# STP8NK80Z - STP8NK80ZFP
# STW8NK80Z

## N-channel 800V - 1.3Ω - 6.2A - TO-220 /TO-220FP/TO-247 Zener-protected SuperMESH™ Power MOSFET

## Features

| Type | $V_{DSS}$ | $R_{DS(on)}$ | $I_D$ |
|------|-----------|--------------|-------|
| STP8NK80Z | 800 V | < 1.5 Ω | 6.2 A |
| STP8NK80ZFP | 800 V | < 1.5 Ω | 6.2 A |
| STW8NK80Z | 800 V | < 1.5 Ω | 6.2 A |

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



TO-220    TO-220FP

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 including revolutionary MDmesh™ products.

## Application

- Switching applications

**Figure 1.    Internal schematic diagram**
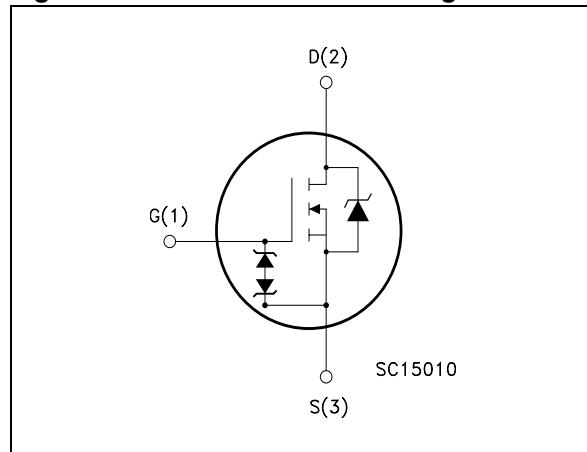


**Table 1.    Device summary**

| Order codes | Marking | Package | Packaging |
|-------------|---------|---------|-----------|
| STP8NK80Z | P8NK80Z | TO-220 | Tube |
| STP8NK80ZFP | P8NK80ZFP | TO-220FP | Tube |
| STW8NK80Z | W8NK80Z | TO-247 | Tube |

# Contents

# 1 Electrical ratings

**Table 2.**    **Absolute maximum ratings**

| Symbol | Parameter | Value | | Unit |
|---|---|---|---|---|
| | | **TO-220 - TO-247** | **TO-220FP** | |
| $V_{DS}$ | Drain-source voltage ($V_{GS} = 0$) | 800 | | V |
| $V_{GS}$ | Gate- source voltage | ± 30 | | V |
| $I_D$ | Drain current (continuous) at $T_C = 25°C$ | 6.2 | 6.2 [1] | A |
| $I_D$ | Drain current (continuous) at $T_C = 100°C$ | 3.9 | 3.9 [1] | A |
| $I_{DM}$ [2] | Drain current (pulsed) | 24.8 | 24.8[1] | A |
| $P_{TOT}$ | Total dissipation at $T_C = 25°C$ | 140 | 30 | W |
| | Derating factor | 1.12 | 0.24 | W/°C |
| $V_{ESD(G-S)}$ | Gate source ESD(HBM-C=100pF, R=1.5KΩ) | 4000 | | V |
| 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 |
| $T_j$ $T_{stg}$ | Max operating Junction temperature Storage temperature | -55 to 150 | | °C |

1. Limited only by maximum temperature allowed

2. Pulse width limited by safe operating area

3. $I_{SD} \leq 6.2$ A, di/dt $\leq 200$A/µs, $V_{DD} \leq V_{(BR)DSS}$, $T_j \leq T_{JMAX}$.

**Table 3.**    **Thermal data**

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

**Table 4.**    **Avalanche characteristics**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $I_{AR}$ | Avalanche current, repetitive or not-repetitive (pulse width limited by Tj Max) | 6.2 | A |
| $E_{AS}$ | Single pulse avalanche energy (starting Tj=25°C, Id=Iar, Vdd=50V) | 300 | mJ |

# 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 | 800 | | | V |
| $I_{DSS}$ | Zero gate voltage Drain current ($V_{GS}$ = 0) | $V_{DS}$ = Max rating $V_{DS}$ = Max rating, @125°C | | | 1 50 | µA 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, $I_D$ = 3.1 A | | 1.3 | 1.5 | Ω |

**Table 6. Dynamic**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------|-----------|-----------------|------|------|------|------|
| $g_{fs}$ [1] | Forward transconductance | $V_{DS}$ = 15v, $I_D$ = 3.1 A | | 5.2 | | S |
| $C_{iss}$ $C_{oss}$ $C_{rss}$ | Input capacitance Output capacitance Reverse transfer capacitance | $V_{DS}$ = 25 V, f = 1 MHz, $V_{GS}$ = 0 | | 1320 143 27 | | pF pF pF |
| $C_{oss\ eq.}$ [2] | Equivalent output capacitance | $V_{DS}$ =0V, $V_{DS}$ = 0V to 640V | | 58 | | pF |
| $t_{d(on)}$ $t_r$ $t_{r(off)}$ $t_r$ | Turn-on delay time Rise time Turn-off delay time Fall time | $V_{DD}$ = 400 V, $I_D$ = 3.1 A, $R_G$ = 4.7 Ω, $V_{GS}$ = 10 V (see *Figure 21*) | | 17 30 48 28 | | ns ns ns ns |
| $Q_g$ $Q_{gs}$ $Q_{gd}$ | Total gate charge Gate-source charge Gate-drain charge | $V_{DD}$ = 640 V, $I_D$ = 6.2 A, $V_{GS}$ = 10 V | | 46 8.5 25 | | nC nC nC |
| $t_{r(Voff)}$ $t_r$ $t_c$ | Off-voltage rise time Fall time Cross-over time | $V_{DD}$ = 640 V, $I_D$ = 6.2 A, $R_G$ = 4.7 Ω, $V_{GS}$ = 10 V (see *Figure 23*) | | 9 9 18 | | ns ns 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) | | | | 6.2 <br> 24.8 | A <br> A |
| $V_{SD}$[2] | Forward on voltage | $I_{SD}$ = 6.2 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 | $I_{SD}$ = 6.2 A, di/dt = 100 A/µs <br> $V_{DD}$ = 50 V, Tj = 150°C <br> (see *Figure 23*) | | 460 <br> 2990 <br> 13 | | ns <br> nC <br> A |

1. Pulsed: pulse duration=300µs, duty cycle 1.5%

2. Pulse width limited by safe operating area

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

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

1. The built-in back-to-back Zener diodes have specifically been designed to enhance not only the device's ESD capability, but also to make them safely absorb possible voltage transients that may occasionally be applied from gate to source. In this respect the Zener voltage is appropriate to achieve an efficient and cost-effective intervention to protect the device's integrity. These integrated Zener diodes thus avoid the usage of external components.

## 2.1 Electrical characteristics (curves)

**Figure 2. Safe operating area for TO-220**
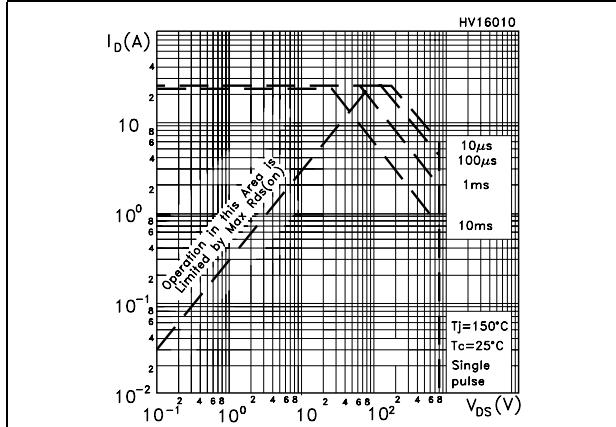


**Figure 3. Thermal impedance for TO-220**
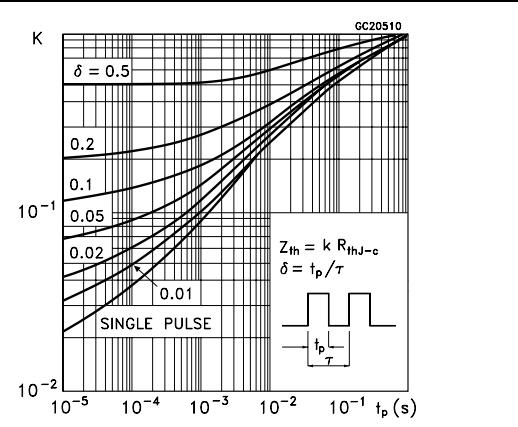


**Figure 4. Safe operating area for TO-220FP**
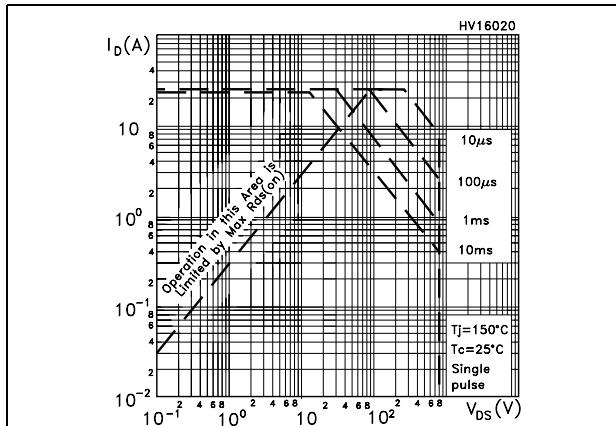


**Figure 5. Thermal impedance for TO-220FP**
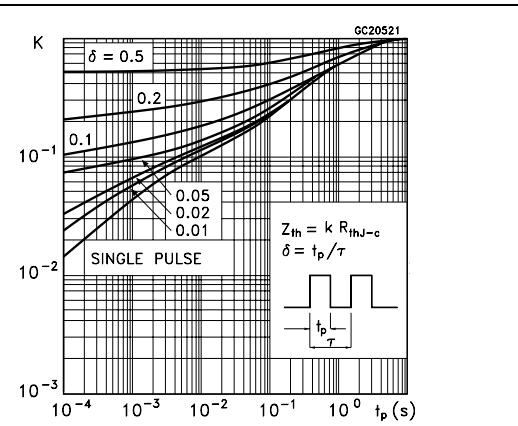


**Figure 6. Safe operating area for TO-247**
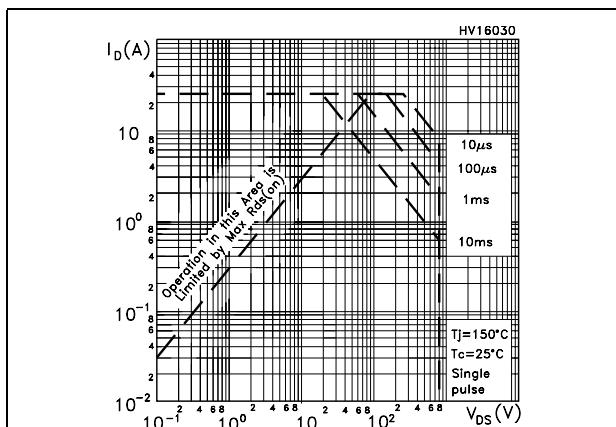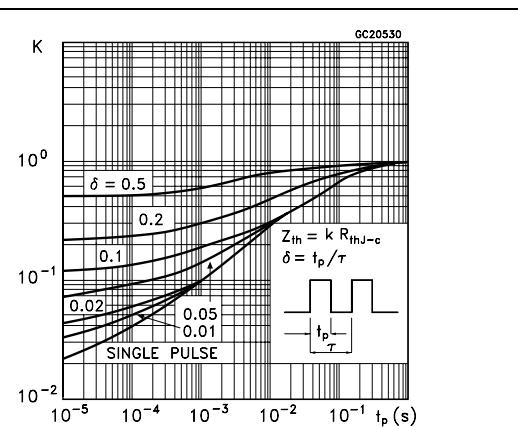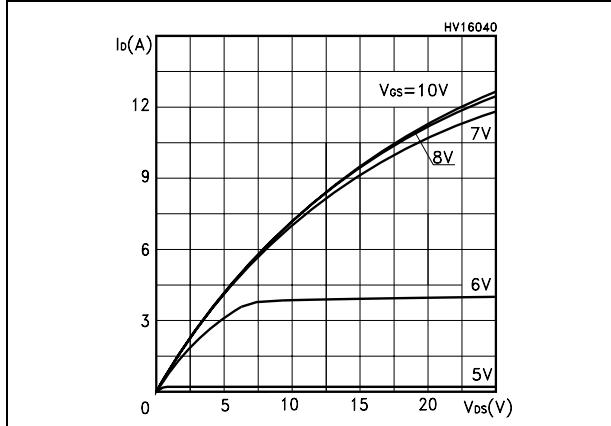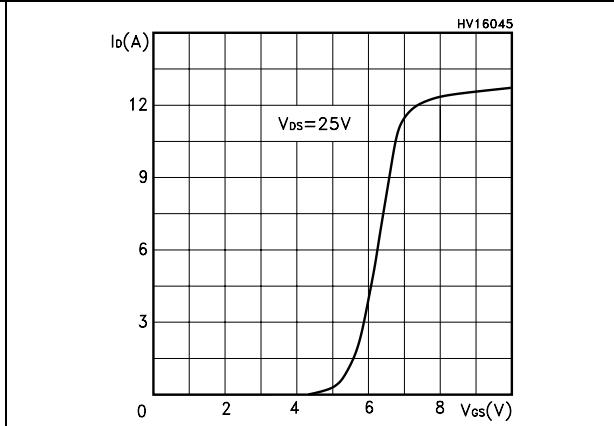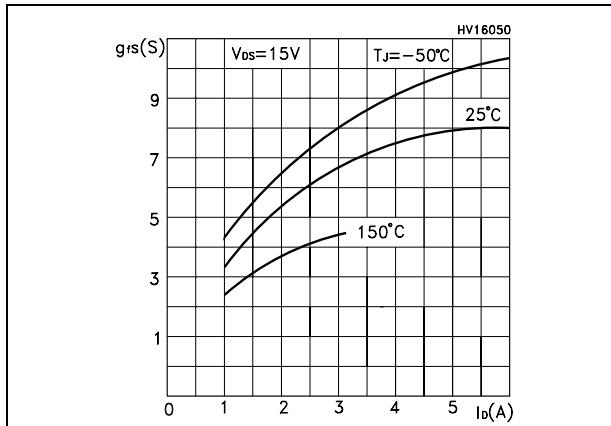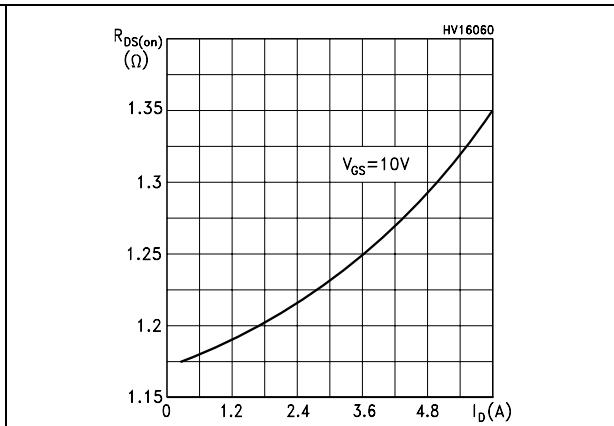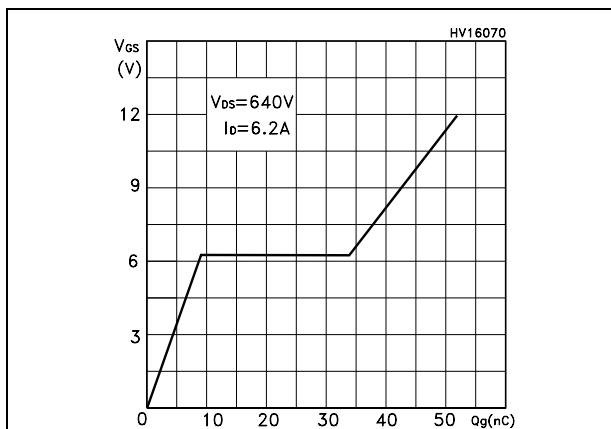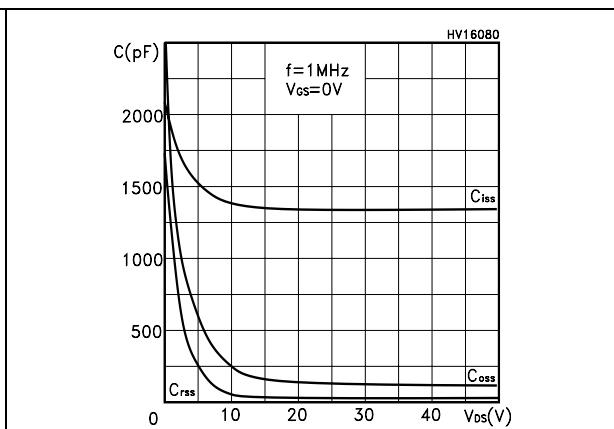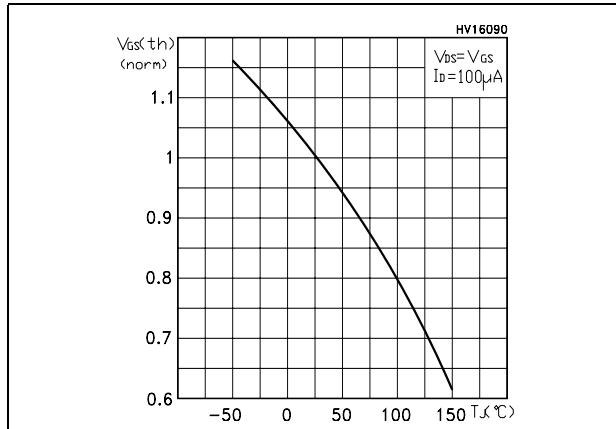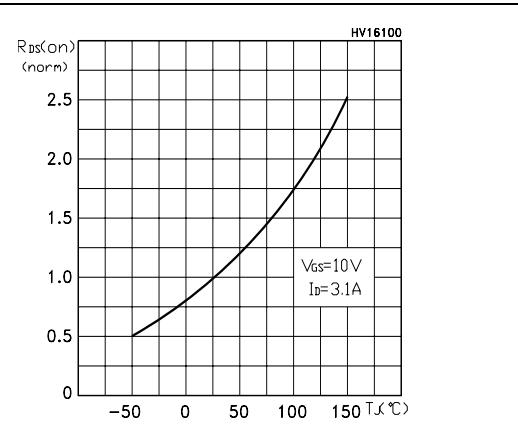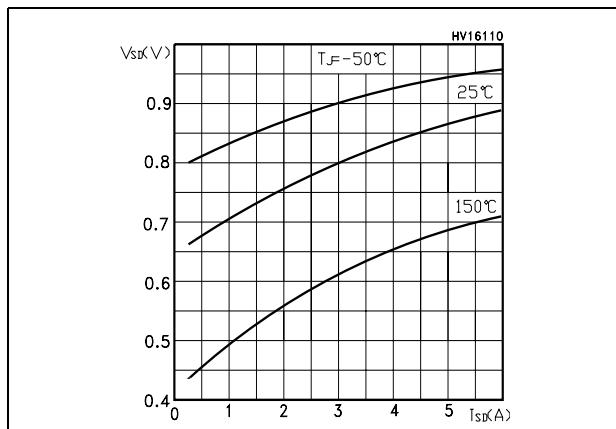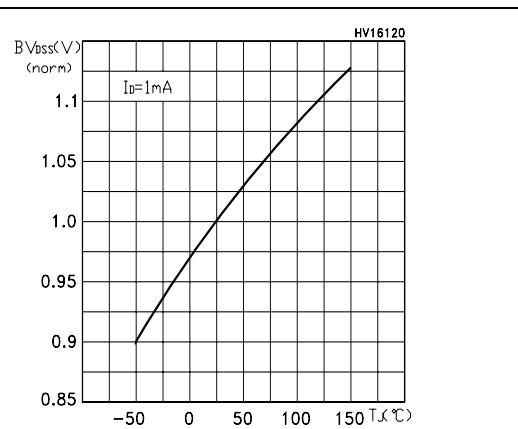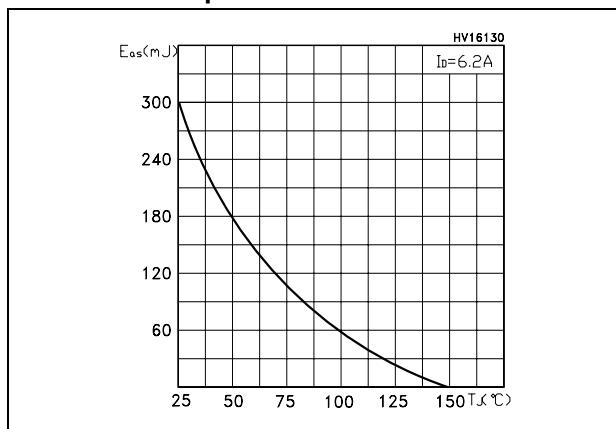


**Figure 7. Thermal impedance for TO-247**
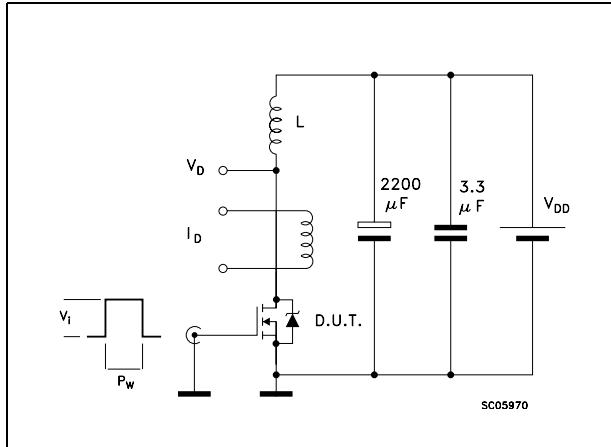
**Figure 8.    Output characteristics**



**Figure 9.    Transfer characteristics**



**Figure 10.  Transconductance**



**Figure 11.  Static drain-source on resistance**



**Figure 12.  Gate charge vs gate-source voltage**



**Figure 13.  Capacitance variations**
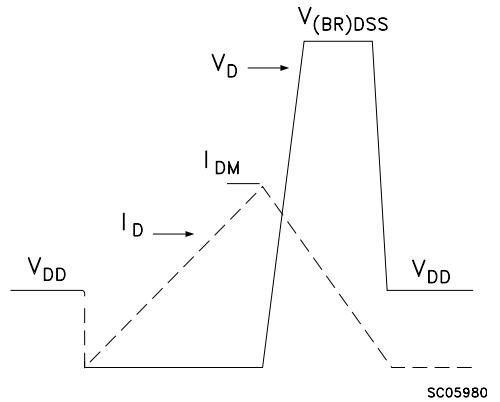
**Figure 14.  Normalized gate threshold voltage vs temperature**

**Figure 15.  Normalized on resistance vs temperature**

**Figure 16.  Source-drain diode forward characteristic**

**Figure 17.  Normalized B$_{VDSS}$ vs temperature**

**Figure 18.  Maximum avalanche energy vs temperature**

# 3    Test circuit
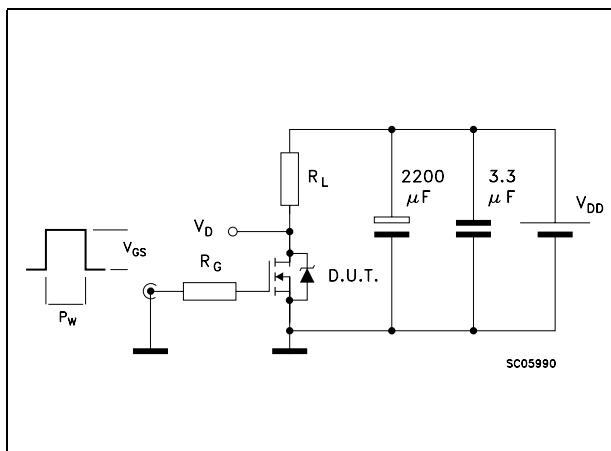
Figure 19.  Unclamped inductive load test circuit
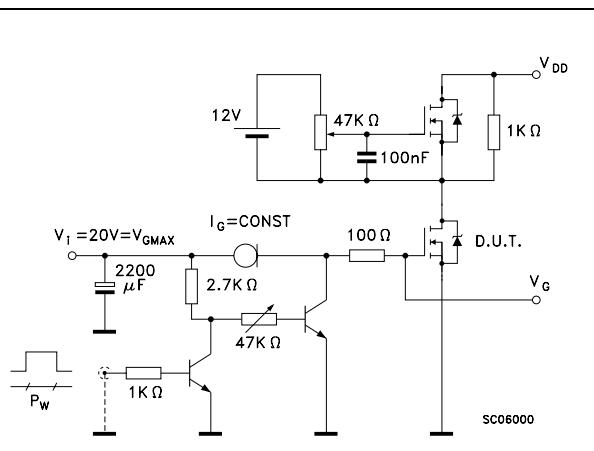


Figure 20.  Unclamped inductive waveform
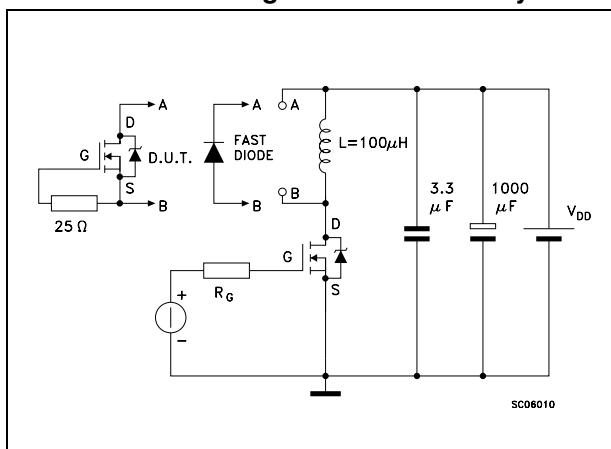


Figure 21.  Switching times test circuit for resistive load



Figure 22.  Gate charge test circuit



Figure 23.  Test circuit for inductive load switching and diode recovery times
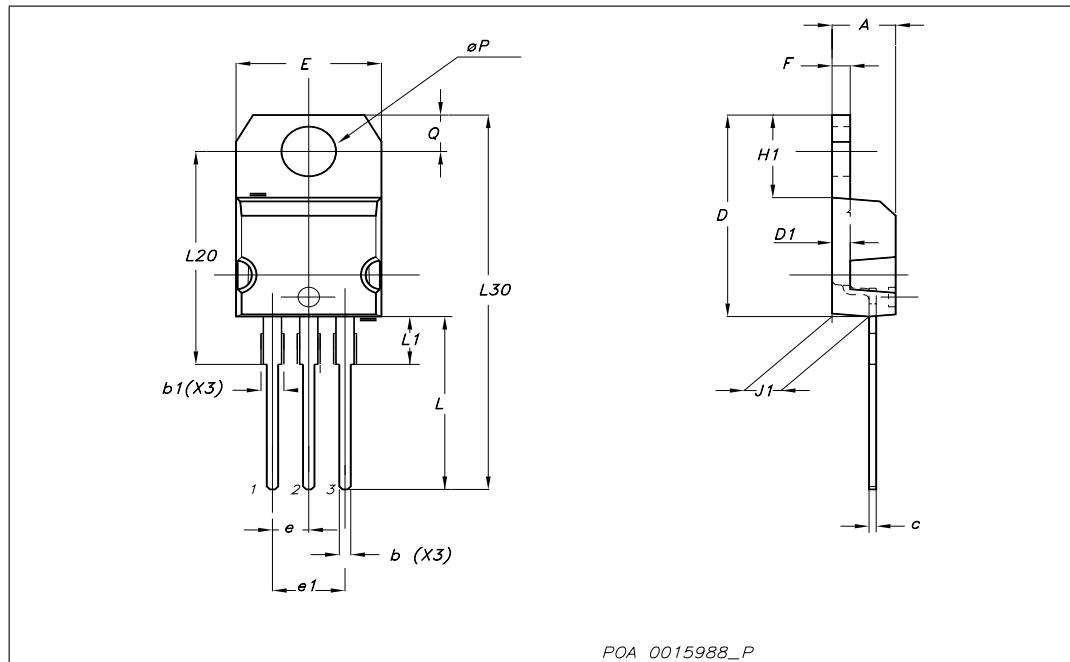
# 4        Package mechanical data

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
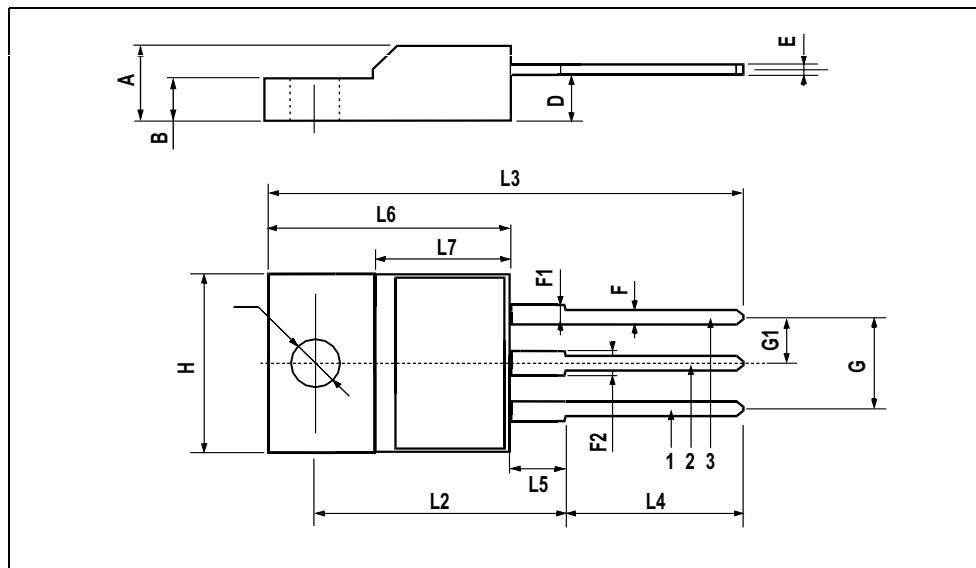
| Dim | mm | | | inch | | |
|-----|-----|-----|-----|------|-----|-----|
| | Min | Typ | Max | Min | Typ | Max |
| A | 4.40 | | 4.60 | 0.173 | | 0.181 |
| b | 0.61 | | 0.88 | 0.024 | | 0.034 |
| b1 | 1.14 | | 1.70 | 0.044 | | 0.066 |
| c | 0.49 | | 0.70 | 0.019 | | 0.027 |
| D | 15.25 | | 15.75 | 0.6 | | 0.62 |
| D1 | | 1.27 | | | 0.050 | |
| 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 | | 0.051 |
| 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 |



POA 0015988_P
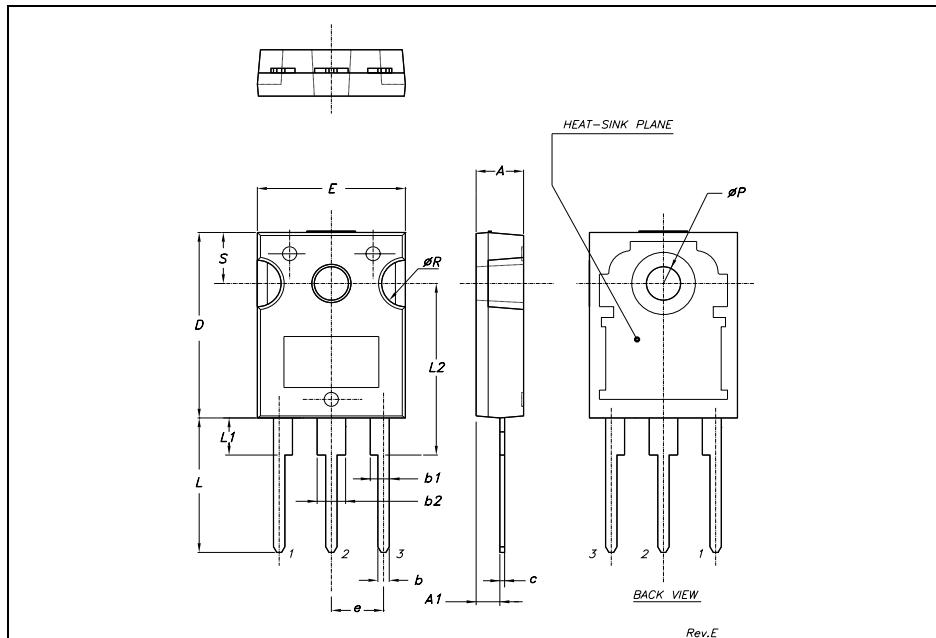
## TO-220FP MECHANICAL DATA

| 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 |

### 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 Revision history

**Table 9. Revision history**

| Date | Revision | Changes |
|------|----------|---------|
| 09-Sep-2004 | 2 | Complete version |
| 17-Aug-2006 | 3 | New template, no content change |
| 20-Apr-2007 | 4 | Typo errors on *Table 6* |
| 02-Jul-2007 | 5 | *Table 2* has been updated |

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