# STP6NK90Z - STP6NK90ZFP
# STB6NK90Z - STW7NK90Z

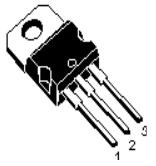
## N-channel 900V - 1.56Ω - 5.8A - TO-220/TO-220FP/D²PAK/TO-247
## Zener-protected SuperMESH™ Power MOSFET



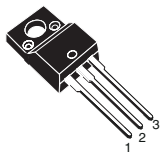
## Features

| Type | $V_{DSS}$ | $R_{DS(on)}$ | $I_D$ |
|---|---|---|---|
| STP6NK90Z | 900 V | < 2 Ω | 5.8 A |
| STP6NK90ZFP | 900 V | < 2 Ω | 5.8 A |
| STB6NK90Z | 900 V | < 2 Ω | 5.8 A |
| STW7NK90Z | 900 V | < 2 Ω | 5.8 A |

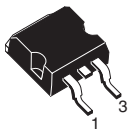
- Extremely high dv/dt capability
- 100% avalanche tested
- Gate charge minimized
- Very low intrinsic capacitances
- Very good manufacturing repeatability



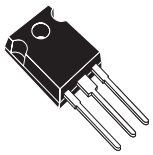

TO-220




TO-220FP




D²PAK



TO-247

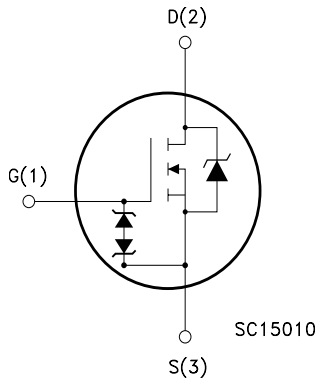
## Description

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.

## Application

- Switching application

## Internal schematic diagram




## Order codes

| Part number | Marking | Package | Packaging |
|---|---|---|---|
| STP6NK90Z | P6NK90Z | TO-220 | Tube |
| STP6NK90ZFP | P6NK90ZFP | TO-220FP | Tube |
| STB6NK90ZT4 | B6NK90Z | D²PAK | Tape e reel |
| STW7NK90Z | W7NK90Z | TO-247 | Tube |

# Contents

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol | Parameter | Value | | Unit |
|---|---|---|---|---|
| | | TO-220/ $D^2PAK$/TO247 | TO220FP | |
| $V_{DS}$ | Drain-source voltage ($V_{GS}$ = 0) | 900 | | V |
| $V_{GS}$ | Gate-source voltage | ± 30 | | V |
| $I_D$ | Drain current (continuous) at $T_C$ = 25°C | 5.8 | 5.8 (1) | A |
| $I_D$ | Drain current (continuous) at $T_C$ = 100°C | 3.65 | 3.65 (1) | A |
| $I_{DM}$ (2) | Drain current (pulsed) | 23.2 | 23.2 (1) | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25°C | 140 | 30 | W |
| | Derating factor | 1.12 | 0.24 | W/°C |
| dv/dt (3) | Peak diode recovery voltage slope | 4.5 | | V/ns |
| $V_{ISO}$ | Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1s; Tc= 25°C) | - | 2500 | V |
| $T_j$<br>$T_{stg}$ | Max operating junction temperature<br>Storage temperature | -55 to 150 | | °C<br>°C |

1. Limited only by maximum temperature allowed
2. Pulse width limited by safe operating area
3. $I_{SD}$ ≤5.8 A, di/dt ≤200A/µs, $V_{DD}$ ≤$V_{(BR)DSS}$, $T_j$ ≤$T_{JMAX}$.

**Table 2. Thermal data**

| Symbol | Parameter | Value | | | | Unit |
|---|---|---|---|---|---|---|
| | | TO-220 | $D^2PAK$ | TO-220FP | TO-247 | |
| $R_{thj\text{-}case}$ | Thermal resistance junction-case max | 0.89 | | 4.2 | 0.89 | °C/W |
| $R_{thj\text{-}pcb}$ | Thermal resistance junction-case max | | 60 | | | °C/W |
| $R_{thj\text{-}amb}$ | Thermal resistance junction-ambient max | 62.5 | | | 50 | °C/W |
| $T_l$ | Maximum lead temperature for soldering purpose | 300 | | | | °C |

**Table 3. Avalanche characteristics**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $I_{AR}$ | Avalanche current, repetitive or not-repetitive (pulse width limited by Tj Max) | 5.8 | A |
| $E_{AS}$ | Single pulse avalanche energy (starting Tj=25°C, Id=Iar, Vdd=50V) | 300 | 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 of 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°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 | 900 | | | V |
| $I_{DSS}$ | Zero gate voltage Drain current ($V_{GS}$ = 0)<br>$V_{DS}$ = Max Rating<br>$V_{DS}$ = Max Rating, $T_C$ = 125°C | | | | 1<br>50 | µA<br>µA |
| $I_{GSS}$ | Gate-body leakage Current ($V_{DS}$ = 0) | $V_{GS}$ = ± 20 V | | | ± 10 | µA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 100 µA | 3 | 3.75 | 4.5 | V |
| $R_{DS(on)}$ | Static drain-source on resistance | $V_{GS}$ = 10 V, $I_D$ = 2.9 A | | 1.56 | 2 | Ω |

**Table 6. Dynamic**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $g_{fs}$ (1) | Forward transconductance | $V_{DS}$ = 15v, $I_D$ = 2.9 A | | 5 | | S |
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$ | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{DS}$ = 25 V, f = 1 MHz, $V_{GS}$ = 0 | | 1350<br>130<br>26 | | pF<br>pF<br>pF |
| $C_{oss\ eq.}$ (2) | Equivalent output capacitance | $V_{DS}$ =0V, $V_{DS}$ = 0V to 720V | | 70 | | pF |
| $t_{d(on)}$<br>$t_r$<br>$t_{r(off)}$<br>$t_r$ | Turn-on delay time<br>Rise time<br>Turn-off delay time<br>Fall time | $V_{DD}$ = 450 V, $I_D$ = 3 A, $R_G$ = 4.7 Ω, $V_{GS}$ = 10 V (see *Figure 20*) | | 17<br>45<br>20<br>20 | | 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 | $V_{DD}$ = 720 V, $I_D$ = 5.8 A, $V_{GS}$ = 10 V | | 46.5<br>8.5<br>25 | 60.5 | nC<br>nC<br>nC |
| $T_{r(Voff)}$<br>$T_r$<br>$T_c$ | Off-voltage rise time<br>Fall time<br>Cross-over time | $V_{DD}$ = 720 V, $I_D$ = 5.8 A, $R_G$ = 4.7 Ω, $V_{GS}$ = 10 V (see *Figure 22*) | | 11<br>12<br>20 | | ns<br>ns<br>ns |

1. Pulsed: pulse duration=300µs, duty cycle 1.5%
2. $C_{oss\ eq.}$ 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. Source drain diode**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{SD}$<br>$I_{SDM}$(1) | Source-drain current<br>Source-drain current (pulsed) | | | | 5.8<br>23.2 | A<br>A |
| $V_{SD}$(2) | Forward on voltage | $I_{SD}$ = 5.8 A, $V_{GS}$ = 0 | | | 1.6 | V |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_{SD}$ = 5.8 A, di/dt = 100 A/µs<br>$V_{DD}$ = 36 V, Tj = 150°C<br>(see *Figure 22*) | | 840<br>5880<br>14 | | ns<br>µC<br>A |

1. Pulsed: pulse duration=300µs, duty cycle 1.5%
2. Pulse width limited by safe operating area

## 2.1 Electrical characteristics (curves)

**Figure 1. Safe operating area for TO-220/ D²PAK**

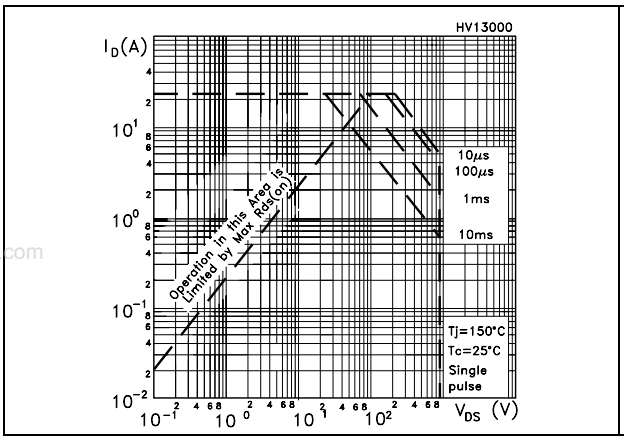



**Figure 2. Thermal impedance for TO-220/ D²PAK**

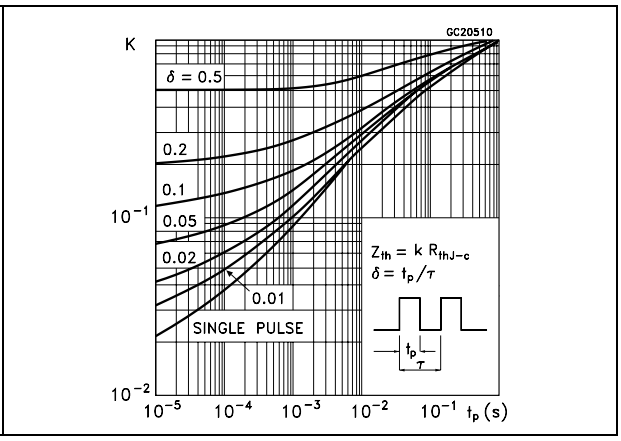



**Figure 3. Safe operating area for TO-220FP**

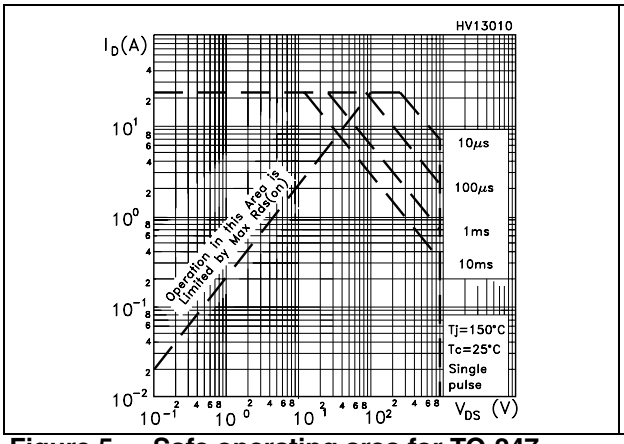



**Figure 4. Thermal impedance for TO-220FP**

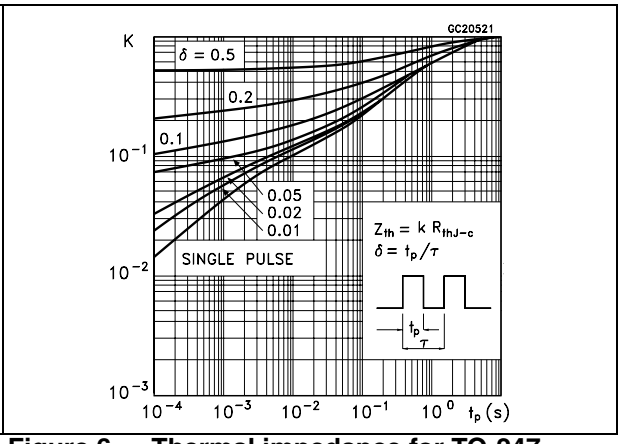



**Figure 5. Safe operating area for TO-247**

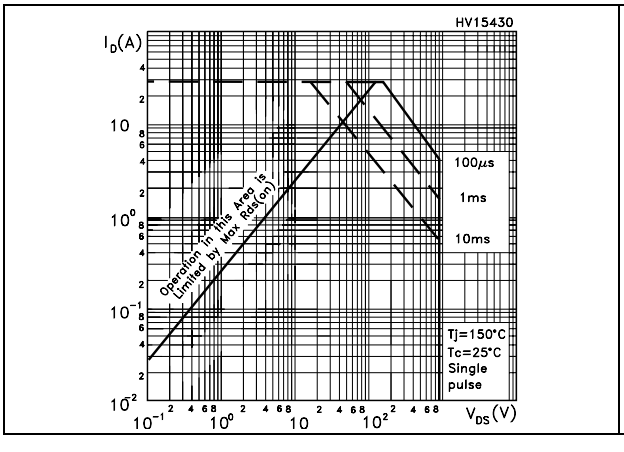



**Figure 6. Thermal impedance for TO-247**

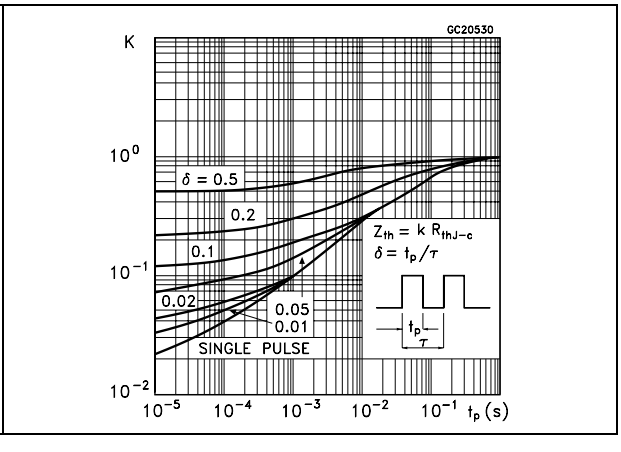


**Figure 7. Output characterisics**

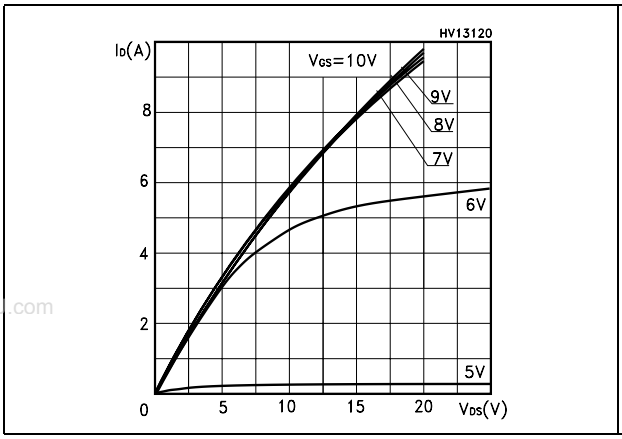



**Figure 8. Transfer characteristics**

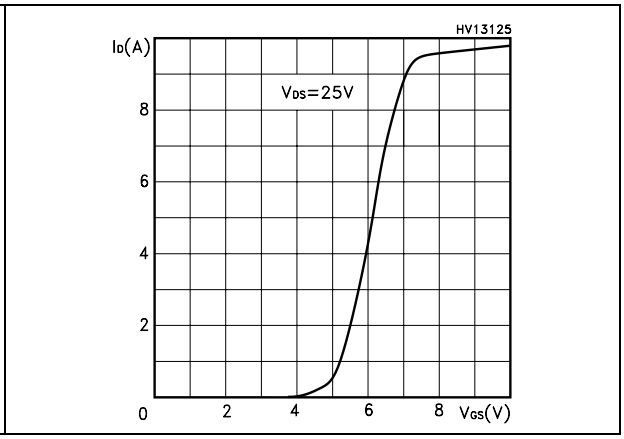





**Figure 9. Transconductance**

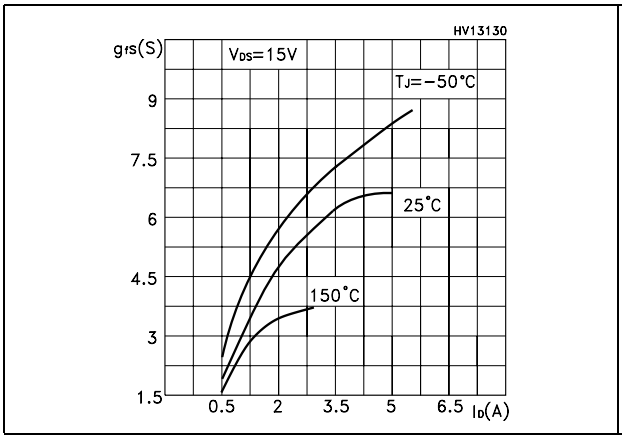



**Figure 10. Static drain-source on resistance**

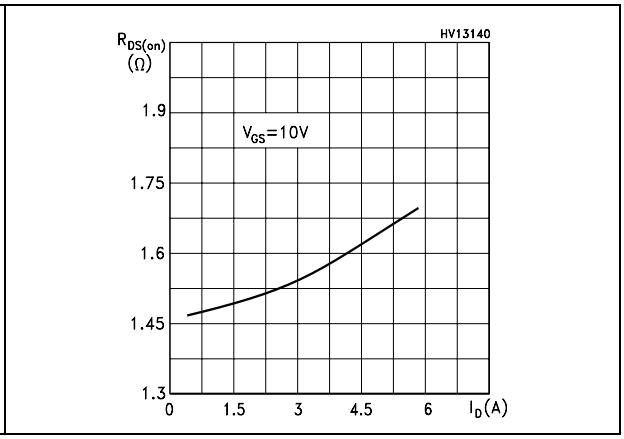



**Figure 11. Gate charge vs gate-source voltage**

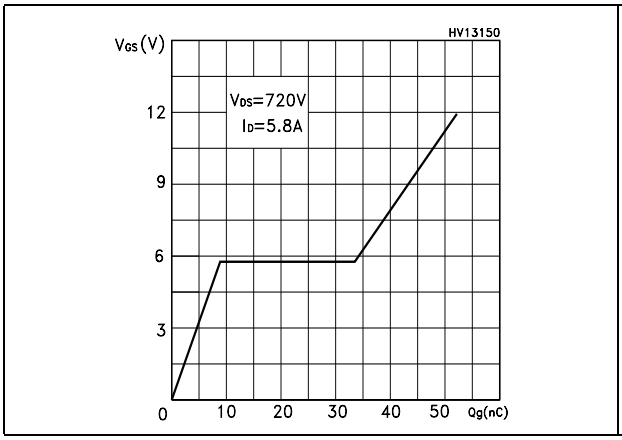



**Figure 12. Capacitance variations**

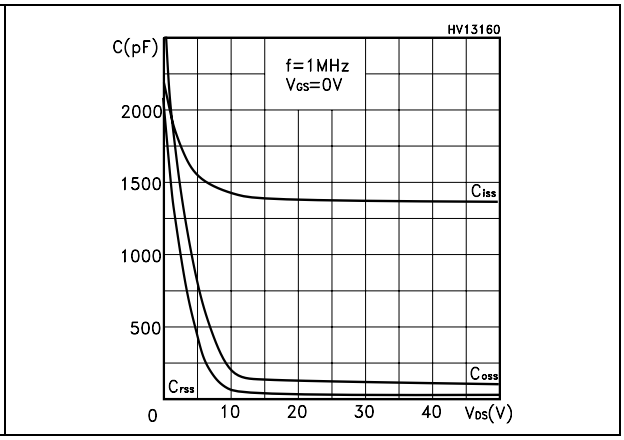


**Figure 13. Normalized gate threshold voltage vs temperature**

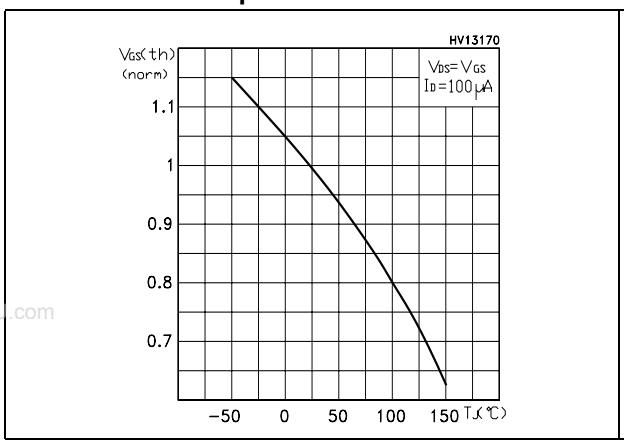



**Figure 14. Normalized on resistance vs temperature**

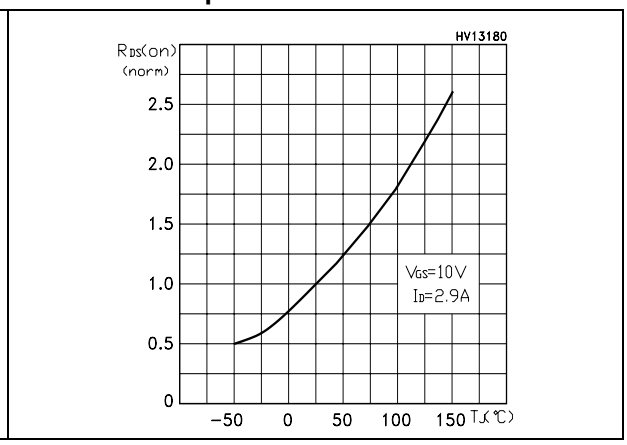



**Figure 15. Source-drain diode forward characteristic**

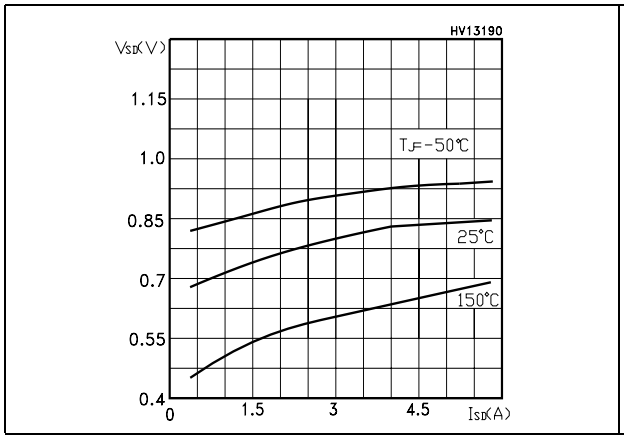



**Figure 16. Normalized BVDSS vs temperature**

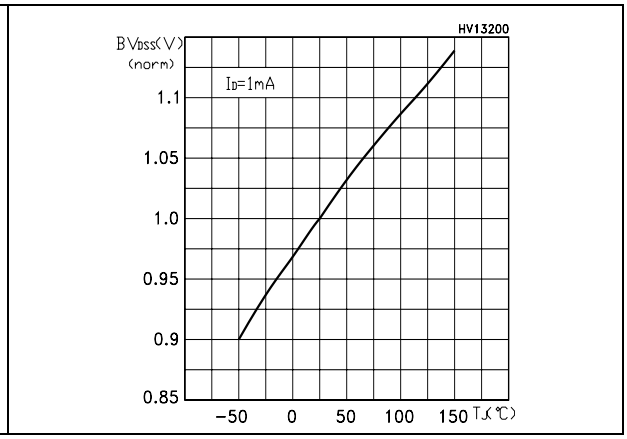
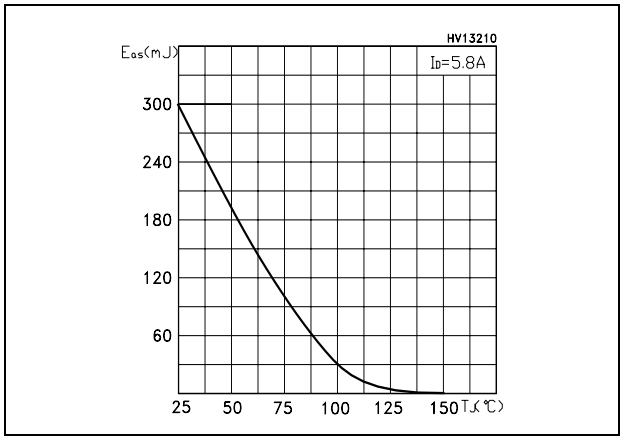



**Figure 17. Maximum avalanche energy vs temperature**



# 3 Test circuit

**Figure 18. Unclamped inductive load test circuit**

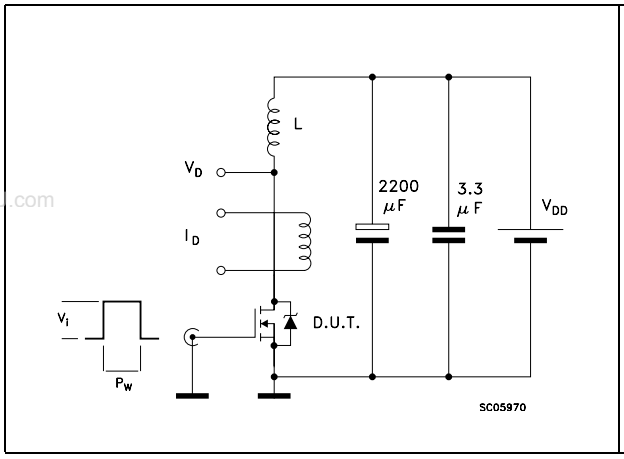



**Figure 19. Unclamped inductive waveform**

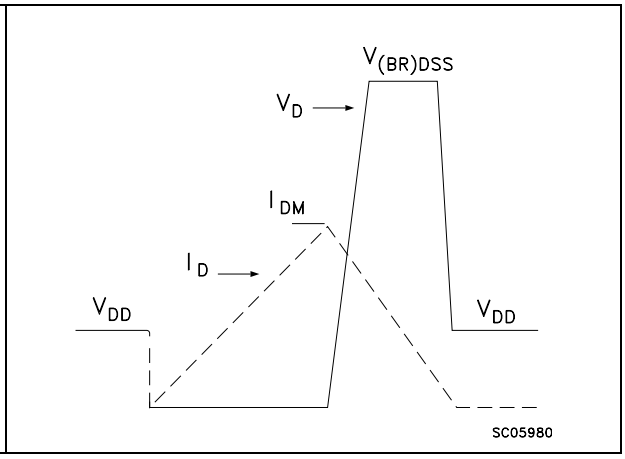



**Figure 20. Switching times test circuit for resistive load**

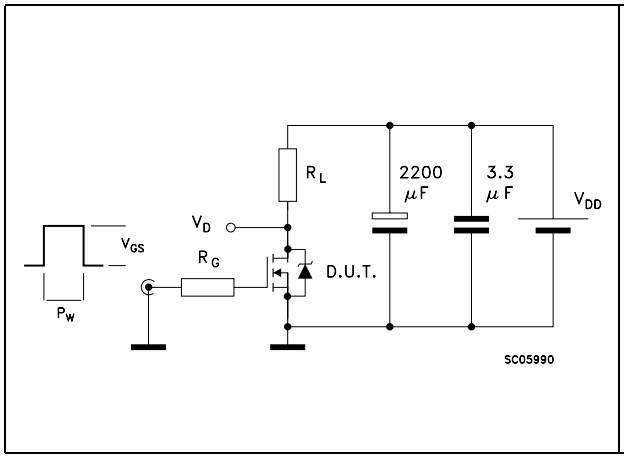



**Figure 21. Gate charge test circuit**

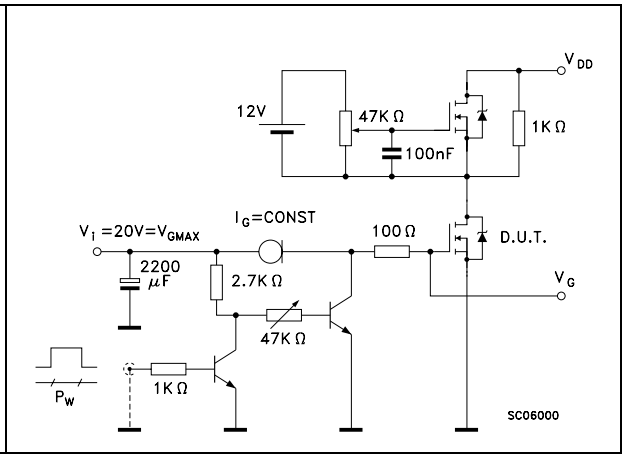
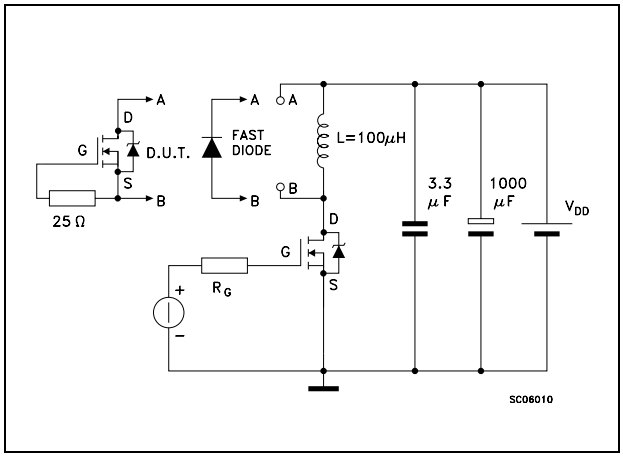



**Figure 22. Test circuit for inductive load switching and diode recovery times**

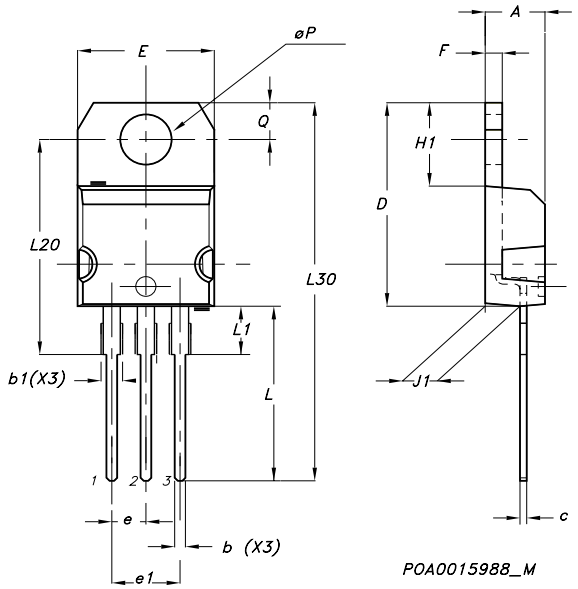


# 4 Package mechanical data

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

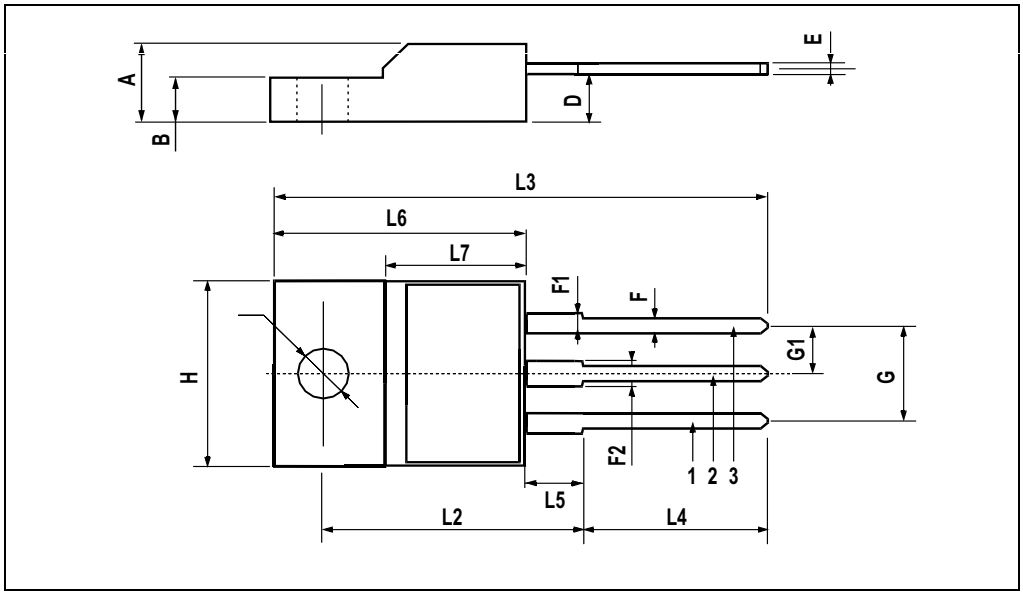
## TO-220 MECHANICAL DATA

| 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 |



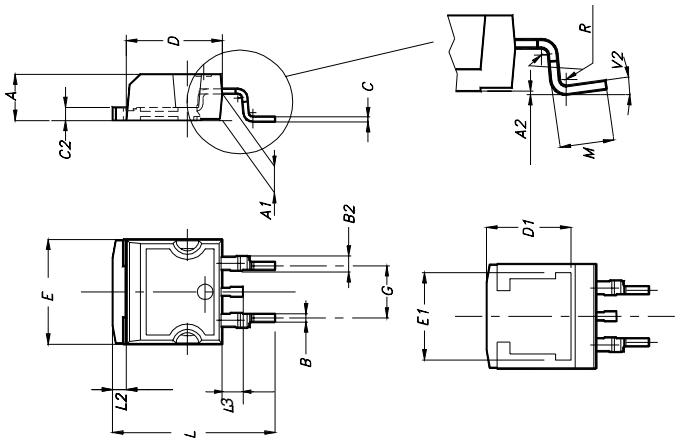
## TO-220FP MECHANICAL DATA

| 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 |



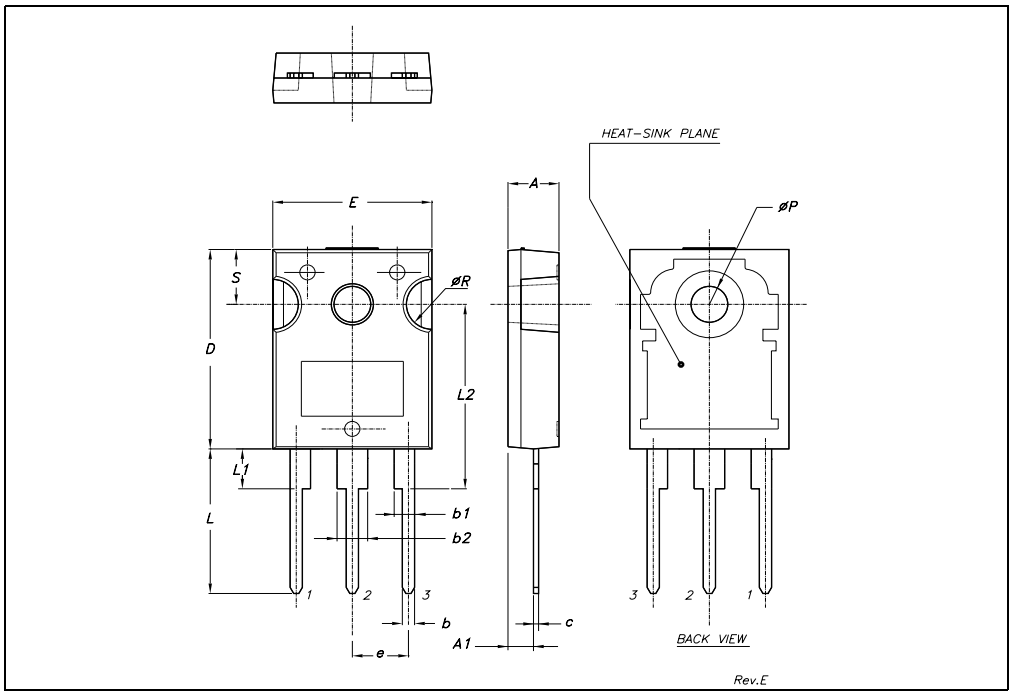
## $D^2PAK$ MECHANICAL DATA

| 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 | 0º | | 4º | | | |



## TO-247 MECHANICAL DATA

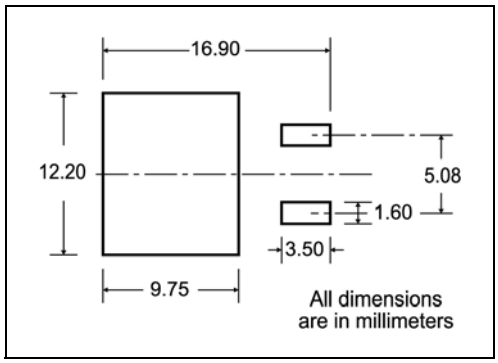
| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | 4.85 | | 5.15 | 0.19 | | 0.20 |
| A1 | 2.20 | | 2.60 | 0.086 | | 0.102 |
| b | 1.0 | | 1.40 | 0.039 | | 0.055 |
| b1 | 2.0 | | 2.40 | 0.079 | | 0.094 |
| b2 | 3.0 | | 3.40 | 0.118 | | 0.134 |
| 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 | |



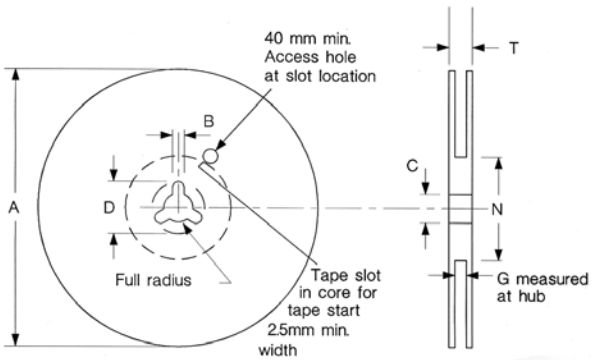
# 5 Packaging mechanical data



## D²PAK FOOTPRINT




## TAPE AND REEL SHIPMENT



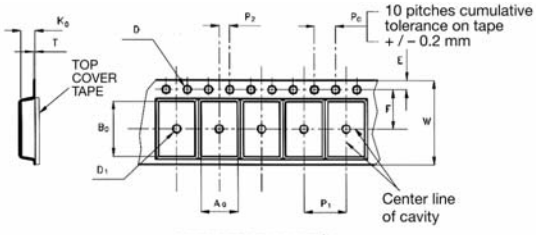

REEL MECHANICAL DATA

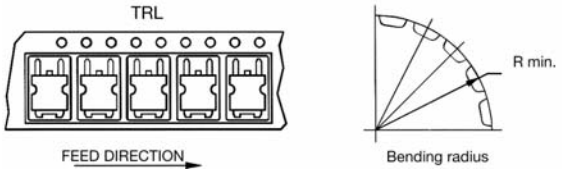
| DIM. | mm | | inch | |
|---|---|---|---|---|
| | MIN. | MAX. | MIN. | MAX. |
| A | | 330 | | 12.992 |
| B | 1.5 | | 0.059 | |
| C | 12.8 | 13.2 | 0.504 | 0.520 |
| D | 20.2 | | 0795 | |
| G | 24.4 | 26.4 | 0.960 | 1.039 |
| N | 100 | | 3.937 | |
| T | | 30.4 | | 1.197 |

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

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 |




* on sales type

# 6 Revision history

**Table 8. Revision history**

| Date | Revision | Changes |
|---|---|---|
| 29-Nov-2005 | 3 | Complete version |
| 16-Aug-2006 | 4 | New template, no content change |
| 10-Apr-2007 | 5 | Typo mistake on *Table 2* |

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