



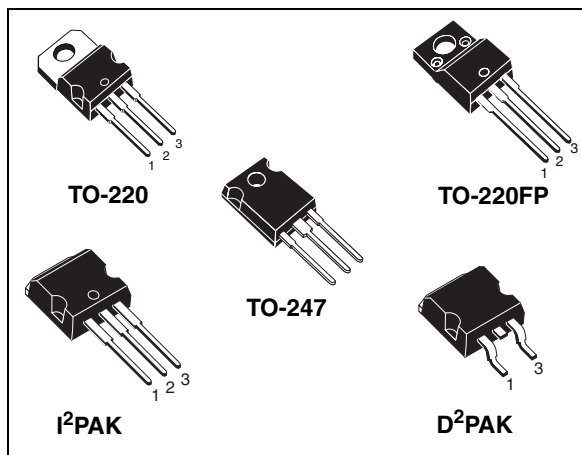
# STP14NK50Z - STP14NK50ZFP STB14NK50Z-STB14NK50Z-1-STW14NK50Z

N-channel 500V - 0.34Ω - 14A TO-220/FP/D<sup>2</sup>PAK/I<sup>2</sup>PAK/TO-247  
Zener-protected SuperMESH™ Power MOSFET

## General features

| Type         | V <sub>DSS</sub> | R <sub>DS(on)</sub> | I <sub>D</sub> | P <sub>w</sub> |
|--------------|------------------|---------------------|----------------|----------------|
| STP14NK50Z   | 500V             | <0.38Ω              | 14A            | 150W           |
| STP14NK50ZFP | 500V             | <0.38Ω              | 14A            | 35W            |
| STB14NK50Z   | 500V             | <0.38Ω              | 14A            | 150W           |
| STB14NK50Z-1 | 500V             | <0.38Ω              | 14A            | 150W           |
| STW14NK50Z   | 500V             | <0.38Ω              | 14A            | 150W           |

- Extremely high dv/dt capability
- 100% avalanche tested
- Gate charge minimized
- Very low intrinsic capacitances
- Very good manufacturing repeatability



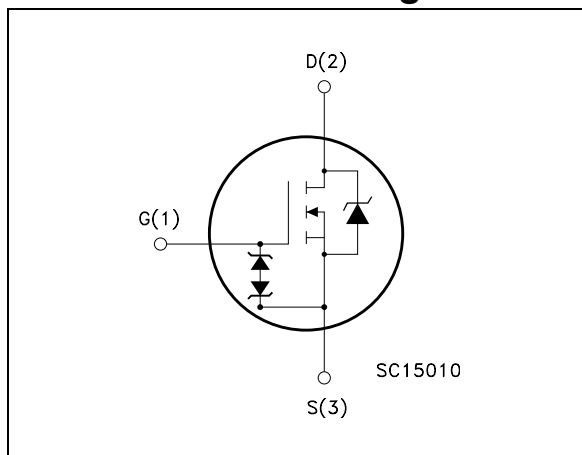
## Description

The SuperMESH™ series is obtained through an extreme optimization of ST's well established strip-based PowerMESH™ layout. In addition to pushing on-resistance significantly down, special care is taken to ensure a very good dv/dt capability for the most demanding applications. Such series complements ST full range of high voltage MOSFETs including revolutionary MDmesh™ products.

## Applications

- Switching application

## Internal schematic diagram



## Order codes

| Part number  | Marking    | Package            | Packaging   |
|--------------|------------|--------------------|-------------|
| STP14NK50Z   | P14NK50Z   | TO-220             | Tube        |
| STP14NK50ZFP | P14NK50ZFP | TO-220FP           | Tube        |
| STB14NK50ZT4 | B14NK50Z   | D <sup>2</sup> PAK | Tape & reel |
| STB14NK50Z-1 | B14NK50Z   | I <sup>2</sup> PAK | Tube        |
| STW14NK50Z   | W14NK50Z   | TO-247             | Tube        |

## Contents

|          |   |           |
|----------|---|-----------|
| <b>1</b> | <b>Electrical ratings</b> .....               | <b>3</b>  |
| <b>2</b> | <b>Electrical characteristics</b> .....       | <b>5</b>  |
|          | 2.1 Electrical characteristics (curves) ..... | 7         |
| <b>3</b> | <b>Test circuit</b> .....                     | <b>10</b> |
| <b>4</b> | <b>Package mechanical data</b> .....          | <b>11</b> |
| <b>5</b> | <b>Packaging mechanical data</b> .....        | <b>17</b> |
| <b>6</b> | <b>Revision history</b> .....                 | <b>18</b> |

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol                             | Parameter  | Value   |                    |        | Unit |
|------------------------------------|--|---|--------------------|--------|------|
|                                    |  | TO-220<br>I <sup>2</sup> PAK/D <sup>2</sup> PAK | TO-220FP           | TO-247 |      |
| V <sub>DS</sub>                    | Drain-source voltage (V <sub>GS</sub> = 0)             | 500   |                    |        | V    |
| V <sub>DGR</sub>                   | Drain-gate voltage (R <sub>GS</sub> = 20KΩ)            | 500   |                    |        | V    |
| V <sub>GS</sub>                    | Gate-source voltage                                    | ± 30  |                    |        | V    |
| I <sub>D</sub>                     | Drain current (continuous)<br>at T <sub>C</sub> = 25°C | 14  | 14 <sup>(1)</sup>  | 14     | A    |
| I <sub>D</sub>                     | Drain current (continuous)<br>at T <sub>C</sub> =100°C | 7.6   | 7.6 <sup>(1)</sup> | 7.6    | A    |
| I <sub>DM</sub> <sup>(2)</sup>     | Drain current (pulsed)                                 | 48  | 48 <sup>(1)</sup>  | 48     | A    |
| P <sub>TOT</sub>                   | Total dissipation at T <sub>C</sub> = 25°C             | 150   | 35                 | 150    | W    |
|                                    | Derating factor  | 1.20  | 0.28               | 1.20   | W/°C |
| Vesd(G-S)                          | G-S ESD (HBM C=100pF, R=1.5kΩ)                         | 4000  |                    |        | KV   |
| dv/dt <sup>(3)</sup>               | Peak diode recovery voltage slope                      | 4.5   |                    |        | V/ns |
| V <sub>ISO</sub>                   | Insulation withstand voltage (DC)                      | --  | 2500               |        | V    |
| T <sub>J</sub><br>T <sub>stg</sub> | Operating junction temperature<br>Storage temperature  | -55 to 150                                      |                    |        | °C   |

- Limited only by maximum temperature allowed
- Pulse width limited by safe operating area
- I<sub>SD</sub> ≤ 3A, di/dt ≤ 200A/μs, V<sub>DD</sub> ≤ V<sub>(BR)DSS</sub>, T<sub>J</sub> ≤ T<sub>JMAX</sub>

**Table 2. Thermal data**

| Symbol                | Parameter   | Value                        |                    |          |        | Unit     |
|-----------------------|---|------------------------------|--------------------|----------|--------|----------|
|                       |   | TO-220<br>I <sup>2</sup> PAK | D <sup>2</sup> PAK | TO-220FP | TO-247 |          |
| R <sub>thj-case</sub> | Thermal resistance junction-case Max              | 0.83                         |                    | 3.6      | 0.83   | °C/<br>W |
| R <sub>thj-pcb</sub>  | Thermal resistance junction-pcb Max<br>(1)        |                              | 60                 |          |        | °C/<br>W |
| R <sub>thj-a</sub>    | Thermal resistance junction-ambient<br>Max        | 62.5                         |                    |          | 50     | °C/<br>W |
| T <sub>I</sub>        | Maximum lead temperature for<br>soldering purpose | 300                          |                    |          |        | °C       |

- When mounted on minimum footprint

**Table 3. Avalanche characteristics**

| Symbol   | Parameter   | Value | Unit |
|----------|---|-------|------|
| $I_{AR}$ | Avalanche current, repetitive or not-repetitive (pulse width limited by Tj Max) | 12    | A    |
| $E_{AS}$ | Single pulse avalanche energy (starting Tj=25°C, Id=Iar, Vdd=50V)               | 400   | mJ   |

**Table 4. Gate-source zener diode**

| Symbol     | Parameter                     | Test conditions       | Min. | Typ. | Max. | Unit |
|------------|-------------------------------|-----------------------|------|------|------|------|
| $BV_{GSO}$ | Gate-source breakdown voltage | Igs=±1mA (Open Drain) | 30   |      |      | V    |

## 1.1 Protection features og gate-to-source zener diodes

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 Electrical characteristics

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

**Table 5. On/off states**

| Symbol        | Parameter  | Test conditions   | Min. | Typ. | Max.     | Unit               |
|---------------|--|---|------|------|----------|--------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage                   | $I_D = 1mA, V_{GS} = 0$   | 500  |      |          | V                  |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = \text{Max rating},$<br>$V_{DS} = \text{Max rating}, T_C = 125^{\circ}C$ |      |      | 1<br>50  | $\mu A$<br>$\mu A$ |
| $I_{GSS}$     | Gate body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 20V$  |      |      | $\pm 10$ | nA                 |
| $V_{GS(th)}$  | Gate threshold voltage                           | $V_{DS} = V_{GS}, I_D = 100\mu A$   | 3    | 3.75 | 4.5      | V                  |
| $R_{DS(on)}$  | Static drain-source on resistance                | $V_{GS} = 10V, I_D = 6A$  |      | 0.34 | 0.38     | $\Omega$           |

**Table 6. Dynamic**

| Symbol                              | Parameter   | Test conditions                               | Min. | Typ.              | Max. | Unit           |
|-------------------------------------|---|---|------|-------------------|------|----------------|
| $g_{fs}^{(1)}$                      | Forward transconductance  | $V_{DS} = 8V, I_D = 6A$                       |      | 12                |      | S              |
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$ | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{DS} = 25V, f = 1 \text{ MHz}, V_{GS} = 0$ |      | 2000<br>238<br>55 |      | pF<br>pF<br>pF |
| $C_{oss \text{ eq}}^{(2)}$          | Equivalent output capacitance   | $V_{GS} = 0, V_{DS} = 0V \text{ to } 400V$    |      | 150               |      | pF             |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$       | Total gate charge<br>Gate-source charge<br>Gate-drain charge            | $V_{DD} = 400V, I_D = 12A$<br>$V_{GS} = 10V$  |      | 69<br>12<br>31    | 92   | nC<br>nC<br>nC |

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

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

**Table 7. Switching times**

| Symbol               | Parameter                       | Test conditions   | Min. | Typ.     | Max. | Unit     |
|----------------------|---------------------------------|---|------|----------|------|----------|
| $t_{d(on)}$<br>$t_r$ | Turn-on delay time<br>Rise time | $V_{DD} = 250 \text{ V}, I_D = 6A,$<br>$R_G = 4.7\Omega, V_{GS} = 10V$<br>(see Figure 19) |      | 24<br>16 |      | ns<br>ns |

**Table 7. Switching times**

|               |                       |   |  |     |  |    |
|---------------|-----------------------|---|--|-----|--|----|
| $t_{d(off)}$  | Turn-off delay time   | $V_{DD}=250V, I_D=6A,$<br>$R_G=4.7\Omega, V_{GS}=10V$<br>(see Figure 19)  |  | 54  |  | ns |
| $t_f$         | Fall time             |   |  | 12  |  | ns |
| $t_{r(Voff)}$ | Off-voltage rise time | $V_{DD}=400V, I_D=12A,$<br>$R_G=4.7\Omega, V_{GS}=10V$<br>(see Figure 21) |  | 9.5 |  | ns |
| $t_f$         | Fall time             |   |  | 9   |  | ns |
| $t_c$         | Cross-over time       |   |  | 20  |  | ns |

**Table 8. Source drain diode**

| Symbol          | Parameter                     | Test conditions  | Min | Typ. | Max | Unit    |
|-----------------|-------------------------------|--|-----|------|-----|---------|
| $I_{SD}$        | Source-drain current          |  |     |      | 12  | A       |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |  |     |      | 48  | A       |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD}=12A, V_{GS}=0$   |     |      | 1.6 | V       |
| $t_{rr}$        | Reverse recovery time         | $I_{SD}=12A,$<br>$di/dt = 100A/\mu s,$<br>$V_{DD}=35V, T_J=150^\circ C$<br>(see Figure 21) |     | 470  |     | ns      |
| $Q_{rr}$        | Reverse recovery charge       |  |     | 3.1  |     | $\mu C$ |
| $I_{RRM}$       | Reverse recovery current      |  |     | 13.2 |     | 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

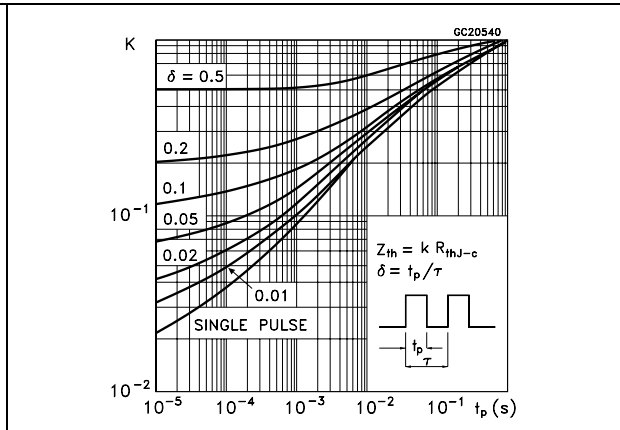
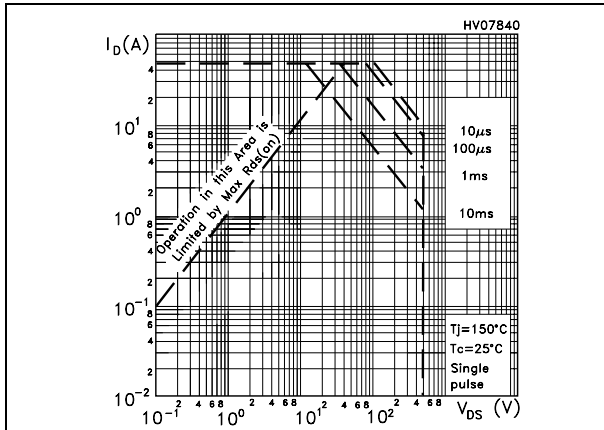


Figure 3. Safe operating area for TO-220FP

Figure 4. Thermal impedance for TO-220FP

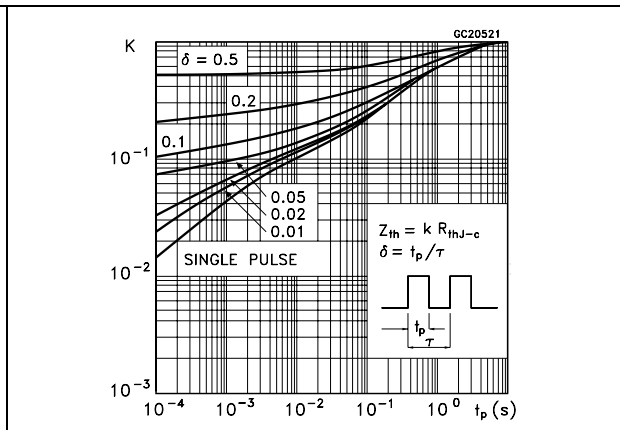
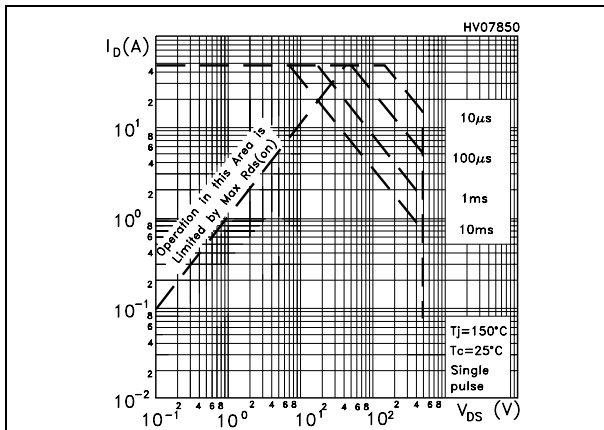


Figure 5. Safe operating area for TO-247

Figure 6. Thermal impedance for TO-247

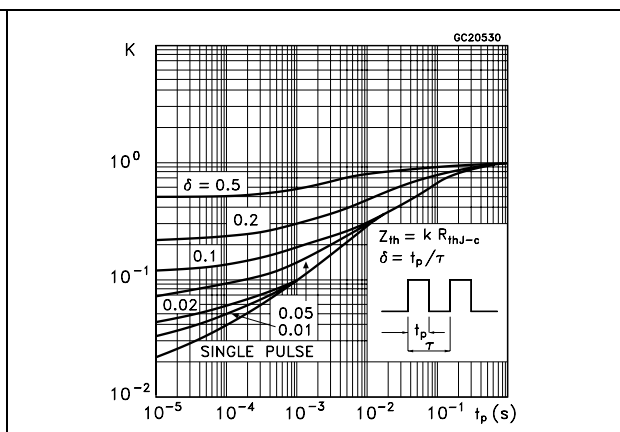
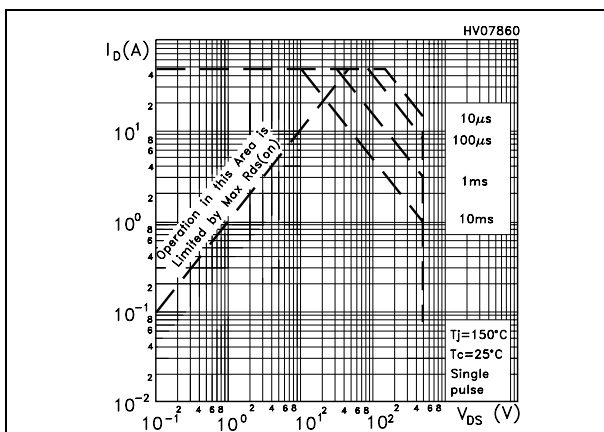


Figure 7. Output characteristics

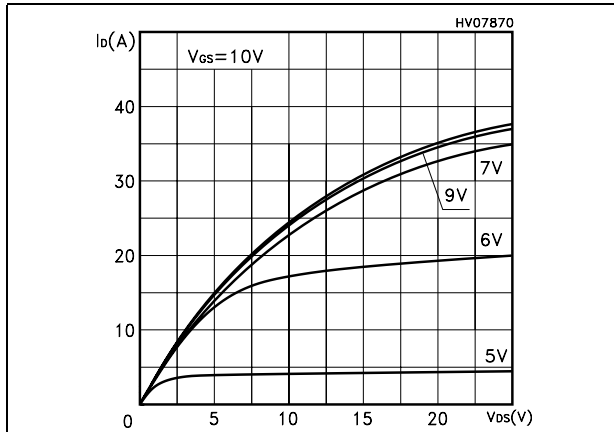


Figure 8. Transfer characteristics

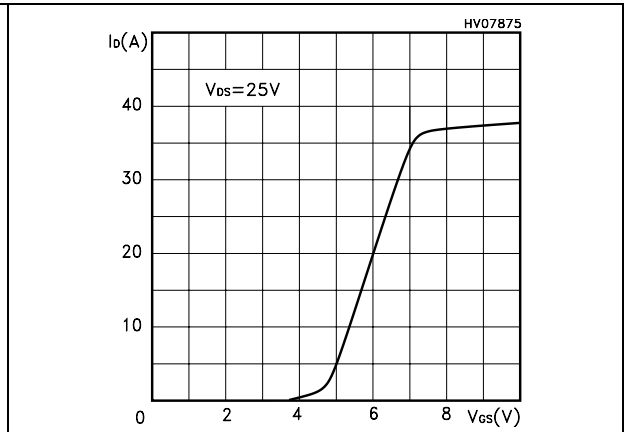


Figure 9. Transconductance

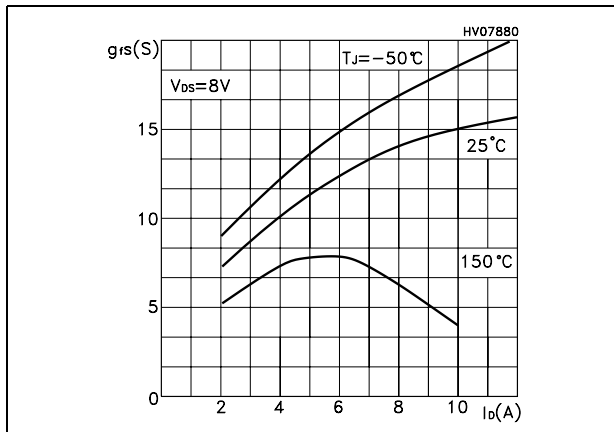


Figure 10. Static drain-source on resistance

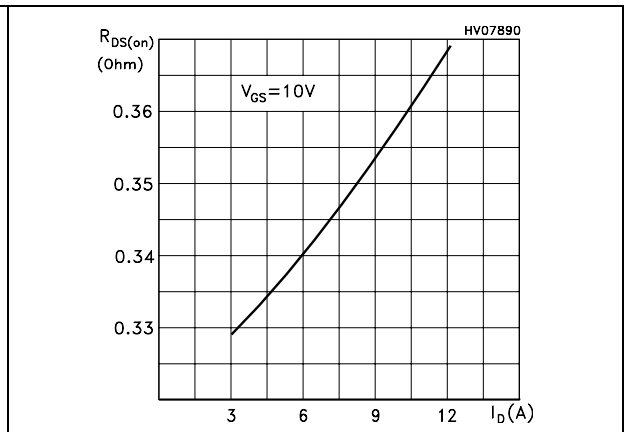


Figure 11. Gate charge vs gate-source voltage

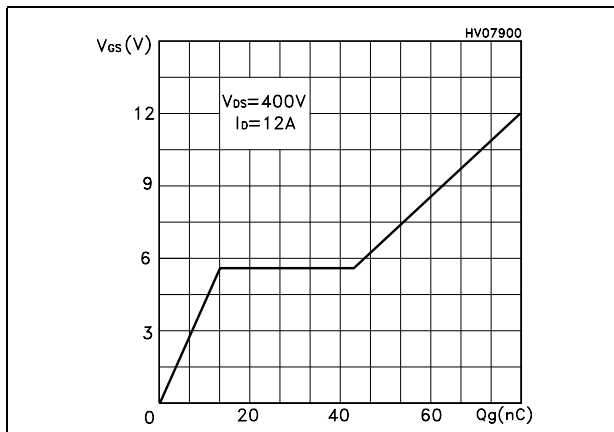


Figure 12. Capacitance variations

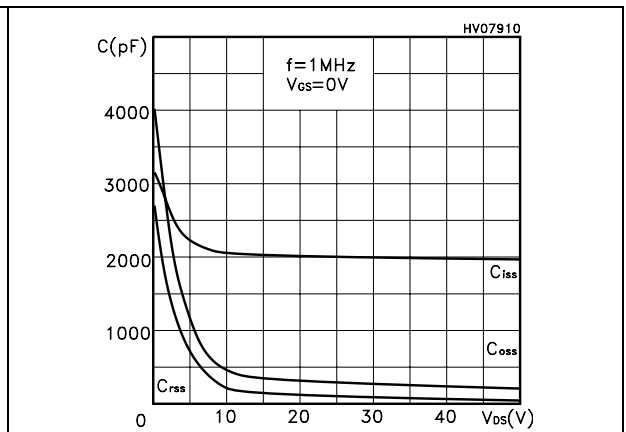




Figure 13. Normalized gate threshold voltage vs temperature

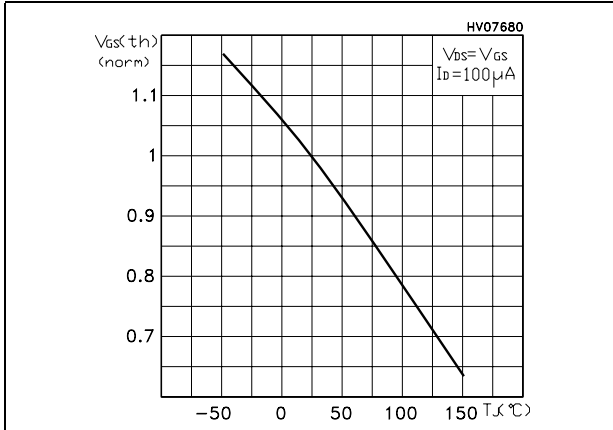


Figure 14. Normalized on resistance vs temperature

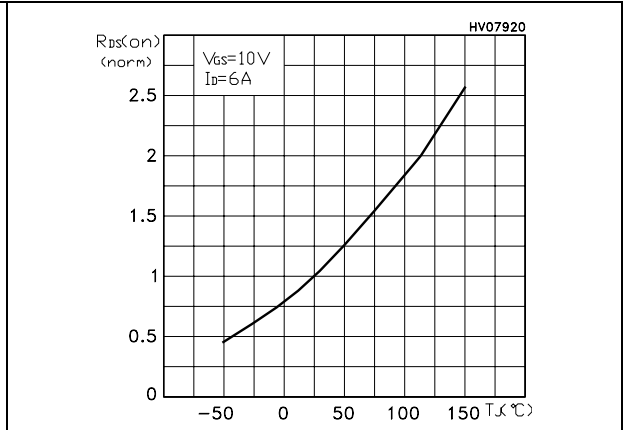


Figure 15. Source-drain diode forward characteristics

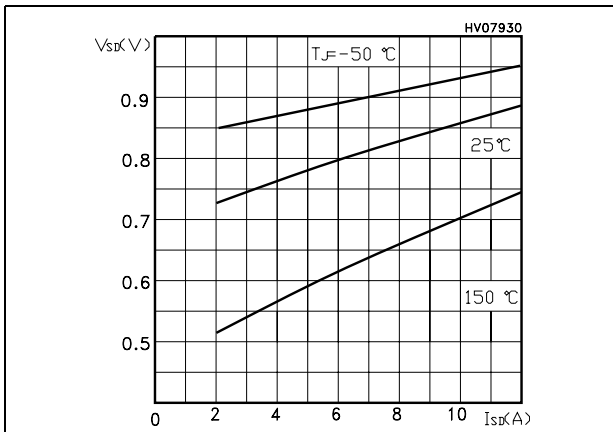


Figure 16. Normalized BV<sub>DSS</sub> vs temperature

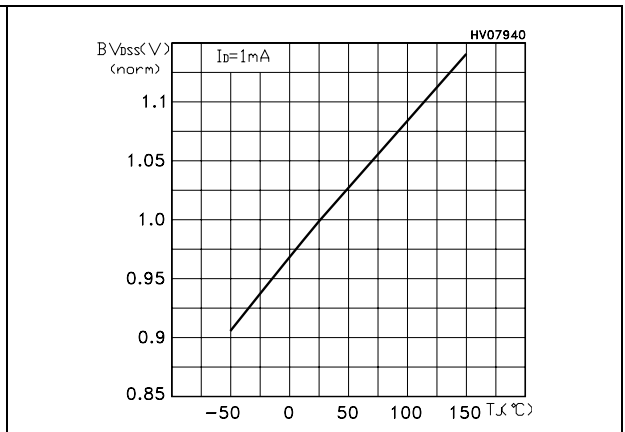


Figure 17. Normalized BV<sub>gso</sub> vs temperature

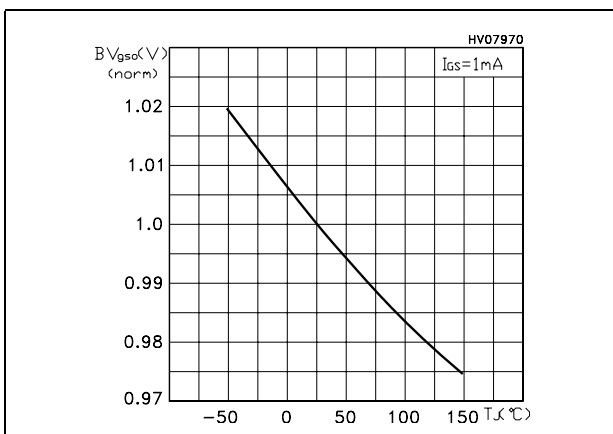
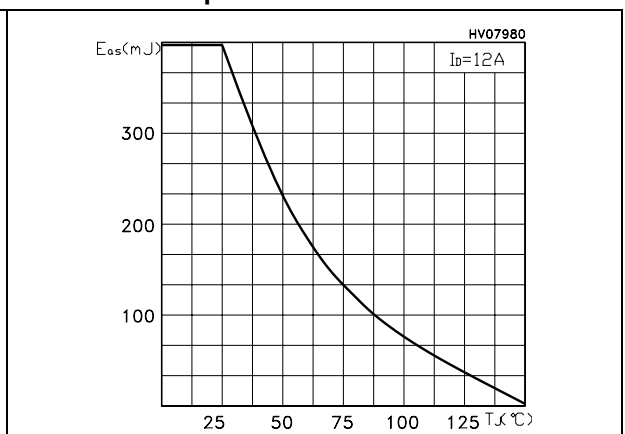


Figure 18. Maximum avalanche energy vs temperature



### 3 Test circuit

Figure 19. Switching times test circuit for resistive load

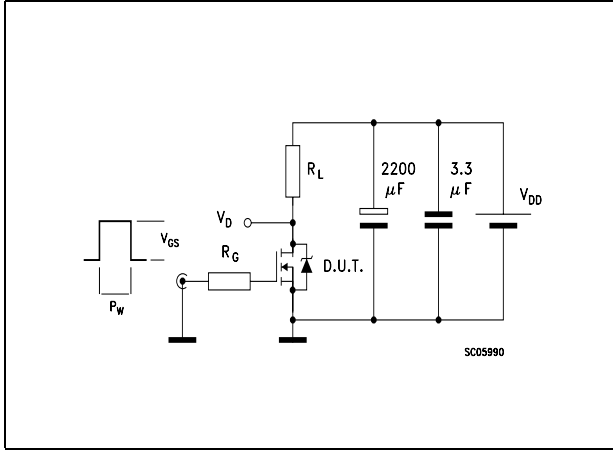


Figure 20. Gate charge test circuit



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



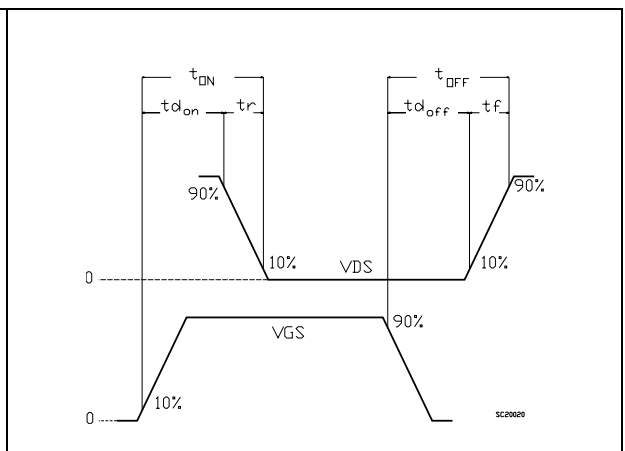
Figure 22. Unclamped Inductive load test circuit



Figure 23. Unclamped inductive waveform



Figure 24. Switching time waveform



## 4 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)

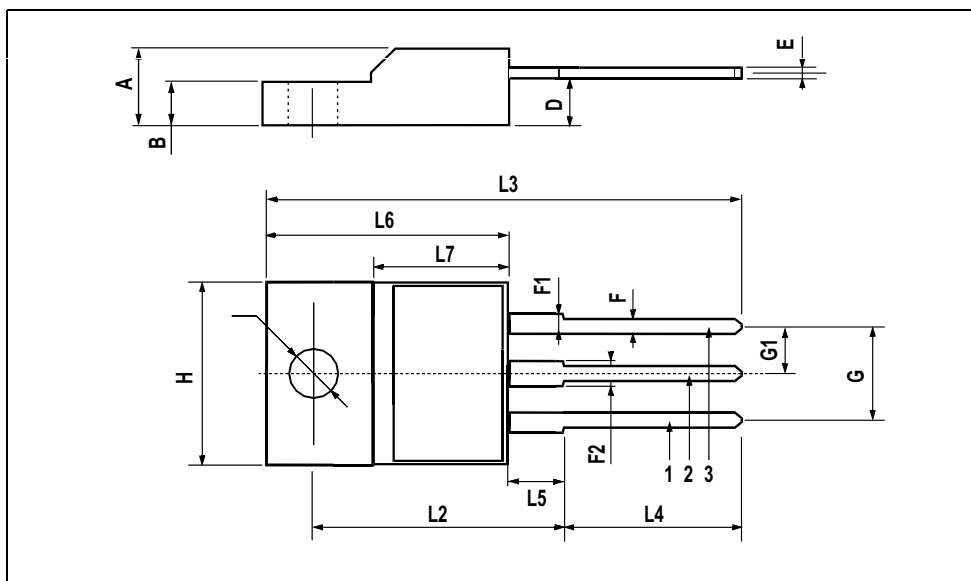
**TO-220 MECHANICAL DATA**

| 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 |



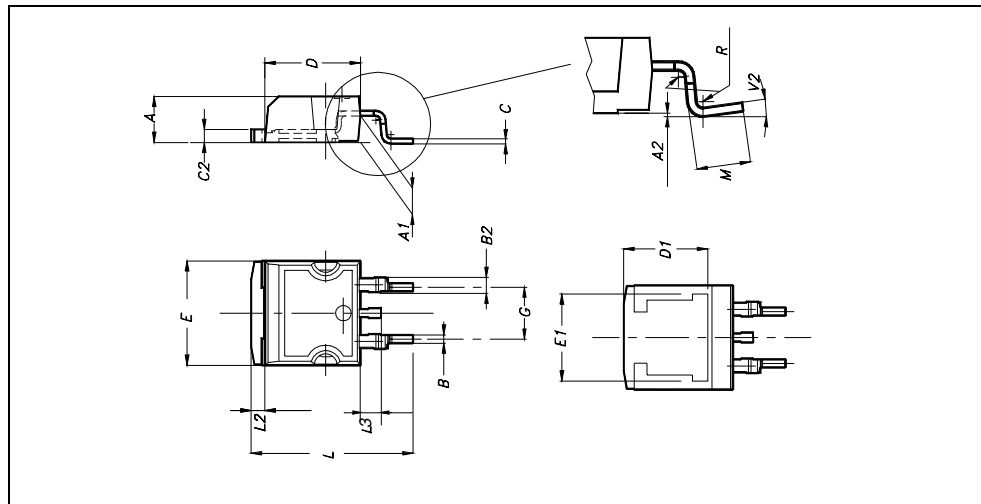
**TO-220FP MECHANICAL DATA**

| DIM. | mm.  |     |      | inch  |       |       |
|------|------|-----|------|-------|-------|-------|
|      | MIN. | TYP | MAX. | MIN.  | TYP.  | MAX.  |
| A    | 4.4  |     | 4.6  | 0.173 |       | 0.181 |
| B    | 2.5  |     | 2.7  | 0.098 |       | 0.106 |
| D    | 2.5  |     | 2.75 | 0.098 |       | 0.108 |
| E    | 0.45 |     | 0.7  | 0.017 |       | 0.027 |
| F    | 0.75 |     | 1    | 0.030 |       | 0.039 |
| F1   | 1.15 |     | 1.7  | 0.045 |       | 0.067 |
| F2   | 1.15 |     | 1.7  | 0.045 |       | 0.067 |
| G    | 4.95 |     | 5.2  | 0.195 |       | 0.204 |
| G1   | 2.4  |     | 2.7  | 0.094 |       | 0.106 |
| H    | 10   |     | 10.4 | 0.393 |       | 0.409 |
| L2   |      | 16  |      |       | 0.630 |       |
| L3   | 28.6 |     | 30.6 | 1.126 |       | 1.204 |
| L4   | 9.8  |     | 10.6 | .0385 |       | 0.417 |
| L5   | 2.9  |     | 3.6  | 0.114 |       | 0.141 |
| L6   | 15.9 |     | 16.4 | 0.626 |       | 0.645 |
| L7   | 9    |     | 9.3  | 0.354 |       | 0.366 |
| Ø    | 3    |     | 3.2  | 0.118 |       | 0.126 |



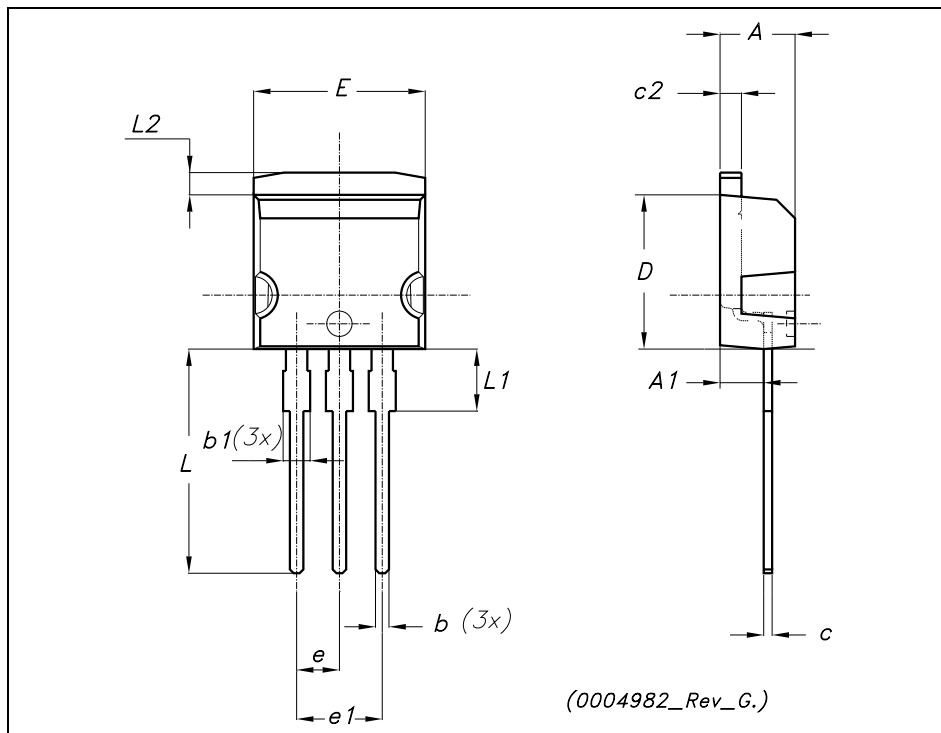
**D<sup>2</sup>PAK MECHANICAL DATA**

| 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°    |       |       |       |



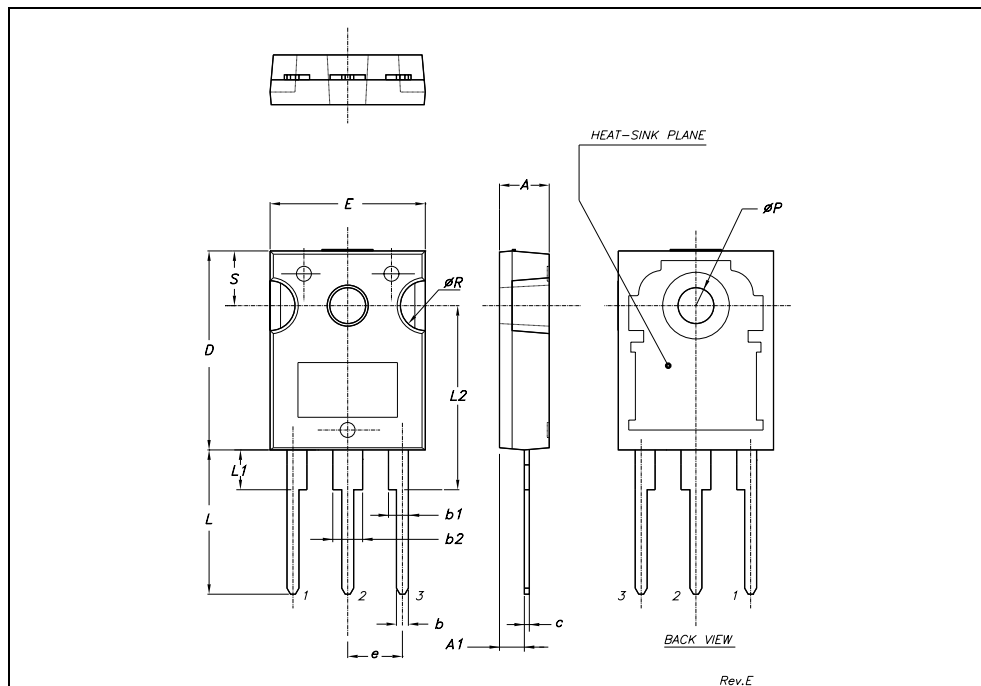
TO-262 (I<sup>2</sup>PAK) MECHANICAL DATA

| 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-247 MECHANICAL DATA**

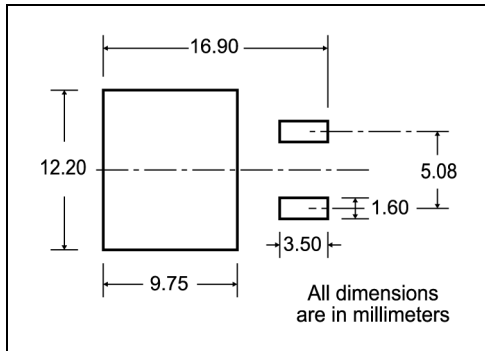
| DIM. | mm.   |       |       | inch  |       |       |
|------|-------|-------|-------|-------|-------|-------|
|      | MIN.  | TYP.  | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 4.85  |       | 5.15  | 0.19  |       | 0.20  |
| A1   | 2.20  |       | 2.60  | 0.086 |       | 0.102 |
| b    | 1.0   |       | 1.40  | 0.039 |       | 0.055 |
| b1   | 2.0   |       | 2.40  | 0.079 |       | 0.094 |
| b2   | 3.0   |       | 3.40  | 0.118 |       | 0.134 |
| c    | 0.40  |       | 0.80  | 0.015 |       | 0.03  |
| D    | 19.85 |       | 20.15 | 0.781 |       | 0.793 |
| E    | 15.45 |       | 15.75 | 0.608 |       | 0.620 |
| e    |       | 5.45  |       |       | 0.214 |       |
| L    | 14.20 |       | 14.80 | 0.560 |       | 0.582 |
| L1   | 3.70  |       | 4.30  | 0.14  |       | 0.17  |
| L2   |       | 18.50 |       |       | 0.728 |       |
| øP   | 3.55  |       | 3.65  | 0.140 |       | 0.143 |
| øR   | 4.50  |       | 5.50  | 0.177 |       | 0.216 |
| S    |       | 5.50  |       |       | 0.216 |       |





## 5 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     |

\* on sales type

## 6 Revision history

**Table 9. Revision history**

| Date        | Revision | Changes                         |
|-------------|----------|---------------------------------|
| 21-Jun-2004 | 2        | Complete version with curves    |
| 26-Jul-2006 | 3        | New template, no content change |

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