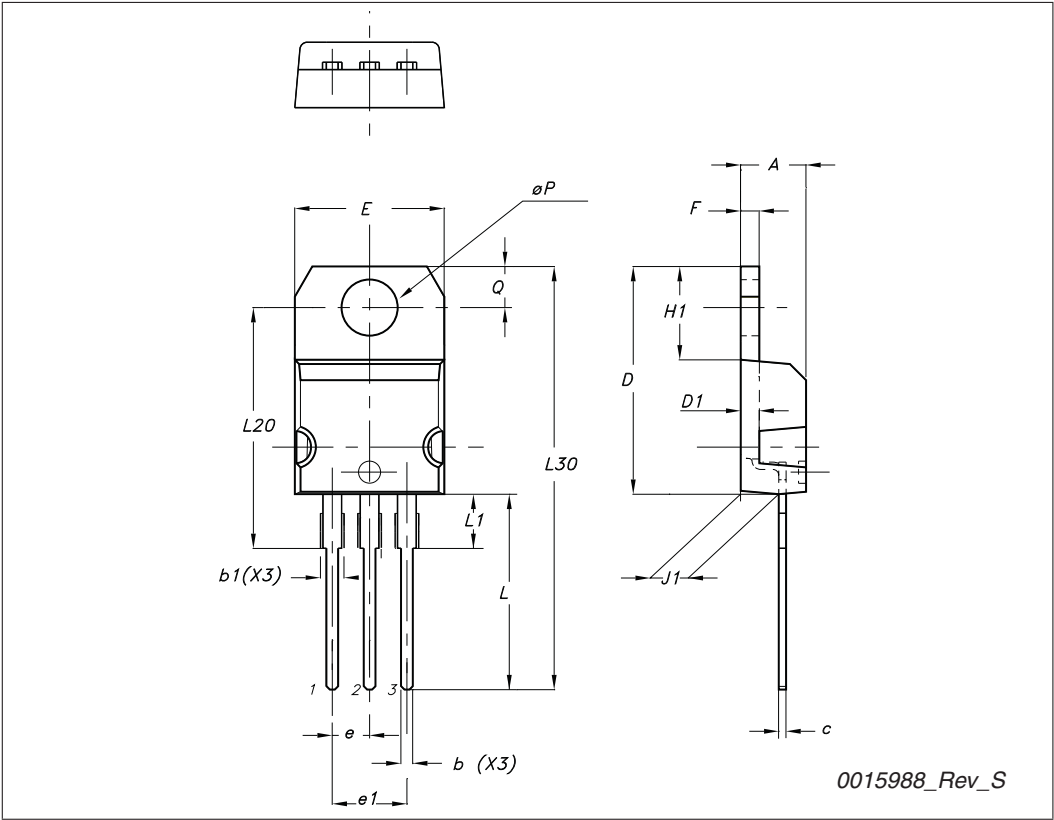
Figure 25. TO-220FP drawing



7012510\_Rev\_K

TO-220 type A mechanical data

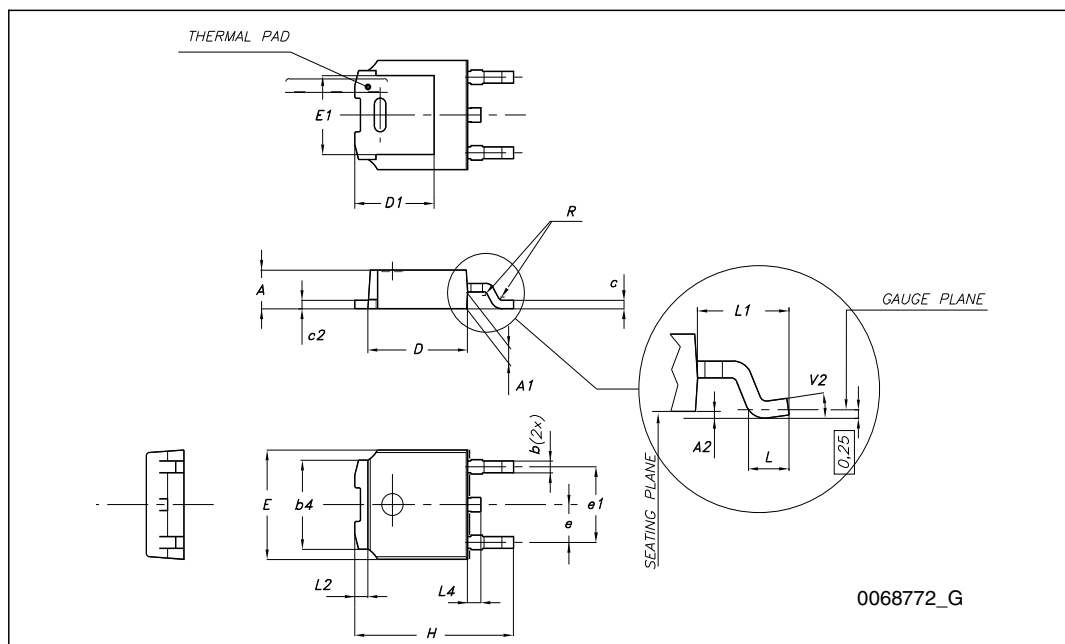
| Dim | mm    |       |       |
|-----|-------|-------|-------|
|     | Min   | Typ   | Max   |
| A   | 4.40  |       | 4.60  |
| b   | 0.61  |       | 0.88  |
| b1  | 1.14  |       | 1.70  |
| c   | 0.48  |       | 0.70  |
| D   | 15.25 |       | 15.75 |
| D1  |       | 1.27  |       |
| E   | 10    |       | 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  |



0015988\_Rev\_S

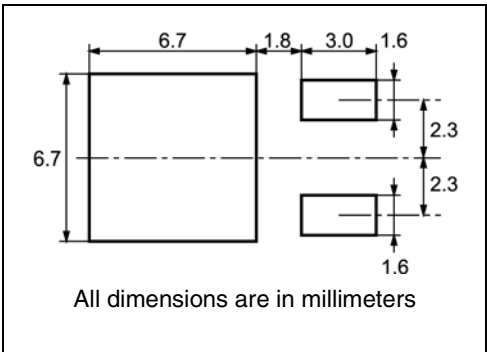
## TO-252 (DPAK) mechanical data

| 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°    |

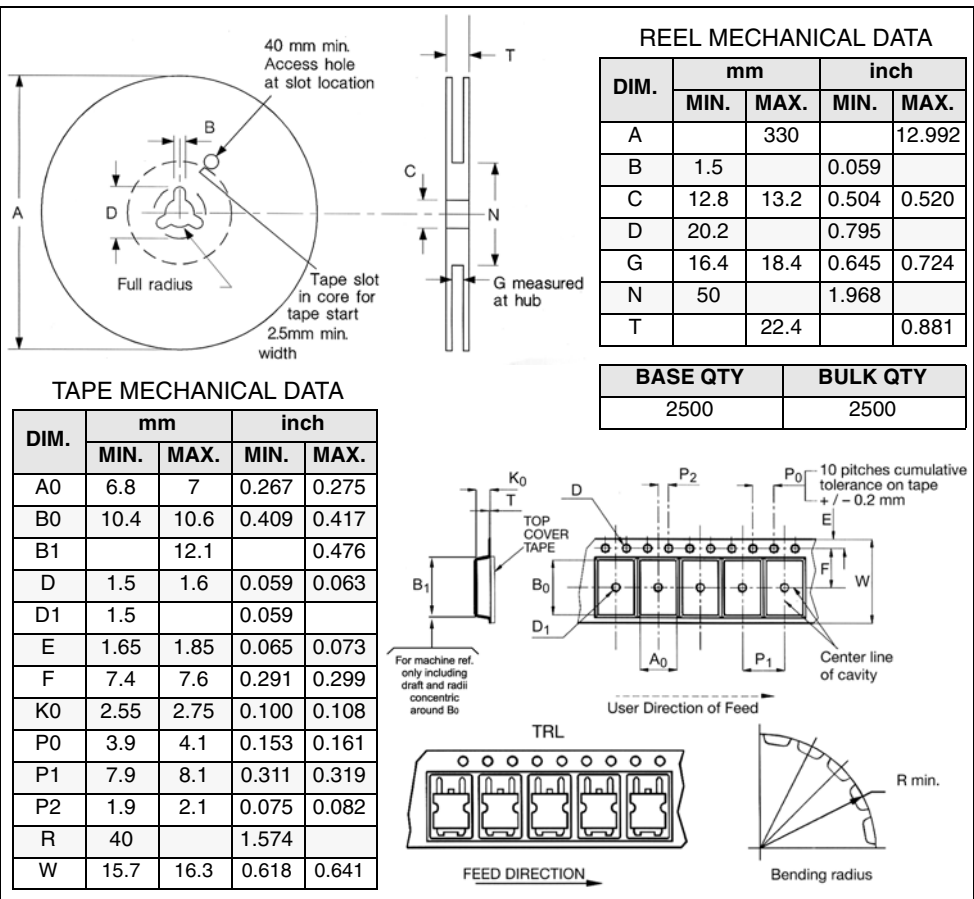


# 5 Package mechanical data

## DPAK FOOTPRINT



## TAPE AND REEL SHIPMENT



## 6 Revision history

**Table 10. Document revision history**

| Date        | Revision | Changes                                                     |
|-------------|----------|-------------------------------------------------------------|
| 09-Oct-2009 | 1        | First release                                               |
| 20-Oct-2010 | 2        | Document status promoted from preliminary data to datasheet |

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