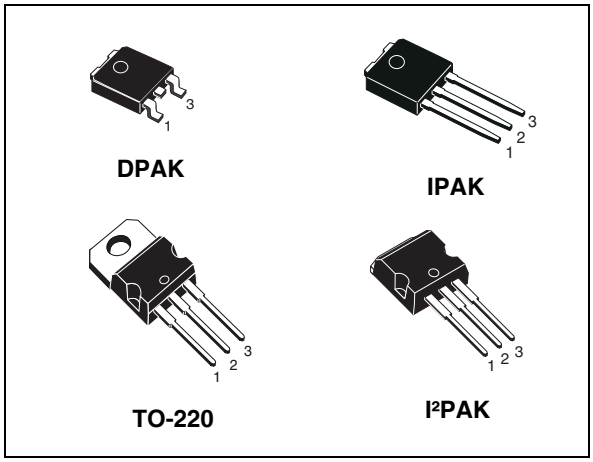
# STD90N4F3 - STI90N4F3
# STP90N4F3 - STU90N4F3

## N-channel 40 V, 5.4 mΩ, 80 A, DPAK, TO-220, IPAK, I²PAK STripFET™ Power MOSFET

## Features

| Type | $V_{DSS}$ | $R_{DS(on)}$ max | $I_D$ | Pw |
|---|---|---|---|---|
| STD90N4F3 | 40 V | < 6.5 mΩ | 80 A | 110 W |
| STI90N4F3 | 40 V | < 6.5 mΩ | 80 A | 110 W |
| STP90N4F3 | 40 V | < 6.5 mΩ | 80 A | 110 W |
| STU90N4F3 | 40 V | < 6.5 mΩ | 80 A | 110 W |

- Standard threshold drive
- 100% avalanche tested




## Application

- Switching applications

## Description

This n-channel enhancement mode Power MOSFET is the latest refinement of STMicroelectronics unique “single feature size“ strip-based process with less critical alignment steps and therefore a remarkable manufacturing reproducibility. The resulting transistor shows extremely high packing density for low on-resistance, rugged avalanche characteristics and low gate charge.

**Figure 1. Internal schematic diagram**

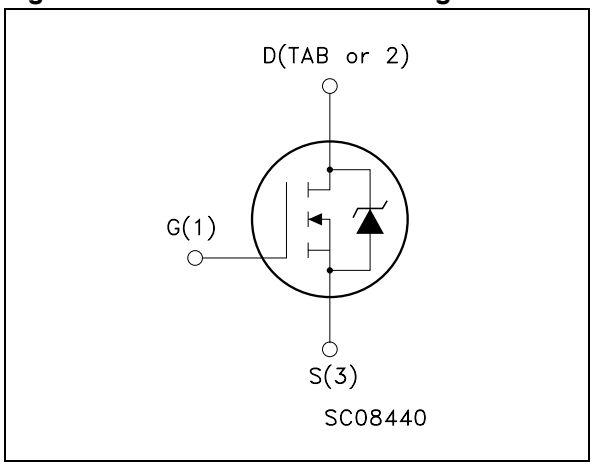



**Table 1. Device summary**

| Order codes | Marking | Package | Packaging |
|---|---|---|---|
| STD90N4F3 | 90N4F3 | DPAK | Tape & reel |
| STI90N4F3 | 90N4F3 | I²PAK | Tube |
| STP90N4F3 | 90N4F3 | TO-220 | Tube |
| STU90N4F3 | 90N4F3 | IPAK | Tube |

# Contents

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{DS}$ | Drain-source voltage ($V_{GS}$=0) | 40 | V |
| $V_{GS}$ | Gate-source voltage | ± 20 | V |
| $I_D$ (1) | Drain current (continuous) at $T_C$ = 25 °C | 80 | A |
| $I_D$ | Drain current (continuous) at $T_C$ = 100 °C | 65 | A |
| $I_{DM}$ (2) | Drain current (pulsed) | 320 | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25 °C | 110 | W |
| | Derating factor | 0.73 | W/°C |
| dv/dt (3) | Peak diode recovery voltage slope | 8 | V/ns |
| $E_{AS}$ (4) | Single pulse avalanche energy | 400 | mJ |
| $T_j$<br>$T_{stg}$ | Operating junction temperature<br>Storage temperature | -55 to 175 | °C |

1. Current limited by package
2. Pulse width limited by safe operating area
3. $I_{SD} \leq$ 80 A, di/dt $\leq$ 400A/µs, $V_{DS} \leq V_{(BR)DSS}$, Tj $\leq$ Tjmax
4. Starting Tj = 25°C, $I_D$ = 40A, $V_{DD}$ = 30V

**Table 3. Thermal resistance**

| Symbol | Parameter | Value | | | Unit |
|---|---|---|---|---|---|
| | | TO-220<br>I²PAK | IPAK | DPAK | |
| Rthj-case | Thermal resistance junction-case max | 1.36 | | | °C/W |
| Rthj-a | Thermal resistance junction-ambient max | 62.5 | 100 | -- | °C/W |
| Rthj-pcb (1) | Thermal resistance junction-ambient max | -- | -- | 50 | °C/W |
| $T_l$ | Maximum lead temperature for soldering purpose | 300 | 275 | -- | °C |

1. When mounted on 1inch² FR-4 2Oz Cu board

# 2 Electrical characteristics

($T_{CASE}$ = 25 °C unless otherwise specified)

**Table 4. Static**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $I_D$ = 250 µA, $V_{GS}$= 0 | 40 | | | V |
| $I_{DSS}$ | Zero gate voltage drain current ($V_{GS}$ = 0) | $V_{DS}$ = Max rating,<br>$V_{DS}$ = Max rating,Tc = 125°C | | | 10<br>100 | µA<br>µA |
| $I_{GSS}$ | Gate body leakage current ($V_{DS}$ = 0) | $V_{GS}$ = ±20 V | | | ±200 | nA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS}$= $V_{GS}$, $I_D$ = 250 µA | 2 | | 4 | V |
| $R_{DS(on)}$ | Static drain-source on resistance | $V_{GS}$= 10 V, $I_D$= 40 A | | 5.4 | 6.5 | mΩ |

**Table 5. Dynamic**

| Symbol | Parameter | Test conditions | Min | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $g_{fs}$ (1) | Forward transconductance | $V_{DS}$ =25 V, $I_D$=40 A | | 100 | | 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 | | 2200<br>580<br>40 | | pF<br>pF<br>pF |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$ | Total gate charge<br>Gate-source charge<br>Gate-drain charge | $V_{DD}$=20 V, $I_D$ = 80 A<br>$V_{GS}$ =10 V<br>*(see Figure 14)* | | 40<br>11<br>8 | 54 | nC<br>nC<br>nC |

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

**Table 6. Switching on/off (inductive load)**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$<br>$t_r$ | Turn-on delay time<br>Rise time | $V_{DD}$=20 V, $I_D$= 40 A,<br>$R_G$=4.7 Ω, $V_{GS}$=10 V<br>*(see Figure 16)* | | 15<br>50 | | ns<br>ns |
| $t_{d(off)}$<br>$t_f$ | Turn-off delay time<br>Fall time | $V_{DD}$=20 V, $I_D$= 40 A,<br>$R_G$=4.7 Ω, $V_{GS}$=10 V<br>*(see Figure 16)* | | 40<br>15 | | ns<br>ns |

**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) | | | | 80<br>320 | A<br>A |
| $V_{SD}$ (2) | Forward on voltage | $I_{SD}$=80 A, $V_{GS}$=0 | | | 1.5 | V |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_{SD}$=80 A,<br>di/dt = 100 A/µs,<br>$V_{DD}$=30 V, Tj=150°C<br>*(see Figure 15)* | | 45<br>60<br>2.8 | | ns<br>nC<br>A |

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

## 2.1 Electrical characteristics (curves)

**Figure 2. Safe operating area**

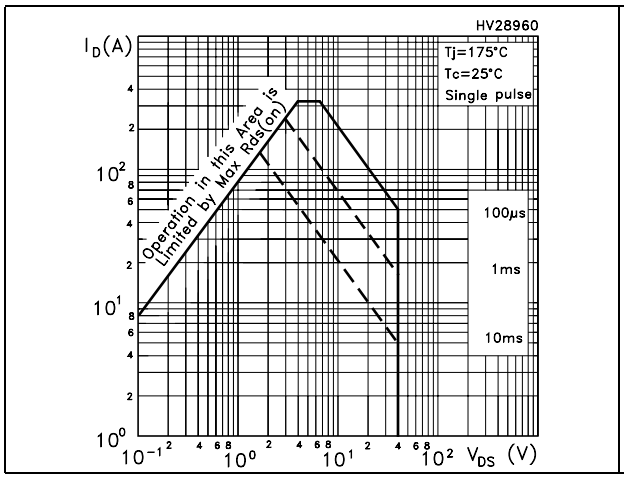



**Figure 3. Thermal impedance**

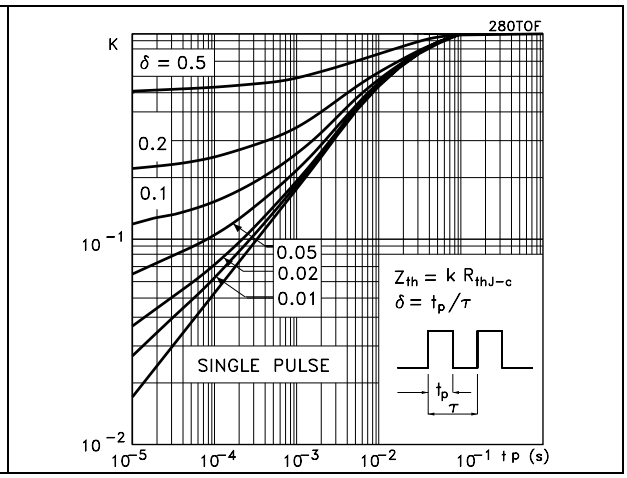



**Figure 4. Output characteristics**

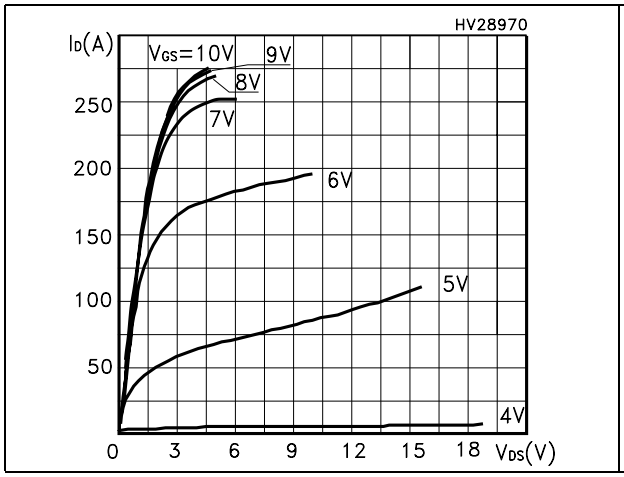



**Figure 5. Transfer characteristics**

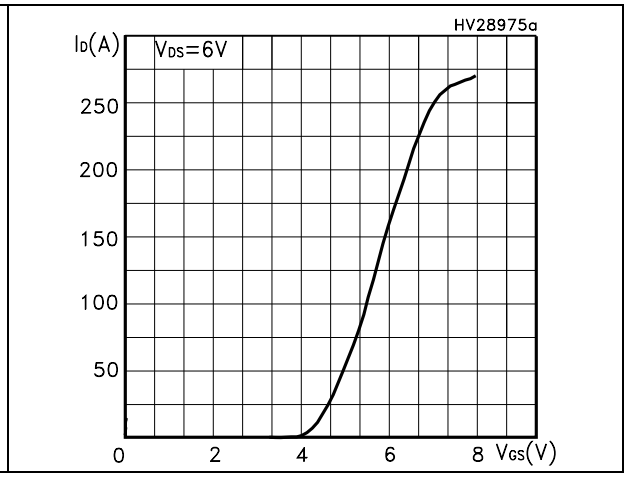



**Figure 6. Static drain-source on resistance**

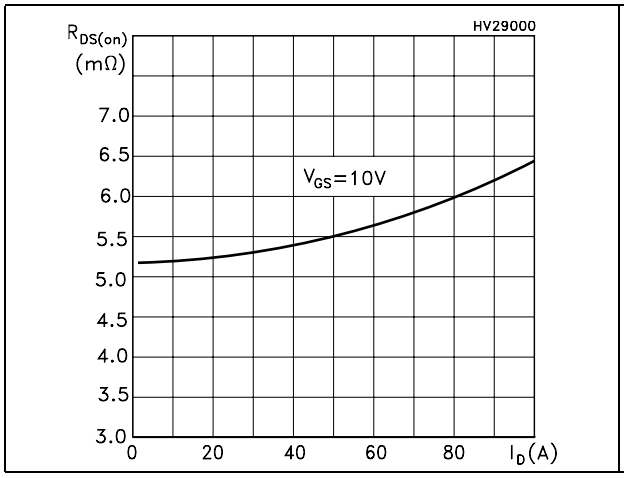



**Figure 7. Normalized BVDSS vs temperature**

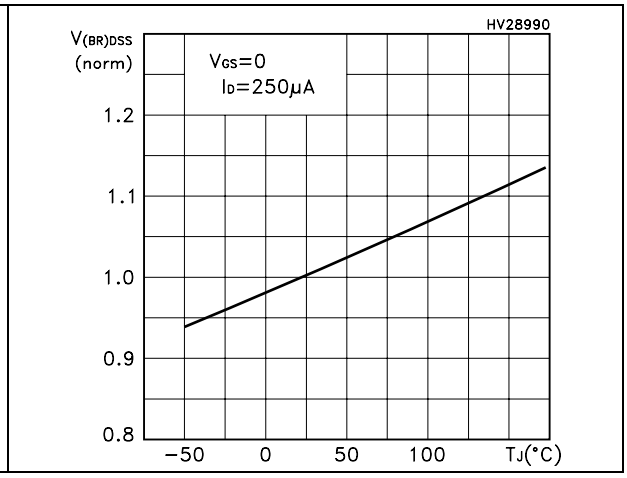


**Figure 8. Gate charge vs gate-source voltage**

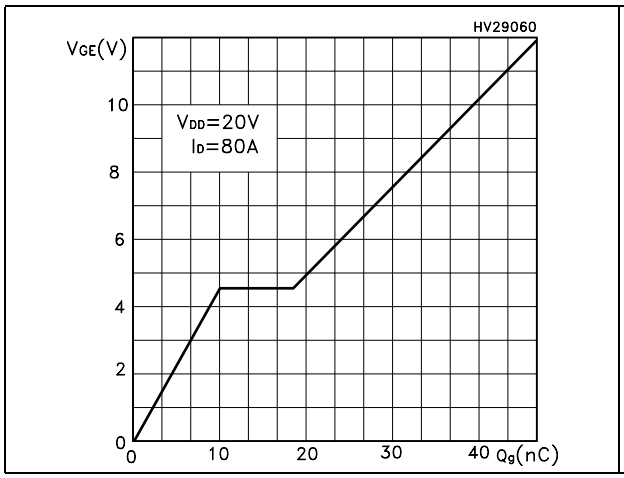



**Figure 9. Capacitance variations**

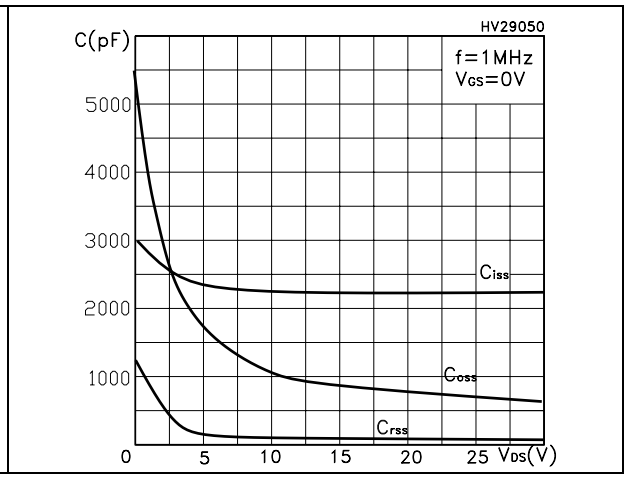



**Figure 10. Normalized gate threshold voltage vs temperature**

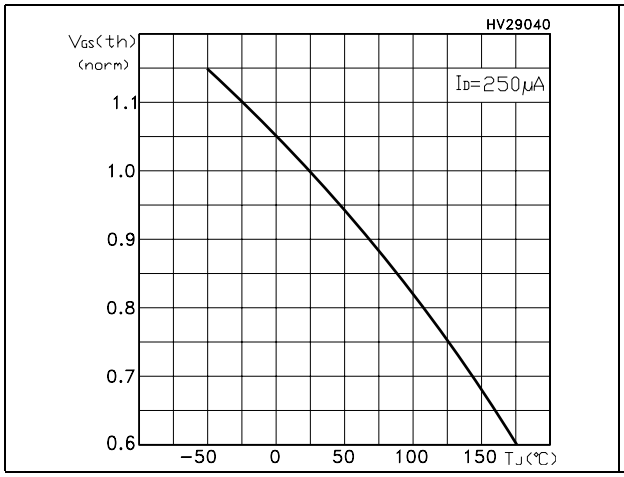



**Figure 11. Normalized on resistance vs temperature**

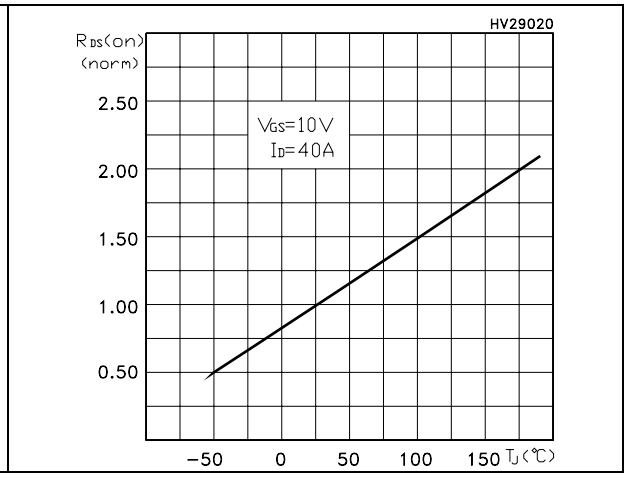
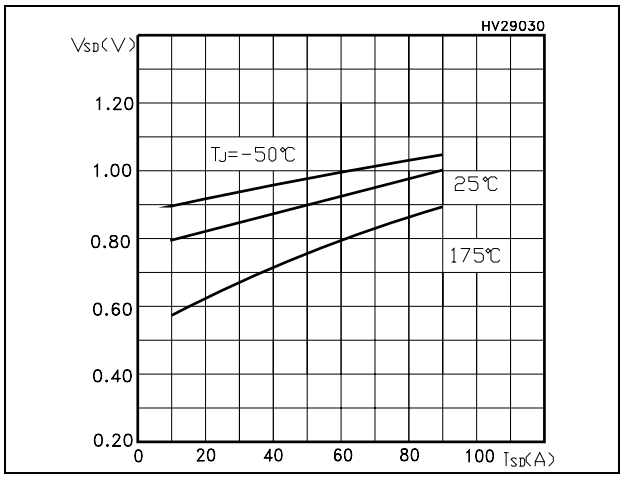



**Figure 12. Source-drain diode forward characteristics**



# 3 Test circuit

**Figure 13. Switching times test circuit for resistive load**

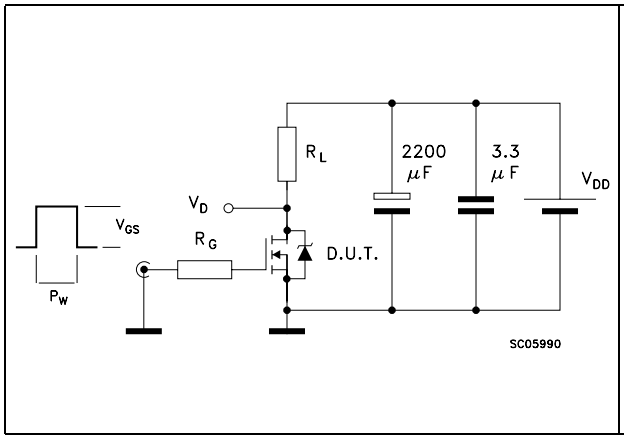



**Figure 14. Gate charge test circuit**

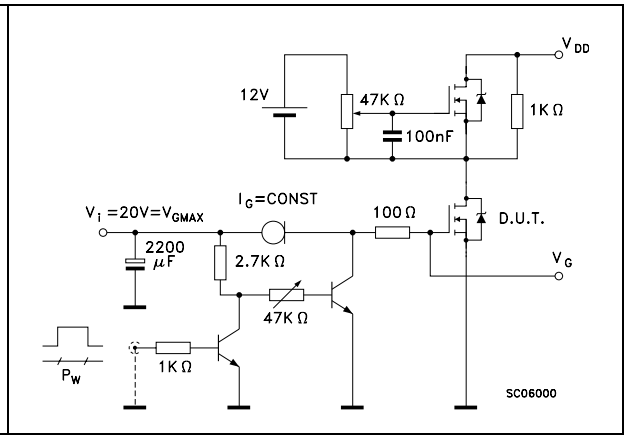



**Figure 15. Test circuit for inductive load switching and diode recovery times**

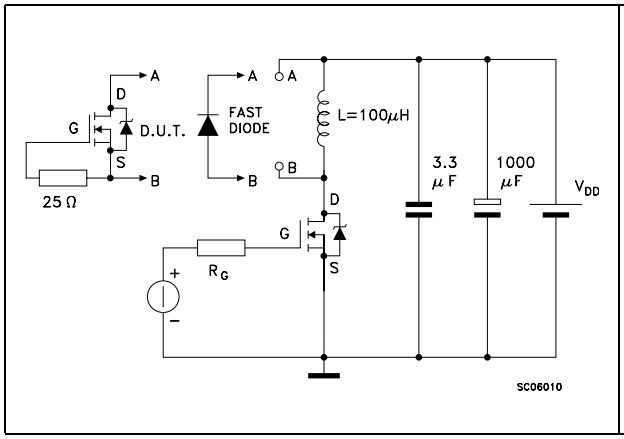



**Figure 16. Unclamped Inductive load test circuit**

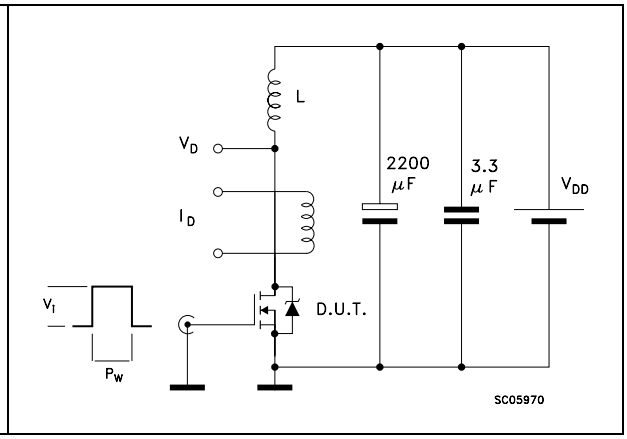



**Figure 17. Unclamped inductive waveform**

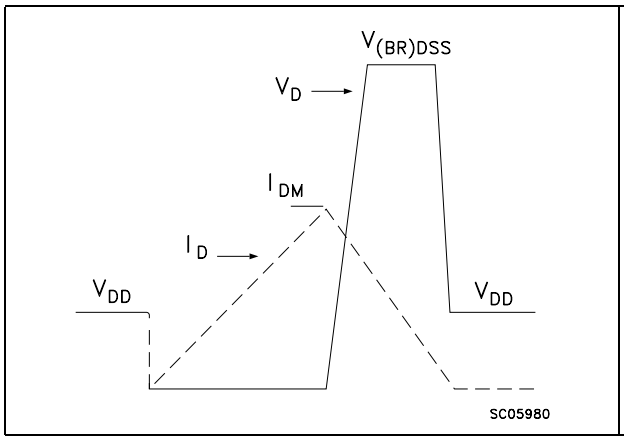
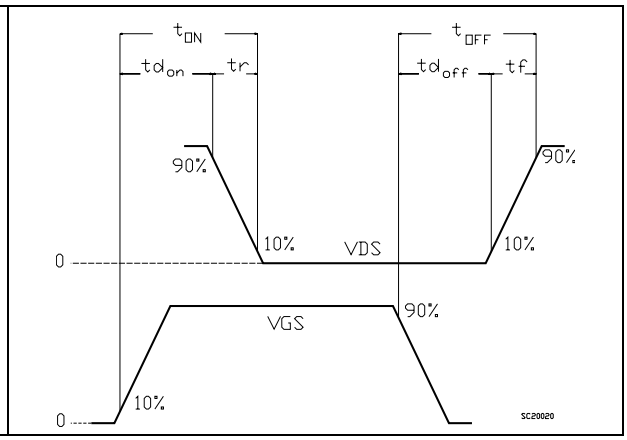



**Figure 18. Switching time waveform**

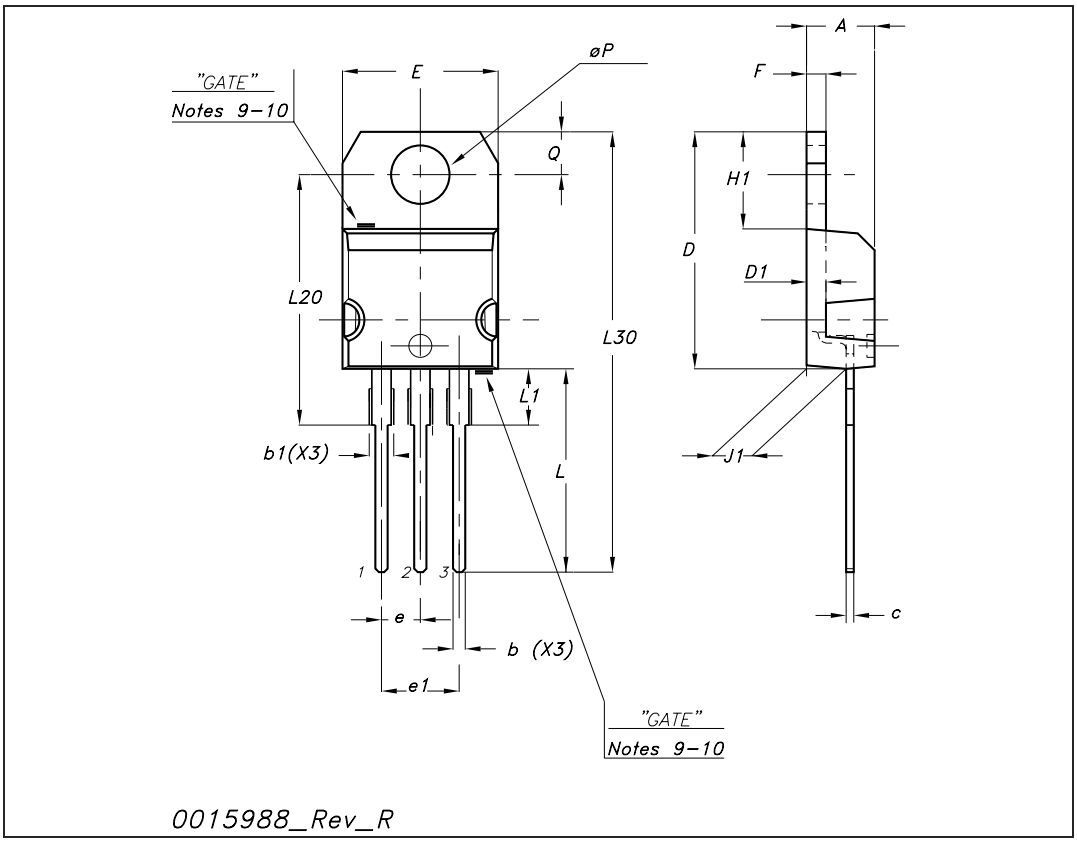


# 4 Package mechanical data

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*

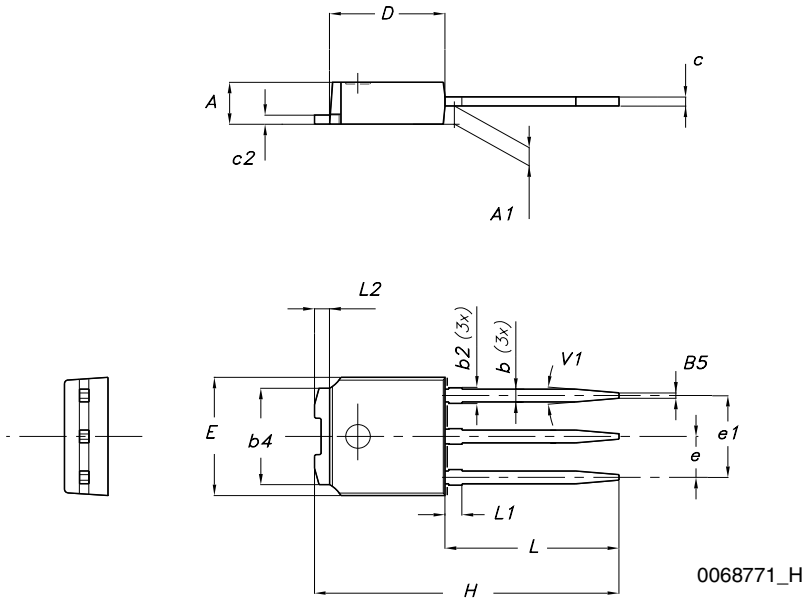
## TO-220 mechanical data

| 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 | |
| ØP | 3.75 | | 3.85 | 0.147 | | 0.151 |
| Q | 2.65 | | 2.95 | 0.104 | | 0.116 |



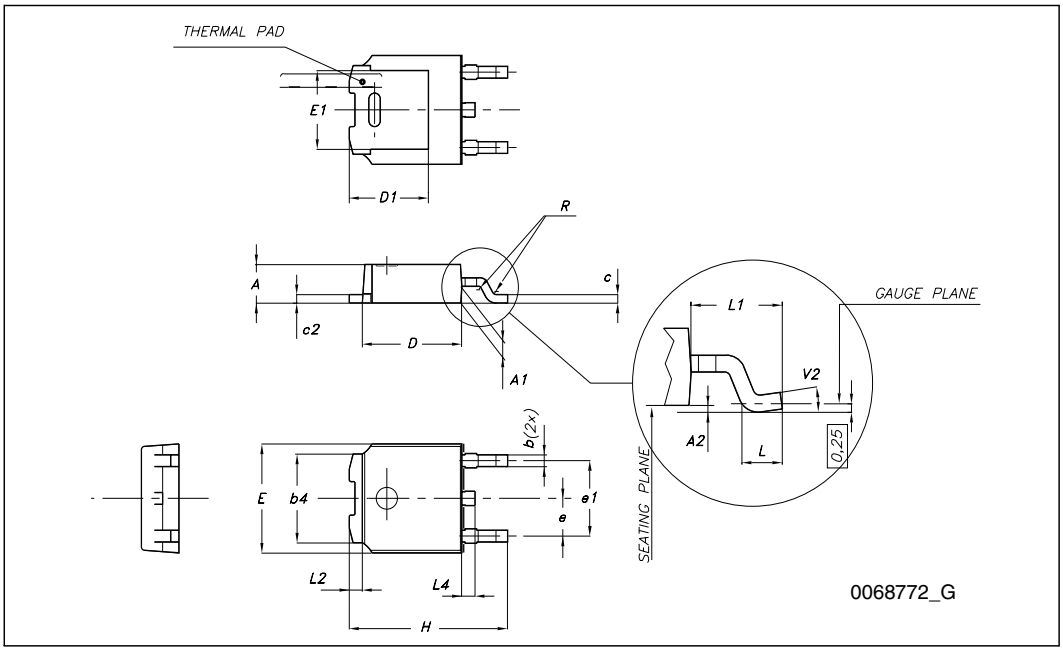
## TO-251 (IPAK) mechanical data

| 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 ° | |



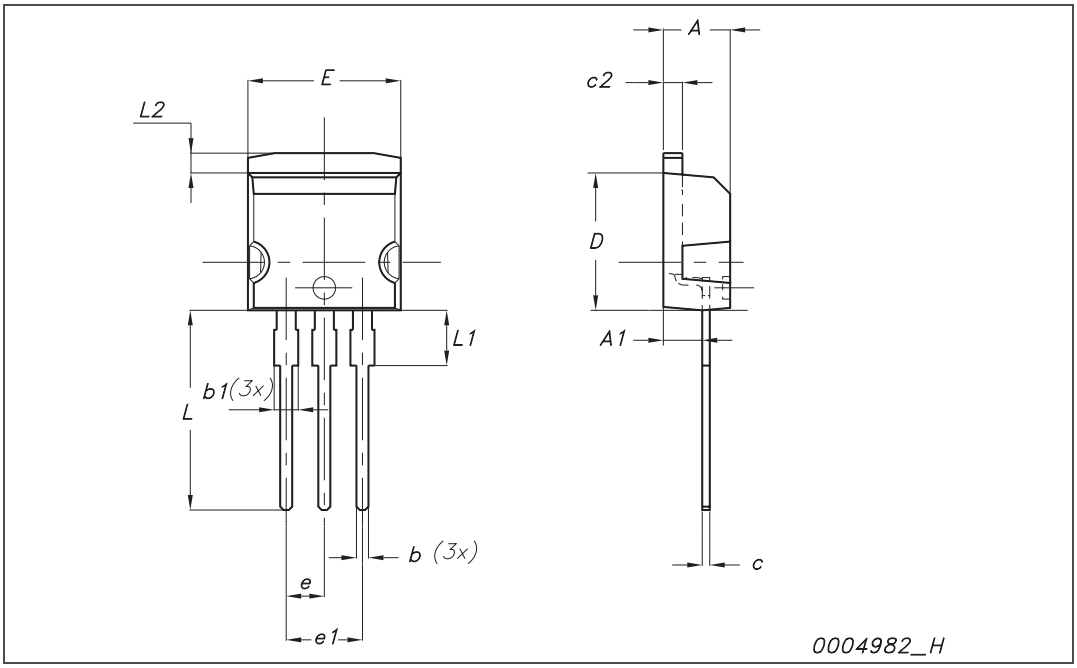
## TO-252 (DPAK) mechanical data

| 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 ° |



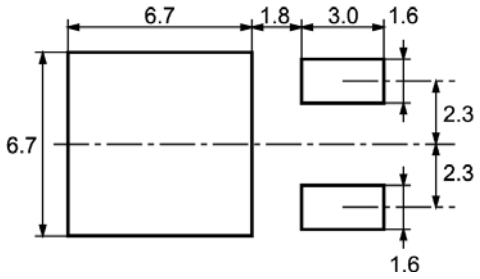
## I²PAK (TO-262) mechanical data

| 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 |



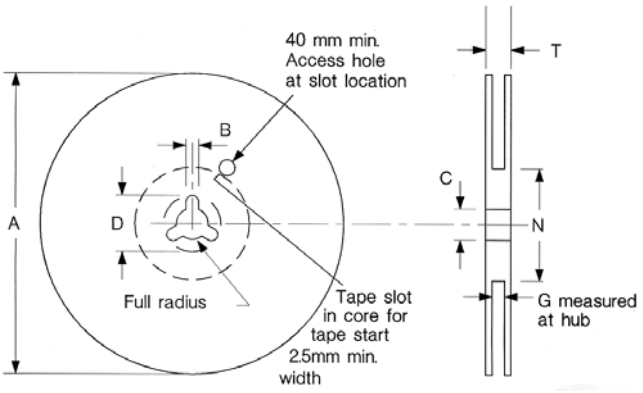
# 5 Packaging mechanical data

## DPAK FOOTPRINT




All dimensions are in millimeters

## TAPE AND REEL SHIPMENT



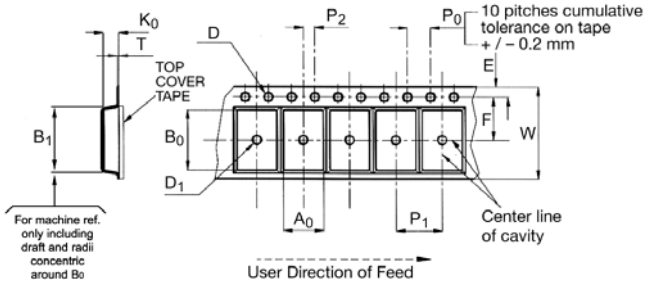

REEL MECHANICAL DATA

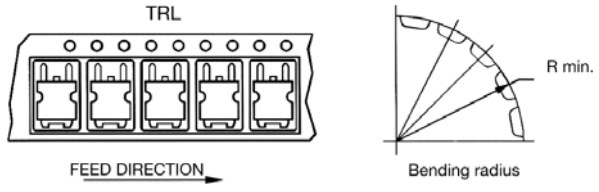
| DIM. | mm | | inch | |
|---|---|---|---|---|
| | MIN. | MAX. | MIN. | MAX. |
| A | | 330 | | 12.992 |
| B | 1.5 | | 0.059 | |
| C | 12.8 | 13.2 | 0.504 | 0.520 |
| D | 20.2 | | 0.795 | |
| G | 16.4 | 18.4 | 0.645 | 0.724 |
| N | 50 | | 1.968 | |
| T | | 22.4 | | 0.881 |

| 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 8. Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 29-Nov-2007 | 1 | First release |
| 15-Jul-2008 | 2 | Added new package, mechanical data: I²PAK |