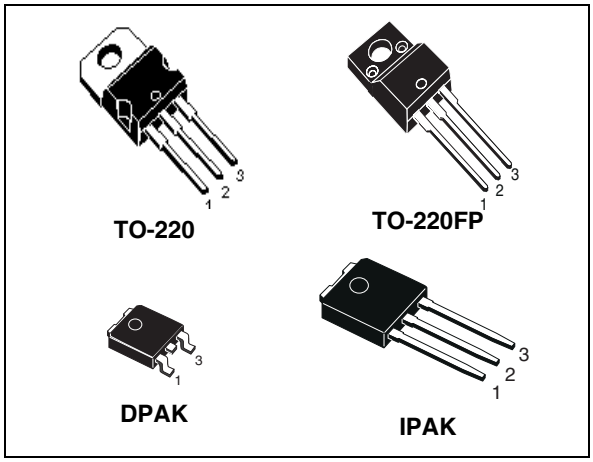
# STD3NK80Z, STD3NK80Z-1
# STF3NK80Z, STP3NK80Z

N-channel 800 V, 3.8 Ω, 2.5 A, TO-220, TO-220FP, DPAK, IPAK
Zener-protected SuperMESH™ Power MOSFET

## Features

| Type | $V_{DSS}$ (@Tjmax) | $R_{DS(on)}$ | $I_D$ |
|---|---|---|---|
| STP3NK80Z | 800 V | < 4.5 Ω | 2.5 A |
| STF3NK80Z | 800 V | < 4.5 Ω | 2.5 A |
| STD3NK80Z | 800 V | < 4.5 Ω | 2.5 A |
| STD3NK80Z-1 | 800 V | < 4.5 Ω | 2.5 A |

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




## Application

- Switching applications

## 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.

**Figure 1. Internal schematic diagram**

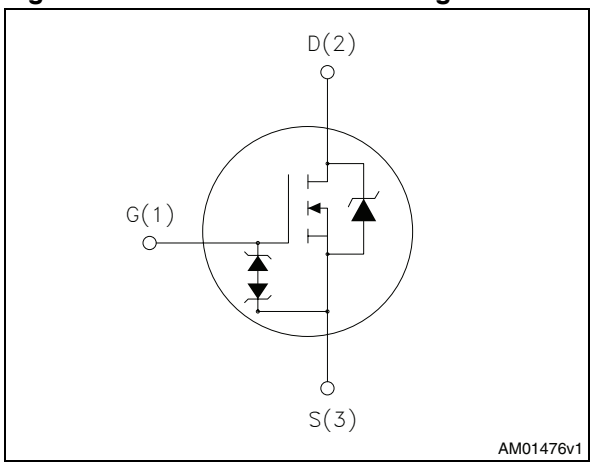



**Table 1. Device summary**

| Order codes | Marking | Package | Packaging |
|---|---|---|---|
| STP3NK80Z | P3NK80Z | TO-220 | Tube |
| STF3NK80Z | F3NK80Z | TO-220FP | Tube |
| STD3NK80ZT4 | D3NK80Z | DPAK | Tape and reel |
| STD3NK80Z-1 | D3NK80Z | IPAK | Tube |

# Contents

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol | Parameter | Value | | Unit |
|---|---|---|---|---|
| | | TO-220, DPAK IPAK | TO-220FP | |
| $V_{DS}$ | Drain-source voltage ($V_{GS}$ = 0) | 800 | | V |
| $V_{DGR}$ | Drain-gate voltage ($R_{GS}$ = 20 kΩ) | 800 | | V |
| $V_{GS}$ | Gate-source voltage | ± 30 | | V |
| $I_D$ | Drain current (continuous) at $T_C$ = 25 °C | 2.5 | 2.5 (1) | A |
| $I_D$ | Drain current (continuous) at $T_C$=100 °C | 1.57 | 1.57 (1) | A |
| $I_{DM}$(2) | Drain current (pulsed) | 10 | 10 (1) | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25 °C | 70 | 25 | W |
| | Derating factor | 0.56 | 0.2 | W/°C |
| $V_{ESD(G-S)}$ | Gate source ESD (HBM-C=100 pF, R=1.5 kΩ) | 2000 | | V |
| dv/dt (3) | Peak diode recovery voltage slope | 4.5 | | V/ns |
| $V_{ISO}$ | Insulation withstand voltage (DC) | | 2500 | V |
| $T_J$<br>$T_{stg}$ | Operating junction temperature<br>Storage temperature | -55 to 150 | | °C |

1. Limited only by maximum temperature allowed
2. Pulse width limited by safe operating area
3. $I_{SD} \leq 2.5$ A, di/dt ≤ 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 | DPAK IPAK | |
| $R_{thj\text{-}case}$ | Thermal resistance junction-case max | 1.78 | 5 | 1.78 | °C/W |
| $R_{thj\text{-}a}$ | Thermal resistance junction-ambient max | 62.5 | | 100 | °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) | 2.5 | A |
| $E_{AS}$ | Single pulse avalanche energy (starting Tj=25 °C, $I_D$=$I_{AR}$, $V_{DD}$=50 V) | 170 | 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 | $I_D$ = 1 mA, $V_{GS}$= 0 | 800 | | | V |
| $I_{DSS}$ | Zero gate voltage drain current ($V_{GS}$ = 0) | $V_{DS}$ = max rating,<br>$V_{DS}$ = max rating, Tc = 125 °C | | | 1<br>50 | µA<br>µA |
| $I_{GSS}$ | Gate body leakage current ($V_{GS}$ = 0) | $V_{GS}$ = ± 20 V | | | ±10 | µA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 50 µA | 3 | 3.75 | 4.5 | V |
| $R_{DS(on)}$ | Static drain-source on resistance | $V_{GS}$ = 10 V, $I_D$ = 1.25 A | | 3.8 | 4.5 | Ω |

**Table 6. Dynamic**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $g_{fs}$ (1) | Forward transconductance | $V_{DS}$ =15 V, $I_D$ = 1.25 A | - | 2.1 | - | 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 | - | 485<br>57<br>11 | - | pF<br>pF<br>pF |
| $C_{oss\ eq.}$ (2) | Equivalent output capacitance | $V_{GS}$=0, $V_{DS}$ =0 to 640 V | - | 22 | - | pF |
| $t_{d(on)}$<br>$t_r$<br>$t_{d(off)}$<br>$t_f$ | Turn-on delay time<br>Rise time<br>Off-voltage rise time<br>Fall time | $V_{DD}$=400 V, $I_D$= 1.25 A, $R_G$= 4.7 Ω, $V_{GS}$=10 V (see *Figure 19*) | - | 17<br>27<br>36<br>40 | - | 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 | $V_{DD}$=640 V, $I_D$ = 2.5 A<br>$V_{GS}$ =10 V | - | 19<br>3.2<br>10.8 | - | nC<br>nC<br>nC |

1. Pulsed: pulse duration=300 µs, 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 |
|---|---|---|---|---|---|---|
| $I_{SD}$ | Source-drain current | | - | | 2.5 | A |
| $I_{SDM}$(1) | Source-drain current (pulsed) | | - | | 10 | A |
| $V_{SD}$(2) | Forward on voltage | $I_{SD}$= 2.5 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 | $I_{SD}$= 2.5 A,<br>di/dt = 100 A/µs,<br>$V_{DD}$=50 V<br>(see *Figure 21*) | - | 384<br>1600<br>8.4 | | ns<br>µC<br>A |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_{SD}$= 2.5 A,<br>di/dt = 100 A/µs,<br>$V_{DD}$=50 V, Tj=150 °C<br>(see *Figure 21*) | - | 474<br>2100<br>8.8 | | ns<br>µC<br>A |

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

**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, DPAK, IPAK**

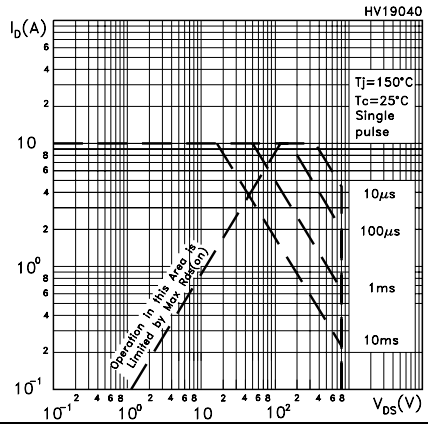



**Figure 3. Thermal impedance for TO-220, DPAK, IPAK**

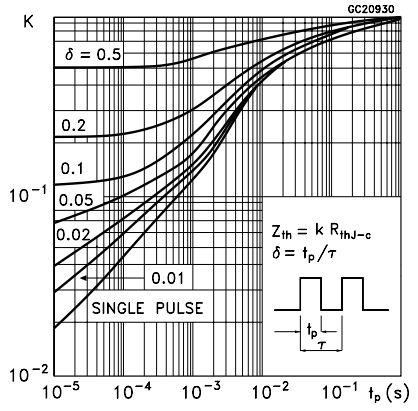



**Figure 4. Safe operating area for TO-220FP**

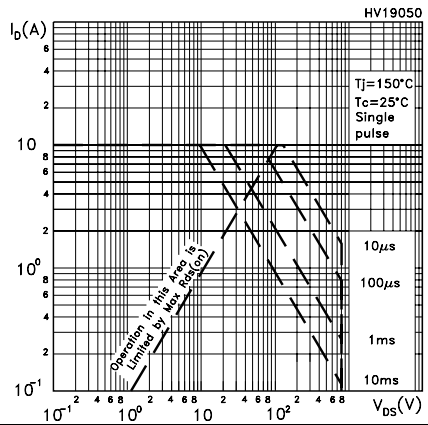



**Figure 5. Thermal impedance for TO-220FP**

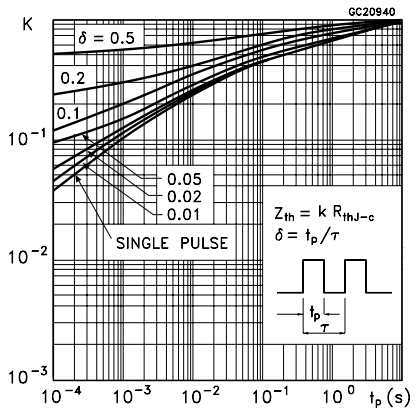



**Figure 6. Output characteristics**

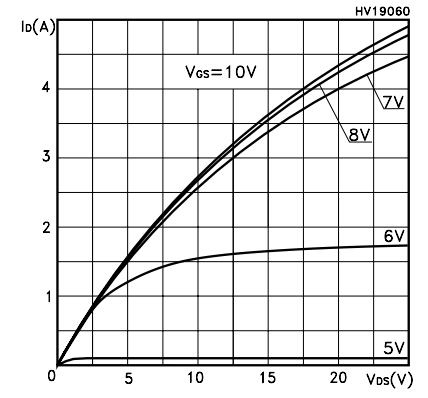



**Figure 7. Transfer characteristics**

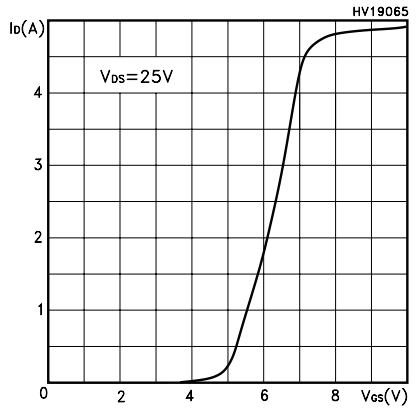


**Figure 8. Transconductance**

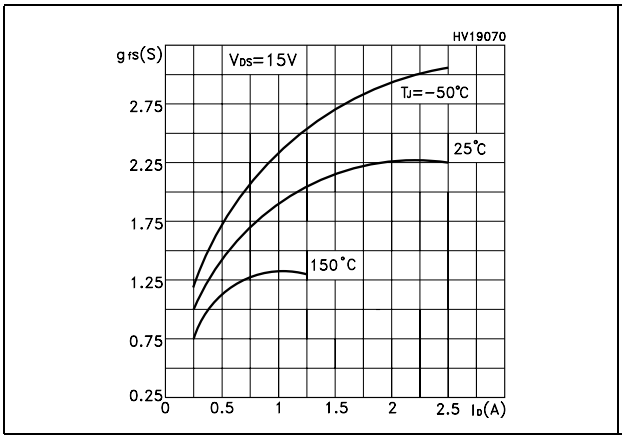



**Figure 9. Static drain-source on resistance**

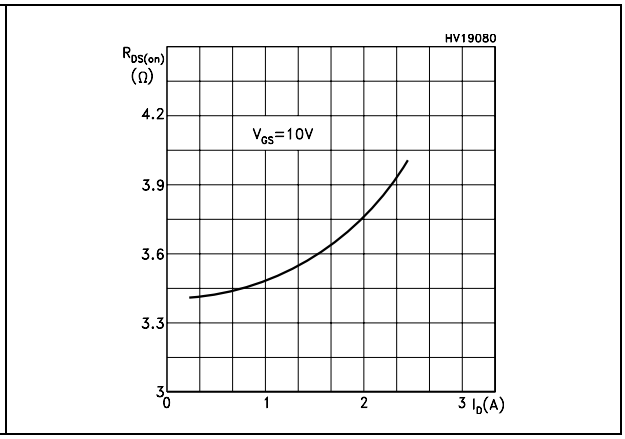



**Figure 10. Gate charge vs gate-source voltage**

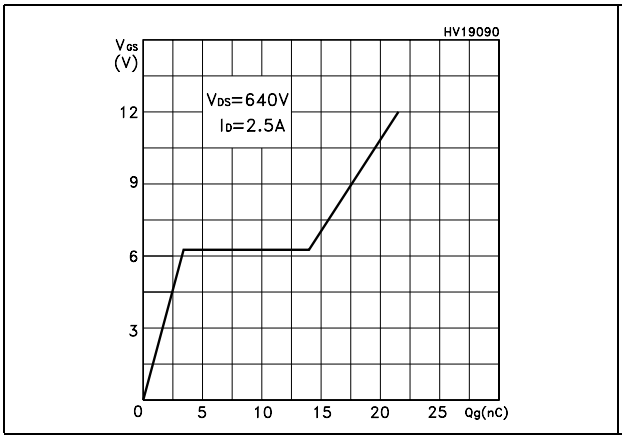



**Figure 11. Capacitance variations**

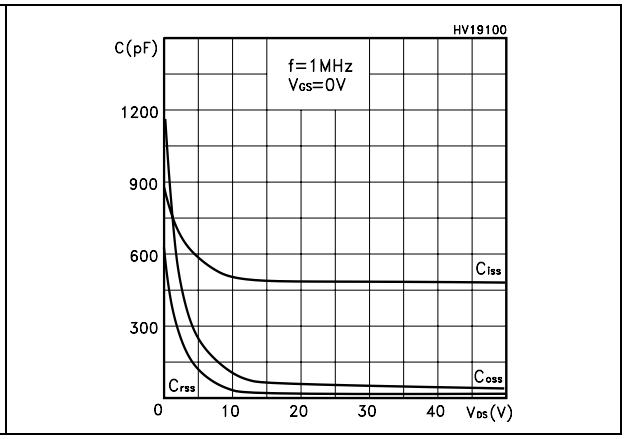



**Figure 12. Normalized gate threshold voltage vs temperature**

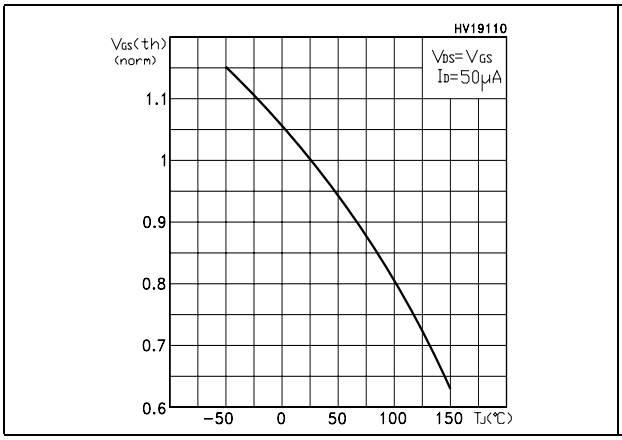



**Figure 13. Normalized on resistance vs temperature**

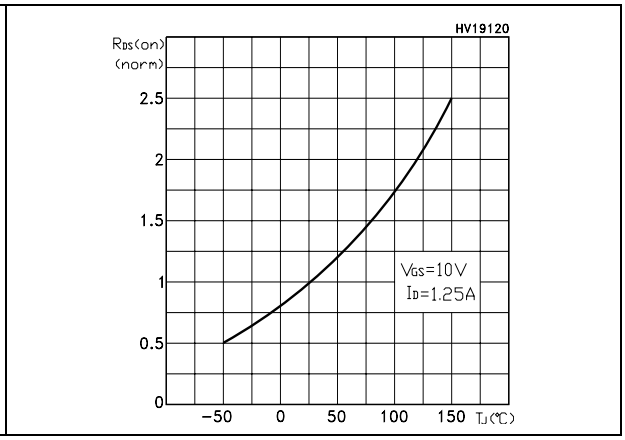


**Figure 14. Source-drain diode forward characteristics**

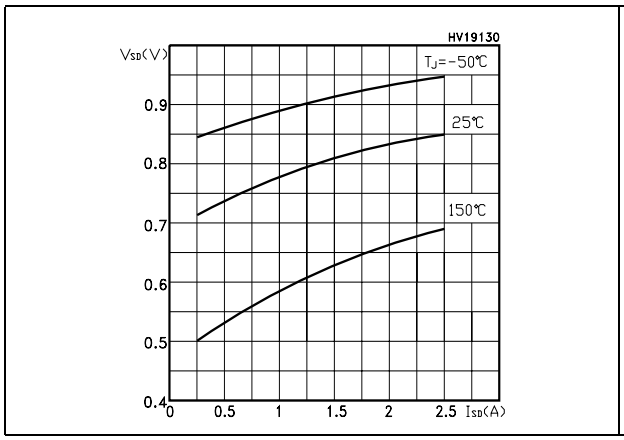



**Figure 15. Normalized $B_{VDSS}$ vs temperature**

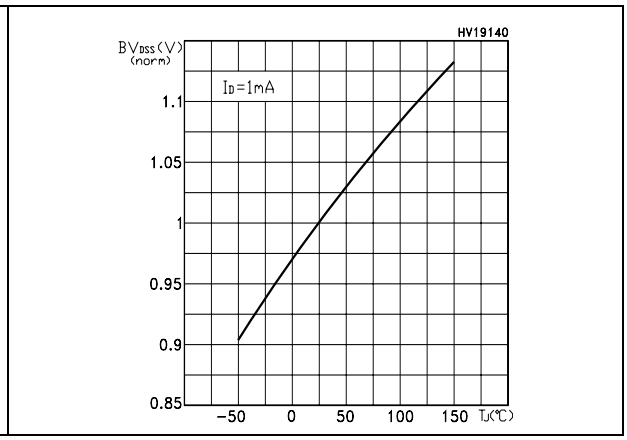
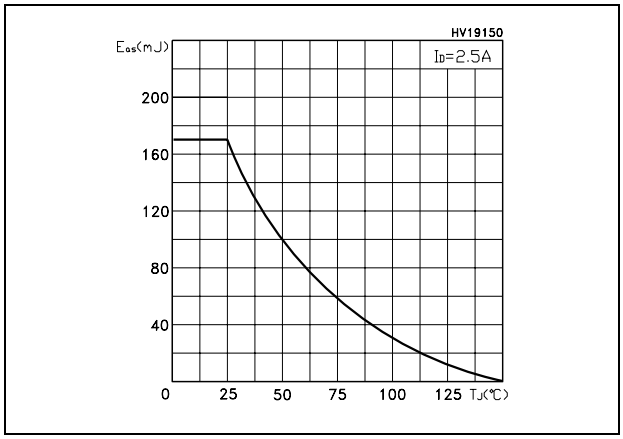



**Figure 16. Maximum avalanche energy vs temperature**



# 3 Test circuits

**Figure 17. Switching times test circuit for resistive load**

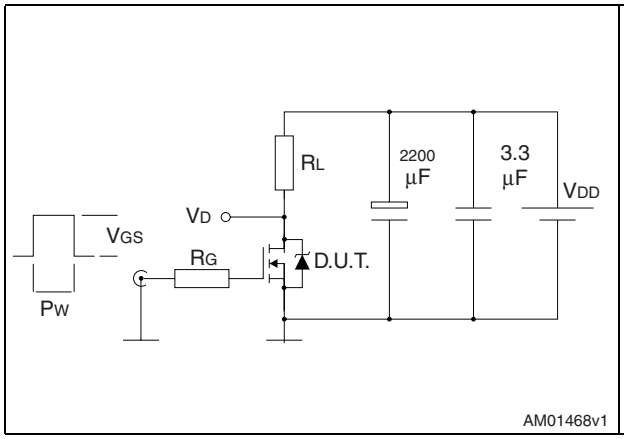



**Figure 18. Gate charge test circuit**

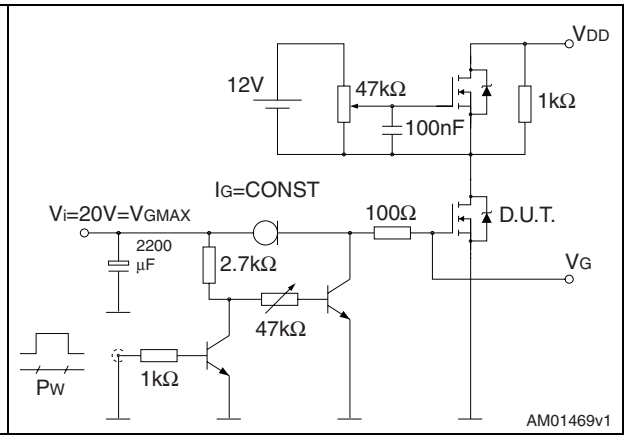



**Figure 19. Test circuit for inductive load switching and diode recovery times**

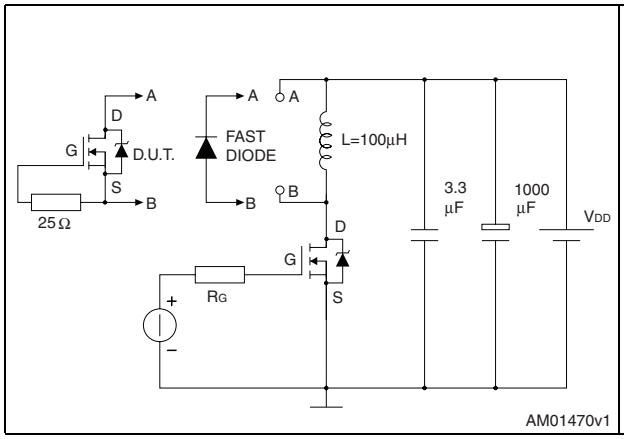



**Figure 20. Unclamped inductive load test circuit**

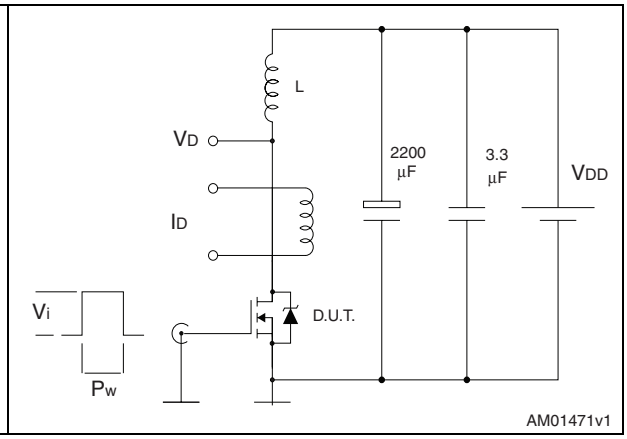



**Figure 21. Unclamped inductive waveform**

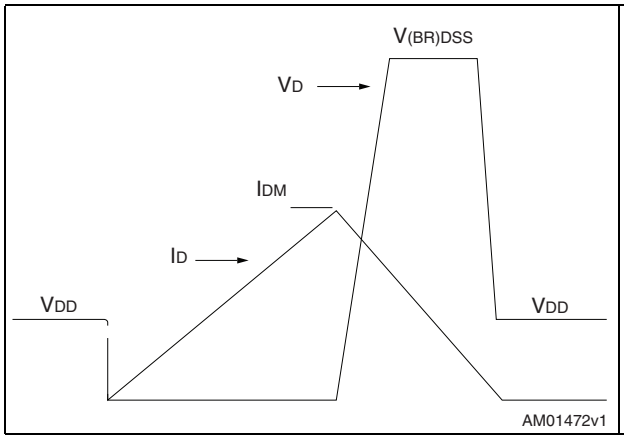
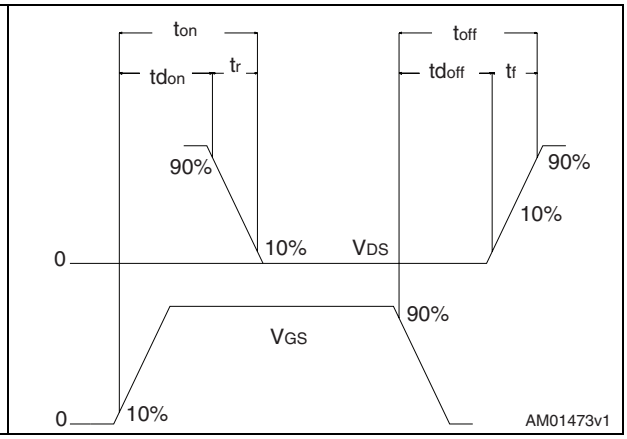



**Figure 22. Switching time waveform**

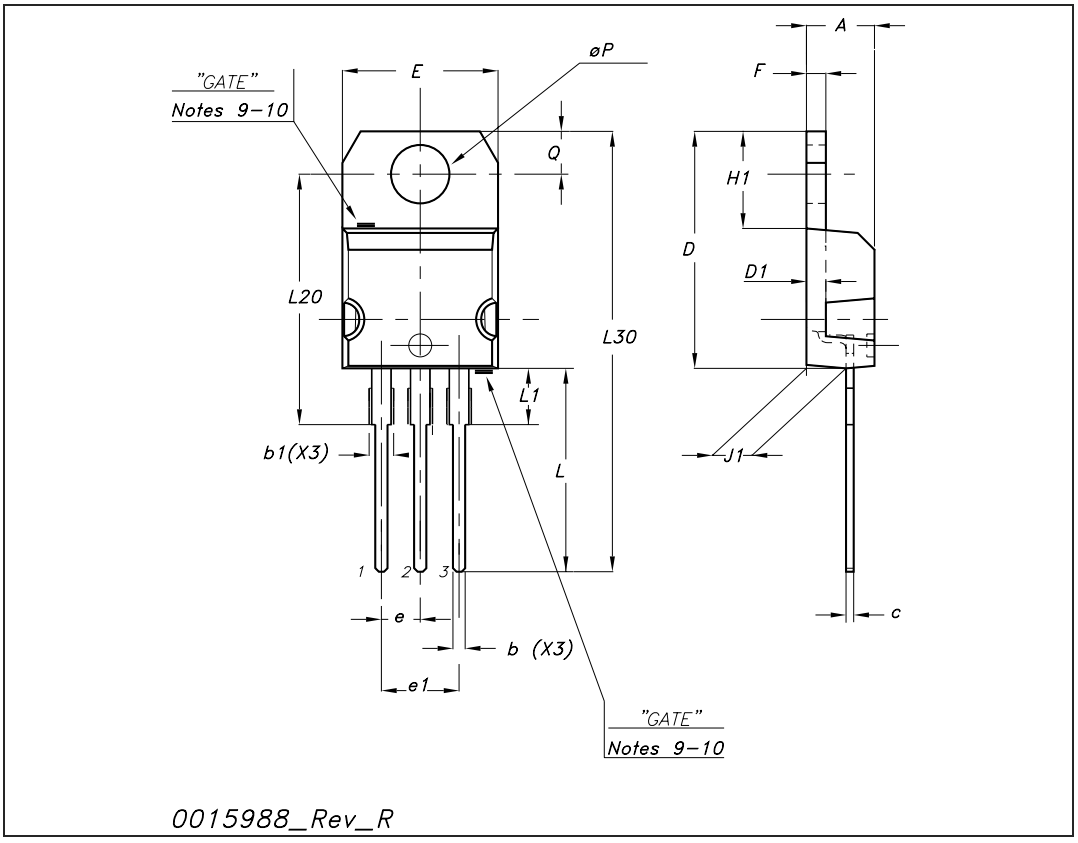


# 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com. ECOPACK is an ST trademark.

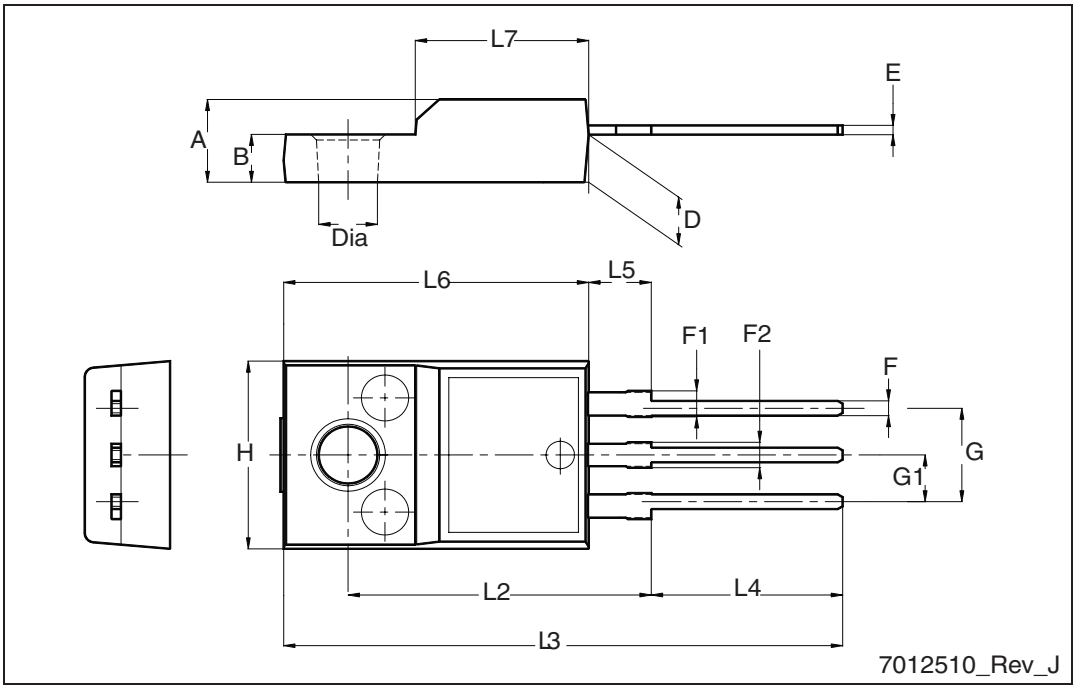
## TO-220 mechanical data

| 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 | 0.48 | | 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 | |
| ∅P | 3.75 | | 3.85 | 0.147 | | 0.151 |
| Q | 2.65 | | 2.95 | 0.104 | | 0.116 |



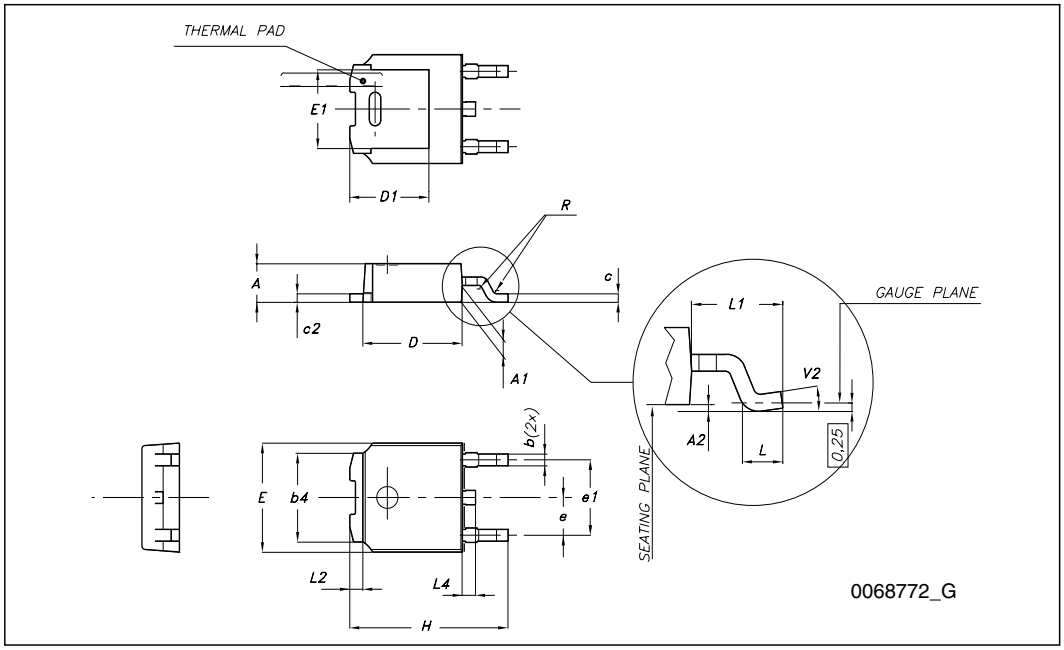
## TO-220FP mechanical data

| 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 | | 1.5 |
| 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 |



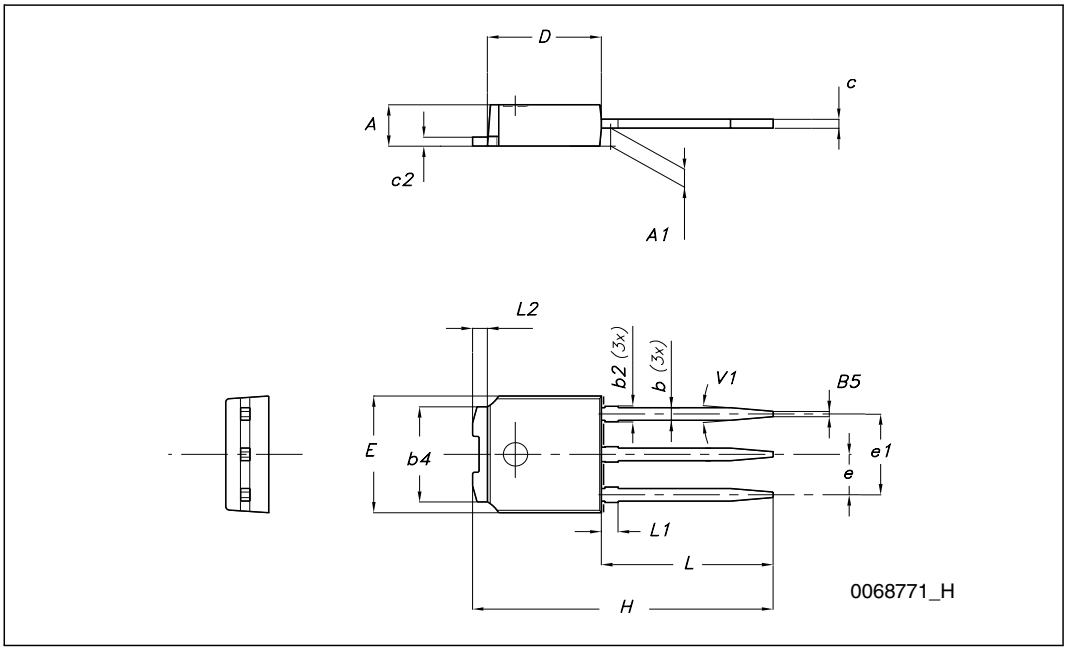
## TO-252 (DPAK) mechanical data

| 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 ° |



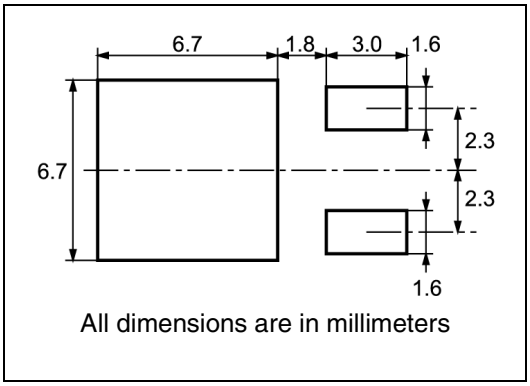
## TO-251 (IPAK) mechanical data

| DIM. | mm. | | |
|---|---|---|---|
| | min. | typ | max. |
| A | 2.20 | | 2.40 |
| A1 | 0.90 | | 1.10 |
| b | 0.64 | | 0.90 |
| b2 | | | 0.95 |
| b4 | 5.20 | | 5.40 |
| c | 0.45 | | 0.60 |
| c2 | 0.48 | | 0.60 |
| D | 6.00 | | 6.20 |
| E | 6.40 | | 6.60 |
| e | | 2.28 | |
| e1 | 4.40 | | 4.60 |
| H | | 16.10 | |
| L | 9.00 | | 9.40 |
| (L1) | 0.80 | | 1.20 |
| L2 | | 0.80 | |
| V1 | | 10 ° | |



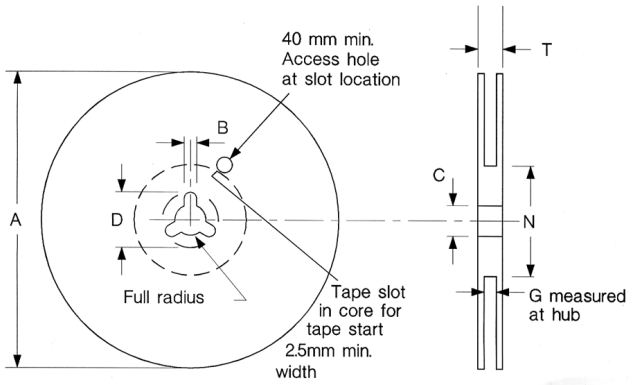
# 5 Packing mechanical data

## DPAK FOOTPRINT




All dimensions are in millimeters

## TAPE AND REEL SHIPMENT



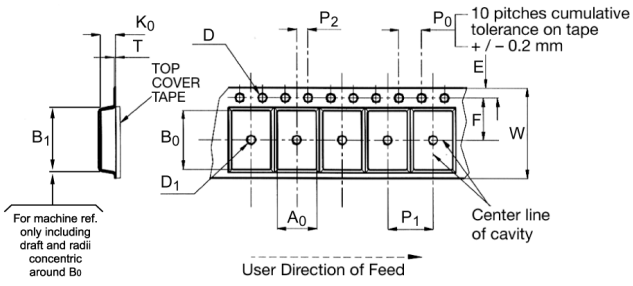

REEL MECHANICAL DATA

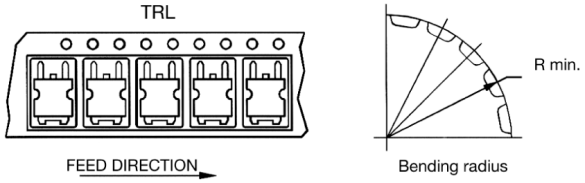
| DIM. | mm | | inch | |
|---|---|---|---|---|
| | MIN. | MAX. | MIN. | MAX. |
| A | | 330 | | 12.992 |
| B | 1.5 | | 0.059 | |
| C | 12.8 | 13.2 | 0.504 | 0.520 |
| D | 20.2 | | 0.795 | |
| G | 16.4 | 18.4 | 0.645 | 0.724 |
| N | 50 | | 1.968 | |
| T | | 22.4 | | 0.881 |

| BASE QTY | BULK QTY |
|---|---|
| 2500 | 2500 |

TAPE MECHANICAL DATA

| DIM. | mm | | inch | |
|---|---|---|---|---|
| | MIN. | MAX. | MIN. | MAX. |
| A0 | 6.8 | 7 | 0.267 | 0.275 |
| B0 | 10.4 | 10.6 | 0.409 | 0.417 |
| B1 | | 12.1 | | 0.476 |
| D | 1.5 | 1.6 | 0.059 | 0.063 |
| D1 | 1.5 | | 0.059 | |
| E | 1.65 | 1.85 | 0.065 | 0.073 |
| F | 7.4 | 7.6 | 0.291 | 0.299 |
| K0 | 2.55 | 2.75 | 0.100 | 0.108 |
| P0 | 3.9 | 4.1 | 0.153 | 0.161 |
| P1 | 7.9 | 8.1 | 0.311 | 0.319 |
| P2 | 1.9 | 2.1 | 0.075 | 0.082 |
| R | 40 | | 1.574 | |
| W | 15.7 | 16.3 | 0.618 | 0.641 |



# 6 Revision history

**Table 9. Revision history**

| Date | Revision | Changes |
|---|---|---|
| 09-Sep-2004 | 3 | Complete document |
| 10-Aug-2006 | 4 | New template, no content change |
| 26-Feb-2009 | 5 | Updated mechanical data |
| 07-Sep-2009 | 6 | $V_{ESD(G-S)}$ value has been corrected |