



# STP140NF75 STB140NF75 - STB140NF75-1

N-channel 75V - 0.0065Ω - 120A - D<sup>2</sup>PAK/I<sup>2</sup>PAK/TO-220  
STripFET™ III Power MOSFET

## General features

| Type         | V <sub>DSS</sub> | R <sub>DS(on)</sub> | I <sub>D</sub>      |
|--------------|------------------|---------------------|---------------------|
| STB140NF75   | 75V              | <0.0075Ω            | 120A <sup>(1)</sup> |
| STB140NF75-1 | 75V              | <0.0075Ω            | 120A <sup>(1)</sup> |
| STP140NF75   | 75V              | <0.0075Ω            | 120A <sup>(1)</sup> |

1. Current limited by package

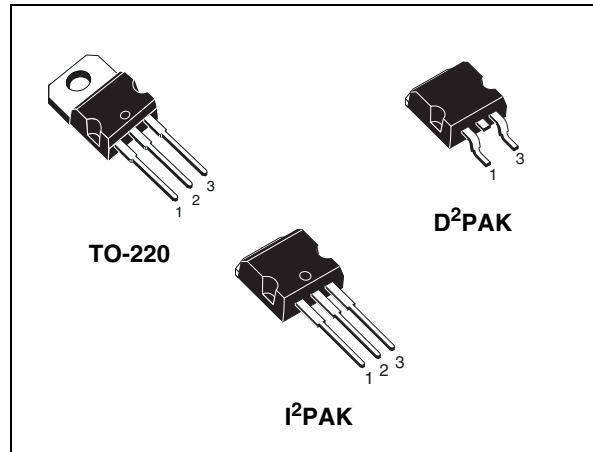
- 100% avalanche tested

## Description

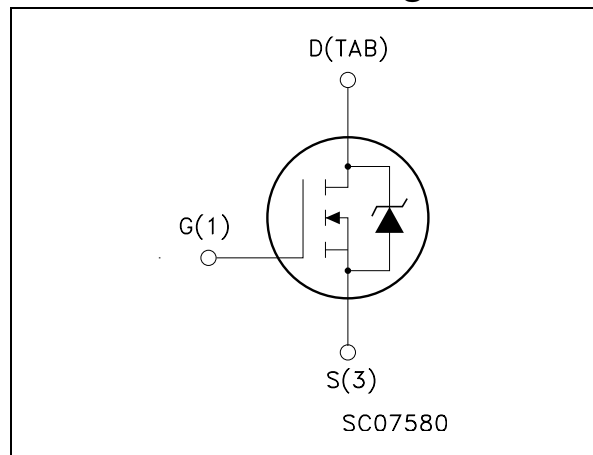
This Power MOSFET is the latest development of STMicroelectronics unique "Single Feature Size™" strip-based process. The resulting transistor shows extremely high packing density for low on-resistance, rugged avalanche characteristics and less critical alignment steps therefore a remarkable manufacturing reproducibility.

## Applications

- Switching application



## Internal schematic diagram



## Order codes

| Part number  | Marking  | Package            | Packaging   |
|--------------|----------|--------------------|-------------|
| STB140NF75T4 | B140NF75 | D <sup>2</sup> PAK | Tape & reel |
| STB140NF75-1 | B140NF75 | I <sup>2</sup> PAK | Tube        |
| STP140NF75   | P140NF75 | TO-220             | Tube        |

# Contents

|          |   |           |
|----------|---|-----------|
| <b>1</b> | <b>Electrical ratings</b> .....           | <b>3</b>  |
| <b>2</b> | <b>Electrical characteristics</b> .....   | <b>4</b>  |
| 2.1      | Electrical characteristics (curves) ..... | 6         |
| <b>3</b> | <b>Spice thermal model</b> .....          | <b>10</b> |
| <b>4</b> | <b>Test circuit</b> .....                 | <b>11</b> |
| <b>5</b> | <b>Package mechanical data</b> .....      | <b>12</b> |
| <b>6</b> | <b>Packaging mechanical data</b> .....    | <b>16</b> |
| <b>7</b> | <b>Revision history</b> .....             | <b>17</b> |

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol         | Parameter   | Value      | Unit                |
|----------------|---|------------|---------------------|
| $V_{DS}$       | Drain-source voltage ( $V_{GS} = 0$ )                   | 75         | V                   |
| $V_{DGR}$      | Drain-gate voltage ( $R_{GS} = 20\text{ k}\Omega$ )     | 75         | V                   |
| $V_{GS}$       | Gate- source voltage                                    | $\pm 20$   | V                   |
| $I_D^{(1)}$    | Drain current (continuous) at $T_C = 25^\circ\text{C}$  | 120        | A                   |
| $I_D^{(1)}$    | Drain current (continuous) at $T_C = 100^\circ\text{C}$ | 100        | A                   |
| $I_{DM}^{(2)}$ | Drain current (pulsed)                                  | 480        | A                   |
| $P_{tot}$      | Total dissipation at $T_C = 25^\circ\text{C}$           | 310        | W                   |
|                | Derating Factor   | 2.08       | W/ $^\circ\text{C}$ |
| $dv/dt^{(3)}$  | Peak diode recovery voltage slope                       | 10         | V/ns                |
| $E_{AS}^{(4)}$ | Single pulse avalanche energy                           | 750        | mJ                  |
| $T_{stg}$      | Storage temperature                                     | -55 to 175 | $^\circ\text{C}$    |
| $T_j$          | Max. operating junction temperature                     |            |                     |

1. Value limited by wire bonding
2. Pulse width limited by safe operating area.
3.  $I_{SD} \leq 20\text{A}$ ,  $di/dt \leq 400\text{A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_j \leq T_{JMAX}$
4. Starting  $T_j = 25^\circ\text{C}$ ,  $I_D = 60\text{A}$ ,  $V_{DD} = 30\text{V}$

**Table 2. Thermal data**

|                |   |      |                           |
|----------------|---|------|---------------------------|
| $R_{thj-case}$ | Thermal resistance junction-case max                          | 0.48 | $^\circ\text{C}/\text{W}$ |
| $R_{thj-amb}$  | Thermal resistance junction-ambient max                       | 62.5 | $^\circ\text{C}/\text{W}$ |
| $T_J$          | Maximum lead temperature for soldering purpose <sup>(1)</sup> | 300  | $^\circ\text{C}$          |

1. for 10 sec. 1.6mm from case

## 2 Electrical characteristics

( $T_{CASE}=25^{\circ}C$  unless otherwise specified)

**Table 3. On/off states**

| Symbol        | Parameter  | Test conditions   | Min. | Typ.   | Max.      | Unit               |
|---------------|--|---|------|--------|-----------|--------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage                   | $I_D = 250\mu A, V_{GS} = 0$  | 75   |        |           | V                  |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = \text{max ratings}$<br>$V_{DS} = \text{max ratings},$<br>$T_C = 125^{\circ}C$ |      |        | 1<br>10   | $\mu A$<br>$\mu A$ |
| $I_{GSS}$     | Gate-body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 20V$  |      |        | $\pm 100$ | nA                 |
| $V_{GS(th)}$  | Gate threshold voltage                           | $V_{DS} = V_{GS}, I_D = 250\mu A$   | 2    |        | 4         | V                  |
| $R_{DS(on)}$  | Static drain-source on resistance                | $V_{GS} = 10V, I_D = 70A$   |      | 0.0065 | 0.0075    | $\Omega$           |

**Table 4. Dynamic**

| Symbol  | Parameter   | Test conditions  | Min. | Typ.                   | Max. | Unit                 |
|---|---|--|------|------------------------|------|----------------------|
| $g_{fs}^{(1)}$                                | Forward transconductance  | $V_{DS} = 15V, I_D = 70A$  |      | 160                    |      | S                    |
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$           | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{DS} = 25V, f = 1MHz,$<br>$V_{GS} = 0$  |      | 5000<br>960<br>310     |      | pF<br>pF<br>pF       |
| $t_{d(on)}$<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     | $V_{DD} = 38V, I_D = 70A$<br>$R_G = 4.7\Omega, V_{GS} = 10V$<br>(see <a href="#">Figure 19</a> ) |      | 30<br>140<br>130<br>90 |      | ns<br>ns<br>ns<br>ns |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$                 | Total gate charge<br>Gate-source charge<br>Gate-drain charge            | $V_{DD} = 60V, I_D = 120A,$<br>$V_{GS} = 10V$<br>(see <a href="#">Figure 20</a> )                |      | 160<br>28<br>70        | 218  | nC<br>nC<br>nC       |

1. Pulsed: Pulse duration = 300  $\mu s$ , duty cycle 1.5 %.

**Table 5. Source drain diode**

| Symbol                            | Parameter  | Test conditions  | Min. | Typ.            | Max.       | Unit          |
|-----------------------------------|--|--|------|-----------------|------------|---------------|
| $I_{SD}$<br>$I_{SDM}^{(1)}$       | Source-drain current<br>Source-drain current<br>(pulsed)                     |  |      |                 | 120<br>480 | A<br>A        |
| $V_{SD}^{(2)}$                    | Forward on voltage   | $I_{SD} = 120A, V_{GS} = 0$  |      |                 | 1.5        | V             |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_{SD} = 120A,$<br>$di/dt = 100A/\mu s,$<br>$V_{DD} = 35V, T_j = 150^\circ C$<br>(see <a href="#">Figure 21</a> ) |      | 115<br>450<br>8 |            | ns<br>nC<br>A |

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

## 2.1 Electrical characteristics (curves)

Figure 1. Safe operating area

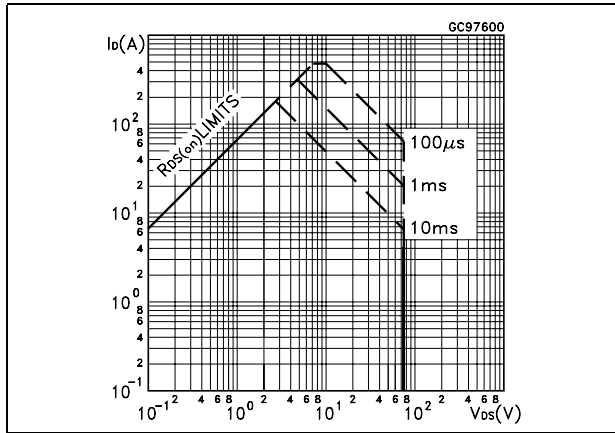


Figure 2. Thermal impedance

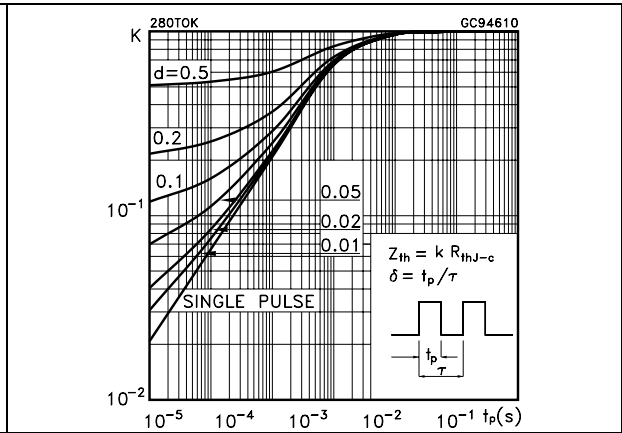


Figure 3. Output characteristics

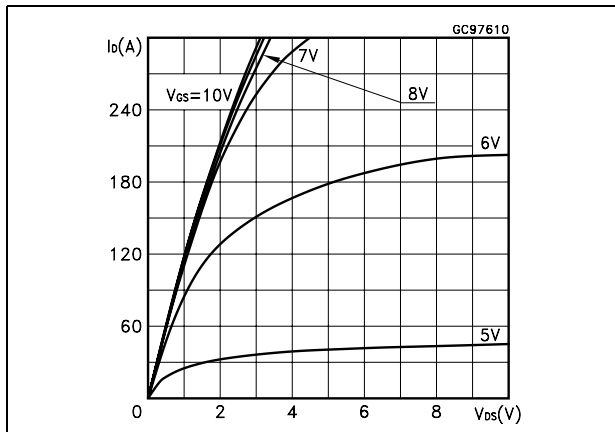


Figure 4. Transfer characteristics

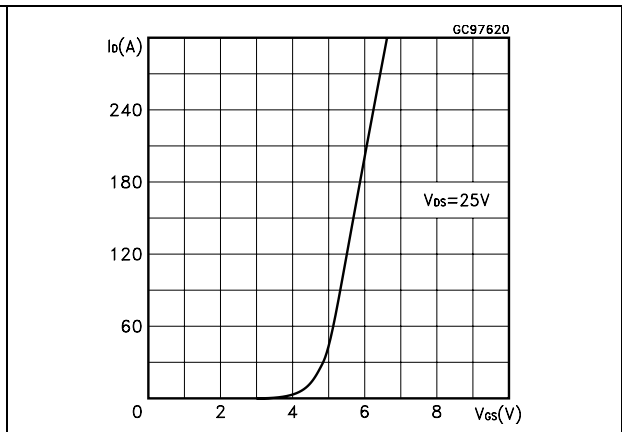


Figure 5. Transconductance

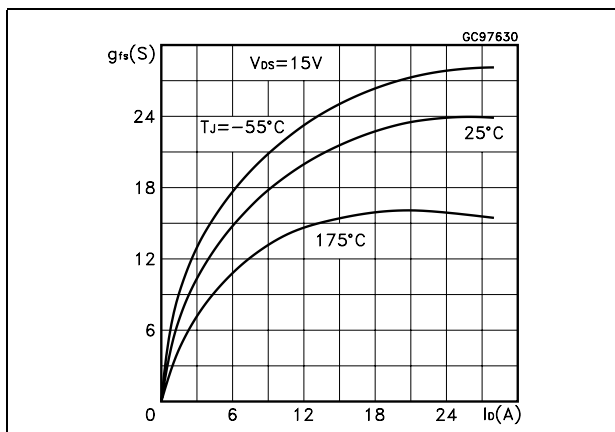


Figure 6. Static drain-source on resistance

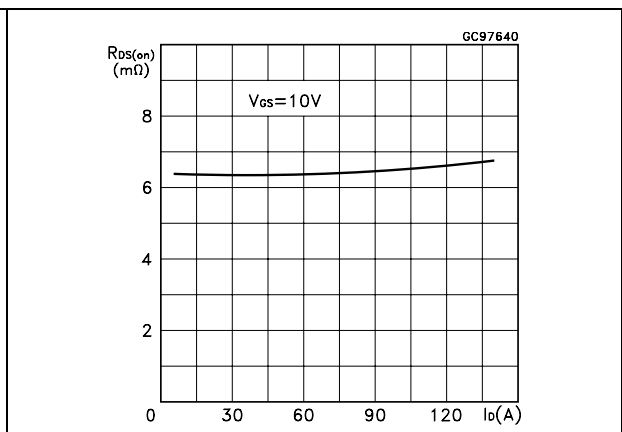


Figure 7. Gate charge vs gate-source voltage Figure 8. Capacitance variations

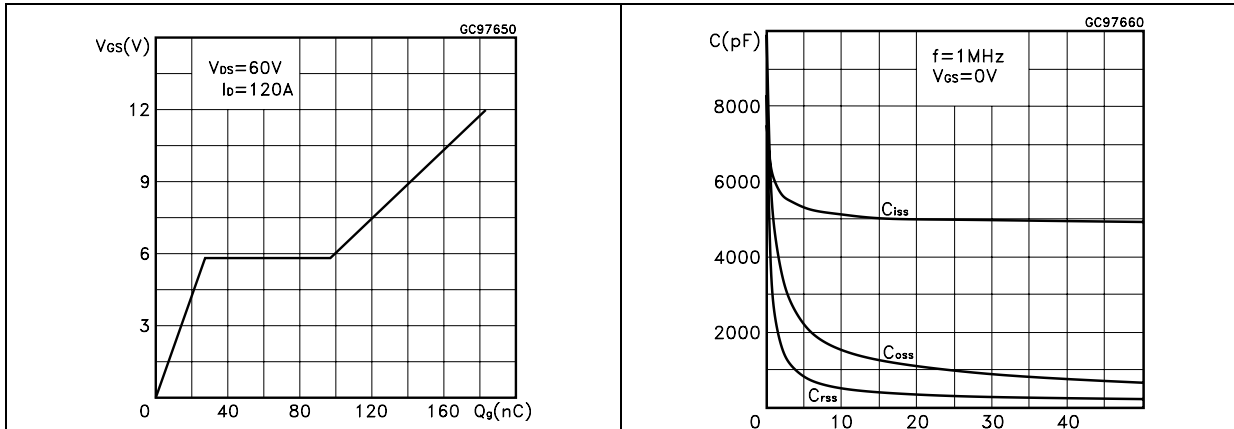


Figure 9. Normalized gate threshold voltage vs temperature Figure 10. Normalized on resistance vs temperature

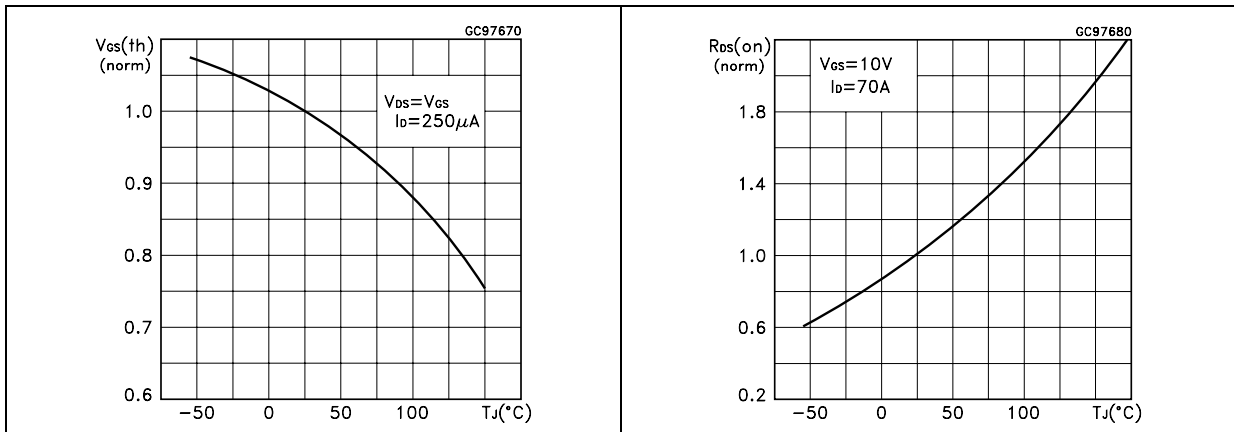


Figure 11. Source-drain diode forward characteristics Figure 12. Normalized  $B_{V_{DS}}$  vs temperature

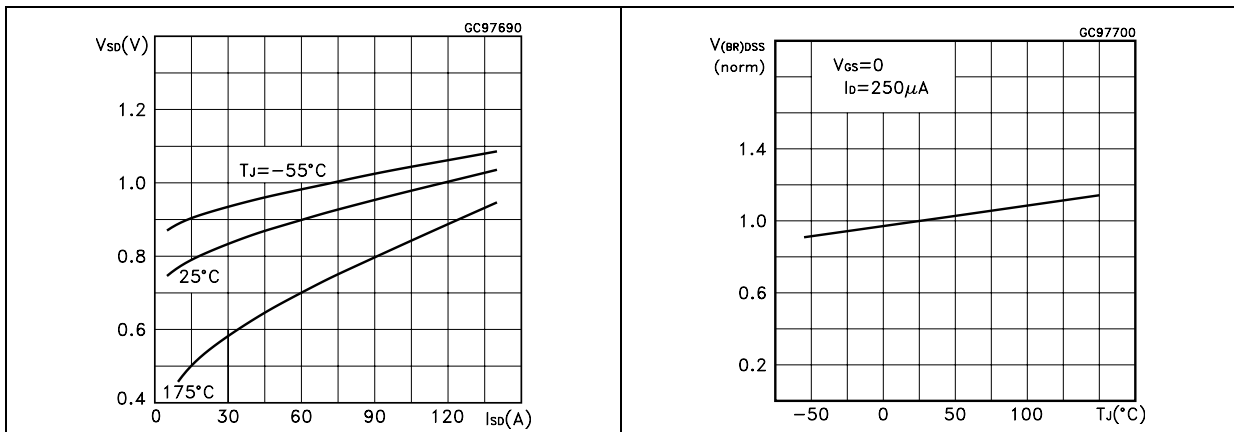


Figure 13. Power derating vs Tc

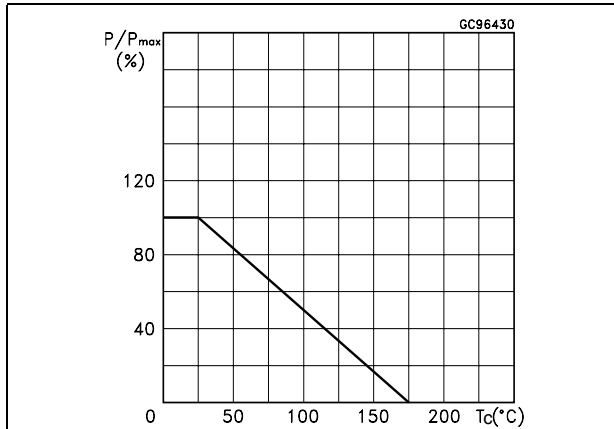


Figure 14. Max I<sub>D</sub> current vs Tc

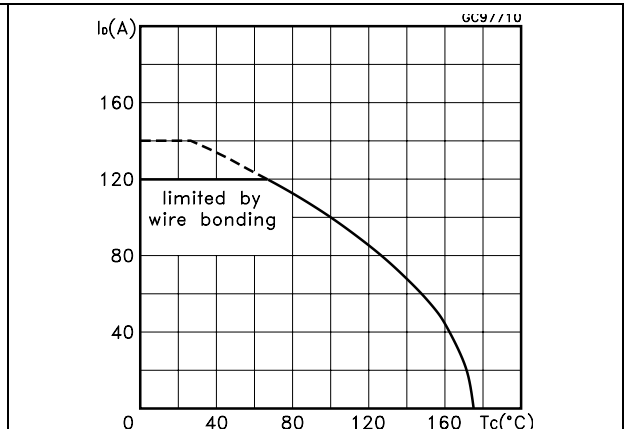


Figure 15. Thermal resistance R<sub>thj-a</sub> vs PCB copper area

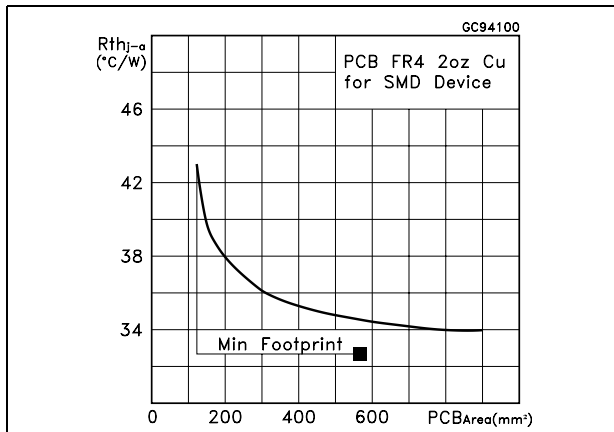


Figure 16. Max power dissipation vs PCB copper area

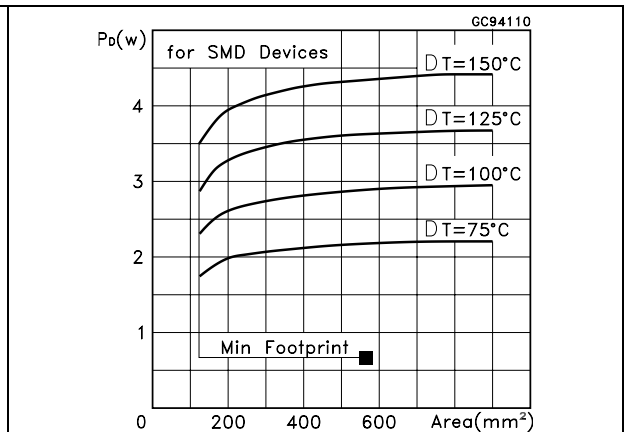
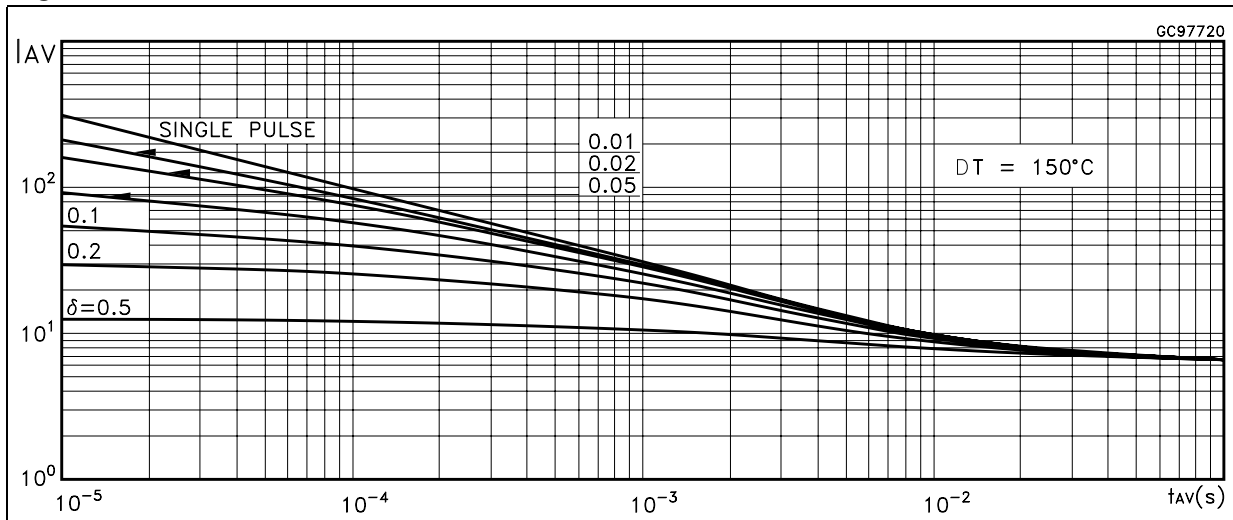




Figure 17. Allowable I<sub>AV</sub> vs time in avalanche



The previous curve gives the safe operating area for unclamped inductive loads, single pulse or repetitive, under the following conditions:

$$P_{D(AVE)} = 0.5 * (1.3 * B_{VDSS} * I_{AV})$$

$$E_{AS(AR)} = P_{D(AVE)} * t_{AV}$$

Where:

$I_{AV}$  is the allowable current in avalanche

$P_{D(AVE)}$  is the average power dissipation in avalanche (single pulse)

$t_{AV}$  is the time in avalanche

To derate above  $25^\circ\text{C}$ , at fixed  $I_{AV}$ , the following equation must be applied:

$$I_{AV} = 2 * (T_{jmax} - T_{CASE}) / (1.3 * B_{VDSS} * Z_{th})$$

Where:

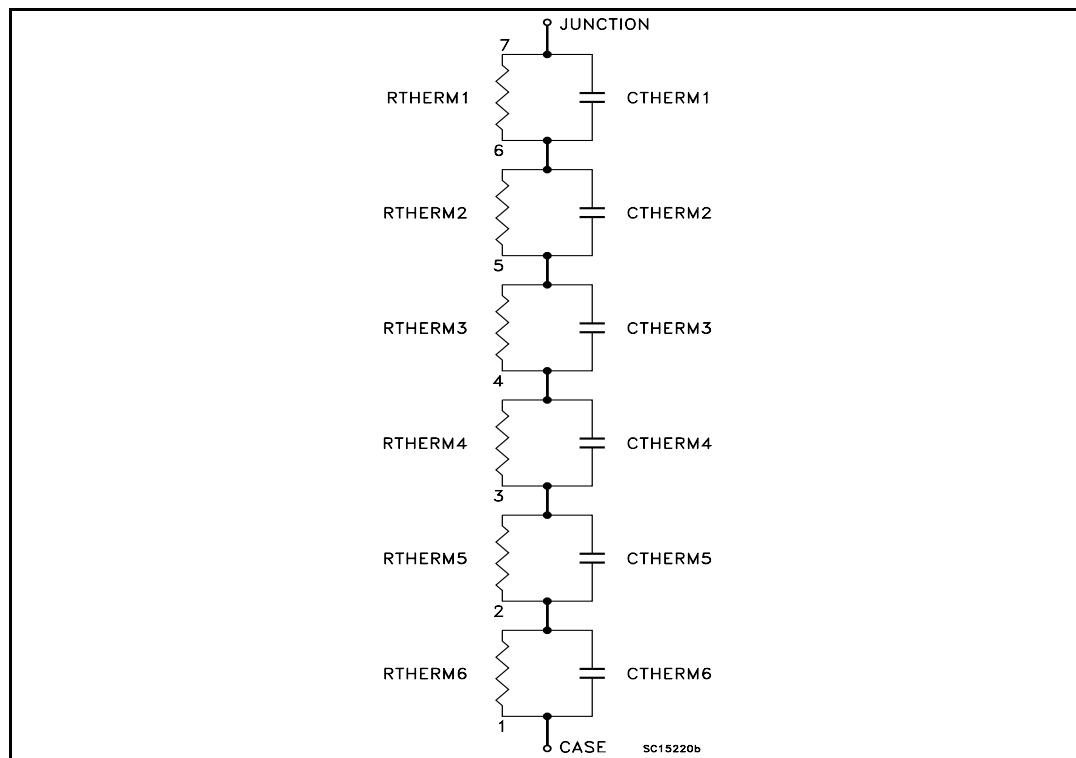
$Z_{th} = K * R_{th}$  is the value coming from normalized thermal response at fixed pulse width equal to  $T_{AV}$ .

### 3 Spice thermal model

Table 6. Parameters

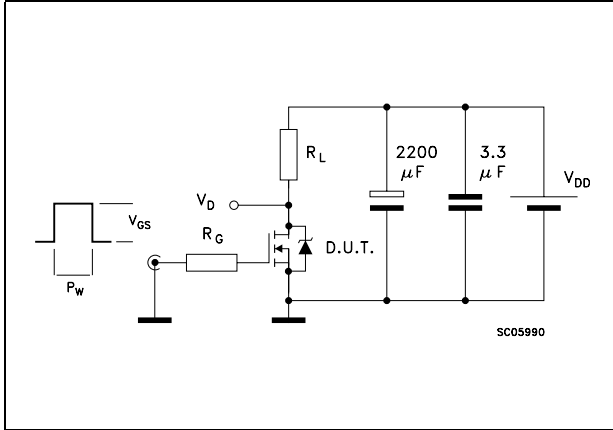
| Parameter | Node  | Value            |
|-----------|-------|------------------|
| CTHERM1   | 7 - 6 | $1.49 * 10^{-3}$ |
| CTHERM2   | 6 - 5 | $3.50 * 10^{-2}$ |
| CTHERM3   | 5 - 4 | $5.94 * 10^{-2}$ |
| CTHERM4   | 4 - 3 | $9.74 * 10^{-2}$ |
| CTHERM5   | 3 - 2 | $8.86 * 10^{-2}$ |
| CTHERM6   | 2 - 1 | $8.27 * 10^{-1}$ |
|           |       |                  |
| RTHERM1   | 7 - 6 | 0.0384           |
| RTHERM2   | 6 - 5 | 0.0624           |
| RTHERM3   | 5 - 4 | 0.072            |
| RTHERM4   | 4 - 3 | 0.0912           |
| RTHERM5   | 3 - 2 | 0.1008           |
| RTHERM6   | 2 - 1 | 0.1152           |

Figure 18. Scheme

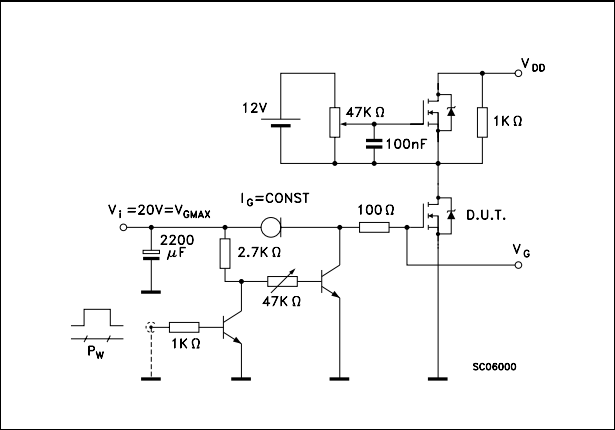


# 4 Test circuit

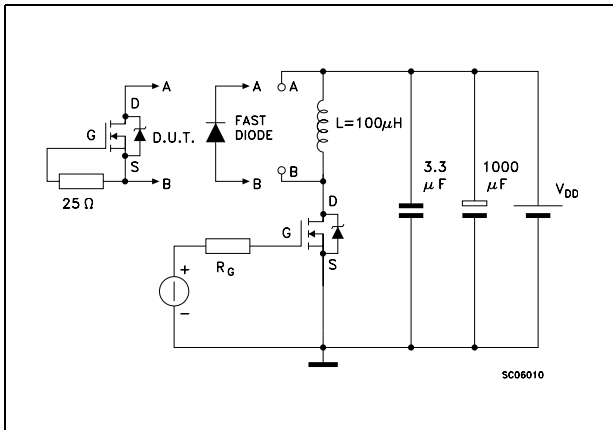
**Figure 19. Switching times test circuit for resistive load**



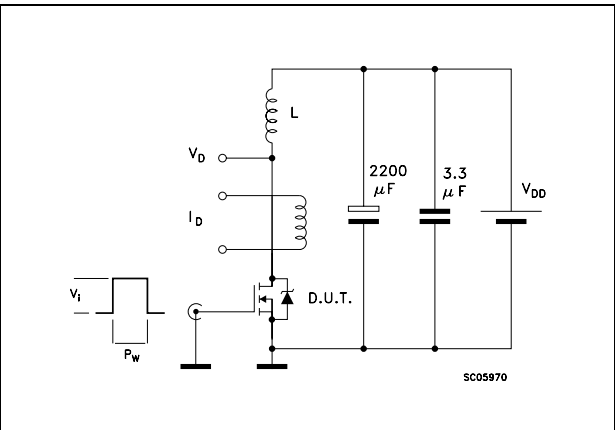
**Figure 20. Gate charge test circuit**



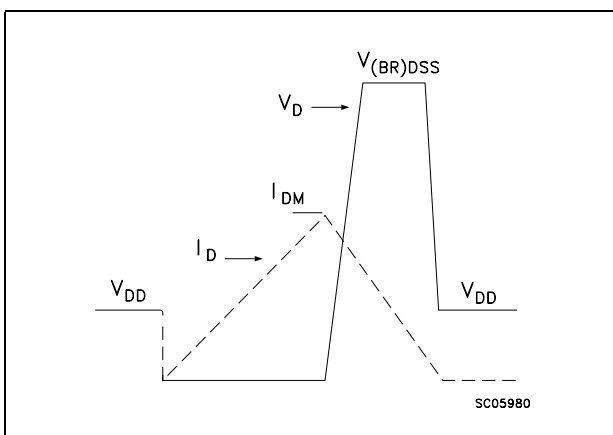
**Figure 21. Test circuit for inductive load switching and diode recovery times**



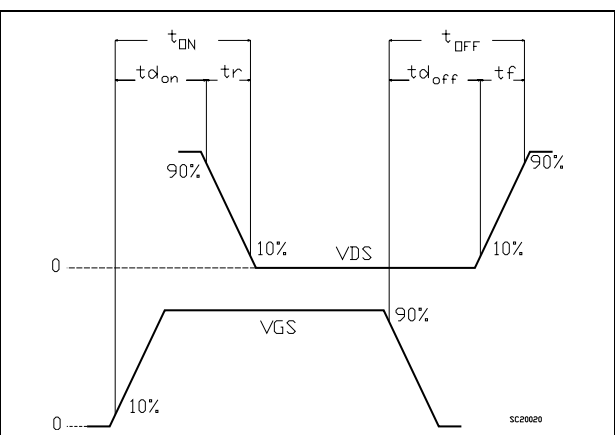
**Figure 22. Unclamped Inductive load test circuit**



**Figure 23. Unclamped inductive waveform**



**Figure 24. Switching time waveform**

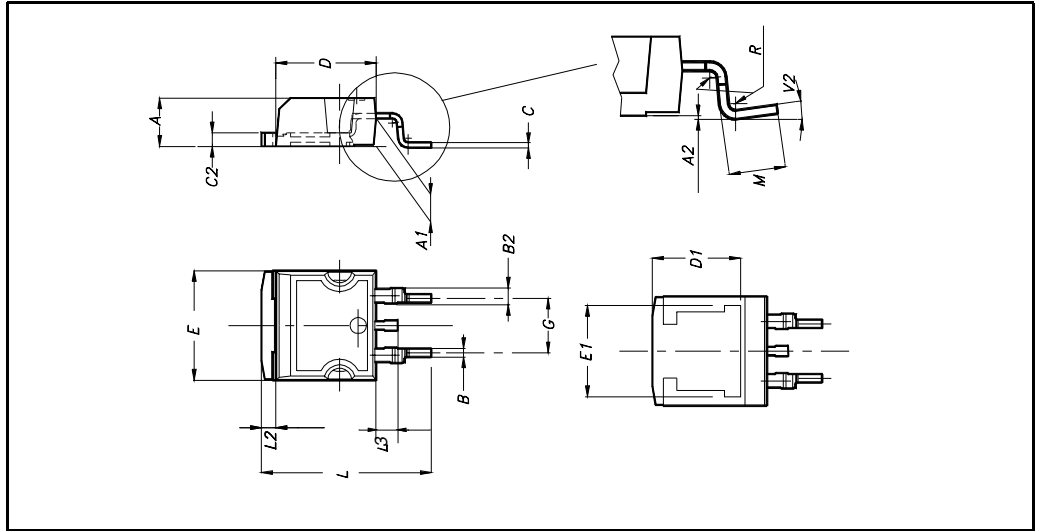


## 5 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect . The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com)

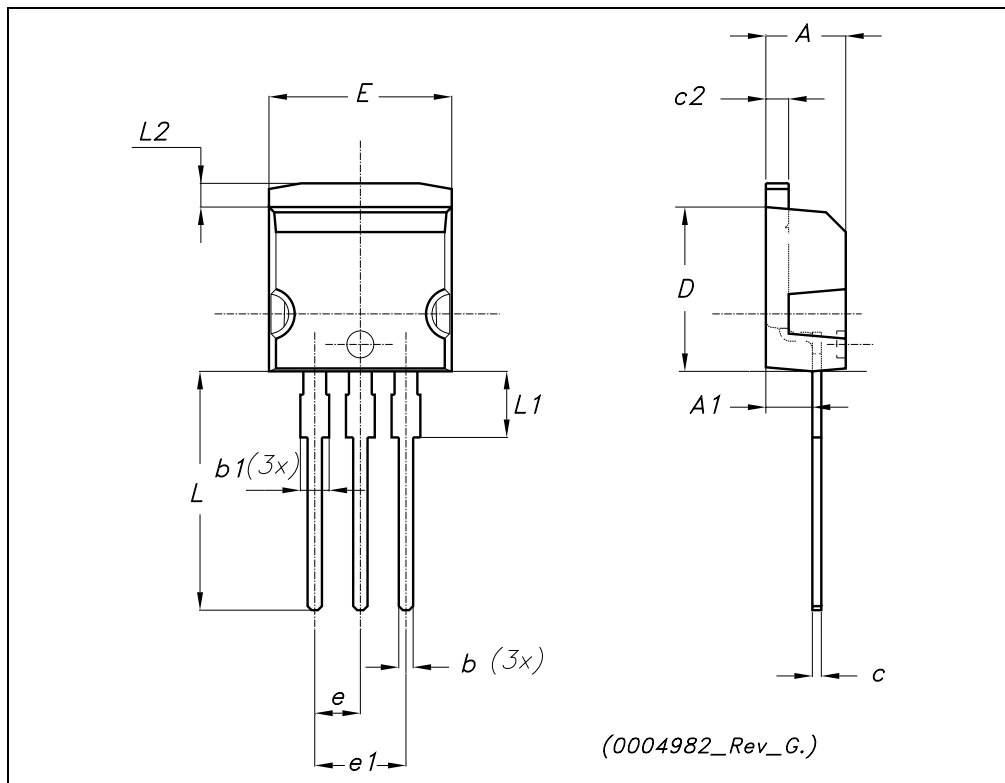
**D<sup>2</sup>PAK MECHANICAL DATA**

| DIM. | mm.  |      |       | inch  |       |       |
|------|------|------|-------|-------|-------|-------|
|      | MIN. | TYP. | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 4.4  |      | 4.6   | 0.173 |       | 0.181 |
| A1   | 2.49 |      | 2.69  | 0.098 |       | 0.106 |
| A2   | 0.03 |      | 0.23  | 0.001 |       | 0.009 |
| B    | 0.7  |      | 0.93  | 0.027 |       | 0.036 |
| B2   | 1.14 |      | 1.7   | 0.044 |       | 0.067 |
| C    | 0.45 |      | 0.6   | 0.017 |       | 0.023 |
| C2   | 1.23 |      | 1.36  | 0.048 |       | 0.053 |
| D    | 8.95 |      | 9.35  | 0.352 |       | 0.368 |
| D1   |      | 8    |       |       | 0.315 |       |
| E    | 10   |      | 10.4  | 0.393 |       |       |
| E1   |      | 8.5  |       |       | 0.334 |       |
| G    | 4.88 |      | 5.28  | 0.192 |       | 0.208 |
| L    | 15   |      | 15.85 | 0.590 |       | 0.625 |
| L2   | 1.27 |      | 1.4   | 0.050 |       | 0.055 |
| L3   | 1.4  |      | 1.75  | 0.055 |       | 0.068 |
| M    | 2.4  |      | 3.2   | 0.094 |       | 0.126 |
| R    |      | 0.4  |       |       | 0.015 |       |
| V2   | 0°   |      | 4°    |       |       |       |



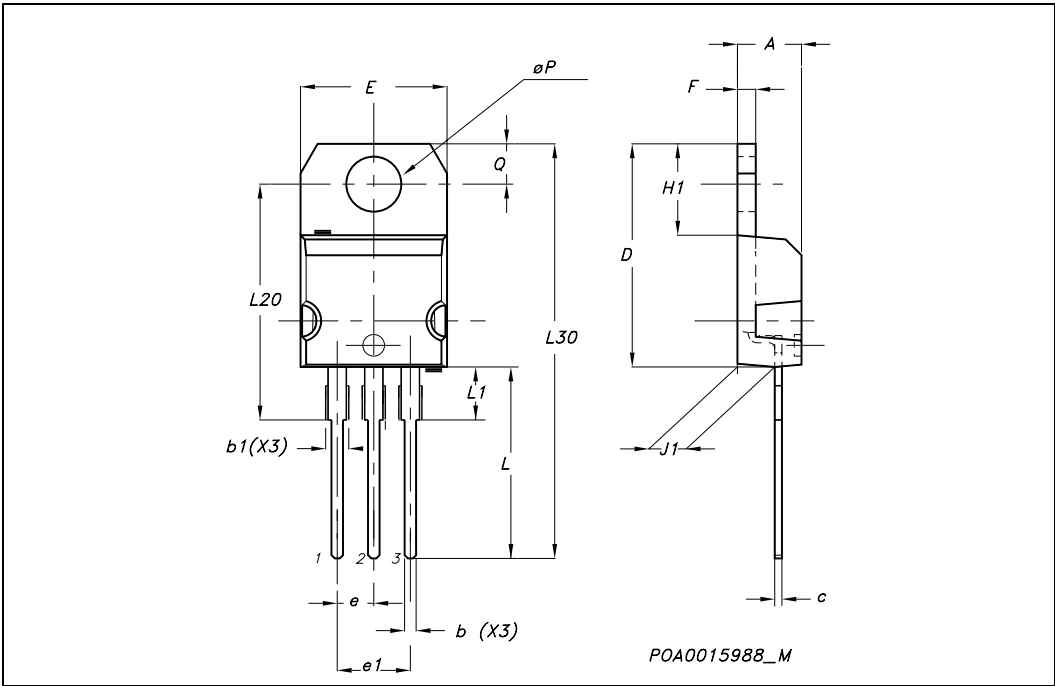
**TO-262 (I<sup>2</sup>PAK) MECHANICAL DATA**

| DIM. | mm.  |      |       | inch  |      |       |
|------|------|------|-------|-------|------|-------|
|      | MIN. | TYP. | MAX.  | MIN.  | TYP. | MAX.  |
| A    | 4.40 |      | 4.60  | 0.173 |      | 0.181 |
| A1   | 2.40 |      | 2.72  | 0.094 |      | 0.107 |
| b    | 0.61 |      | 0.88  | 0.024 |      | 0.034 |
| b1   | 1.14 |      | 1.70  | 0.044 |      | 0.066 |
| c    | 0.49 |      | 0.70  | 0.019 |      | 0.027 |
| c2   | 1.23 |      | 1.32  | 0.048 |      | 0.052 |
| D    | 8.95 |      | 9.35  | 0.352 |      | 0.368 |
| e    | 2.40 |      | 2.70  | 0.094 |      | 0.106 |
| e1   | 4.95 |      | 5.15  | 0.194 |      | 0.202 |
| E    | 10   |      | 10.40 | 0.393 |      | 0.410 |
| L    | 13   |      | 14    | 0.511 |      | 0.551 |
| L1   | 3.50 |      | 3.93  | 0.137 |      | 0.154 |
| L2   | 1.27 |      | 1.40  | 0.050 |      | 0.055 |



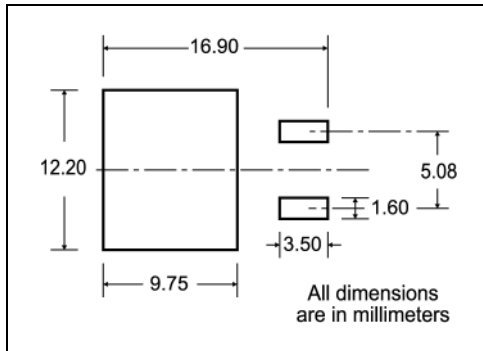
**TO-220 MECHANICAL DATA**

| DIM. | mm.   |       |       | inch  |       |       |
|------|-------|-------|-------|-------|-------|-------|
|      | MIN.  | TYP.  | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 4.40  |       | 4.60  | 0.173 |       | 0.181 |
| b    | 0.61  |       | 0.88  | 0.024 |       | 0.034 |
| b1   | 1.15  |       | 1.70  | 0.045 |       | 0.066 |
| c    | 0.49  |       | 0.70  | 0.019 |       | 0.027 |
| D    | 15.25 |       | 15.75 | 0.60  |       | 0.620 |
| E    | 10    |       | 10.40 | 0.393 |       | 0.409 |
| e    | 2.40  |       | 2.70  | 0.094 |       | 0.106 |
| e1   | 4.95  |       | 5.15  | 0.194 |       | 0.202 |
| F    | 1.23  |       | 1.32  | 0.048 |       | 0.052 |
| H1   | 6.20  |       | 6.60  | 0.244 |       | 0.256 |
| J1   | 2.40  |       | 2.72  | 0.094 |       | 0.107 |
| L    | 13    |       | 14    | 0.511 |       | 0.551 |
| L1   | 3.50  |       | 3.93  | 0.137 |       | 0.154 |
| L20  |       | 16.40 |       |       | 0.645 |       |
| L30  |       | 28.90 |       |       | 1.137 |       |
| øP   | 3.75  |       | 3.85  | 0.147 |       | 0.151 |
| Q    | 2.65  |       | 2.95  | 0.104 |       | 0.116 |



## 6 Packaging mechanical data

### D<sup>2</sup>PAK FOOTPRINT



### TAPE AND REEL SHIPMENT

**TAPE MECHANICAL DATA**

| DIM. | mm   |      | inch   |        |
|------|------|------|--------|--------|
|      | MIN. | MAX. | MIN.   | MAX.   |
| A0   | 10.5 | 10.7 | 0.413  | 0.421  |
| B0   | 15.7 | 15.9 | 0.618  | 0.626  |
| D    | 1.5  | 1.6  | 0.059  | 0.063  |
| D1   | 1.59 | 1.61 | 0.062  | 0.063  |
| E    | 1.65 | 1.85 | 0.065  | 0.073  |
| F    | 11.4 | 11.6 | 0.449  | 0.456  |
| K0   | 4.8  | 5.0  | 0.189  | 0.197  |
| P0   | 3.9  | 4.1  | 0.153  | 0.161  |
| P1   | 11.9 | 12.1 | 0.468  | 0.476  |
| P2   | 1.9  | 2.1  | 0.075  | 0.082  |
| R    | 50   |      | 1.574  |        |
| T    | 0.25 | 0.35 | 0.0098 | 0.0137 |
| W    | 23.7 | 24.3 | 0.933  | 0.956  |

**REEL MECHANICAL DATA**

| DIM. | mm   |      | inch  |        |
|------|------|------|-------|--------|
|      | MIN. | MAX. | MIN.  | MAX.   |
| A    |      | 330  |       | 12.992 |
| B    | 1.5  |      | 0.059 |        |
| C    | 12.8 | 13.2 | 0.504 | 0.520  |
| D    | 20.2 |      | 0.795 |        |
| G    | 24.4 | 26.4 | 0.960 | 1.039  |
| N    | 100  |      | 3.937 |        |
| T    |      | 30.4 |       | 1.197  |

| BASE QTY | BULK QTY |
|----------|----------|
| 1000     | 1000     |

10 pitches cumulative tolerance on tape +/- 0.2 mm

\* on sales type



## 7 Revision history

**Table 7. Revision history**

| Date        | Revision | Changes  |
|-------------|----------|--|
| 21-Jun-2004 | 2        | Preliminary datasheet  |
| 19-Jun-2006 | 3        | New template, content change   |
| 28-Jun-2006 | 4        | Graphical updates, <a href="#">Figure 10</a> and <a href="#">Figure 13</a> |

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