



# STB9NK90Z - STF9NK90Z STP9NK90Z - STW9NK90Z

N-channel 900V - 1.1Ω - 8A - TO-220 /FP- D<sup>2</sup>PAK - TO-247  
Zener-protected superMESH™ MOSFET

## Features

| Type      | V <sub>DSS</sub> | R <sub>DS(on)</sub> | I <sub>D</sub> | P <sub>w</sub> |
|-----------|------------------|---------------------|----------------|----------------|
| STB9NK90Z | 900V             | <1.3Ω               | 8A             | 160 W          |
| STW9NK90Z | 900V             | <1.3Ω               | 8A             | 160 W          |
| STP9NK90Z | 900V             | <1.3Ω               | 8A             | 160 W          |
| STF9NK90Z | 900V             | <1.3Ω               | 8A             | 40 W           |

- Extremely high dv/dt capability
- 100% avalanche tested
- Gate charge minimized

## 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.

## Application

- Switching applications

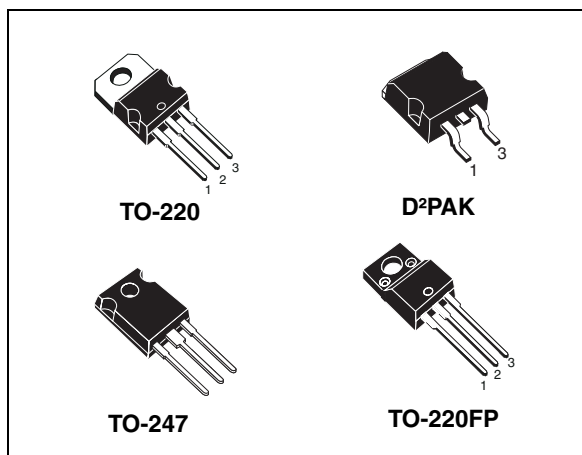


Figure 1. Internal schematic diagram

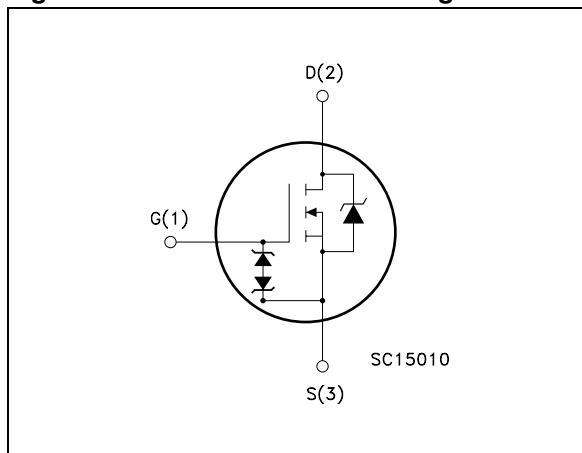


Table 1. Device summary

| Order codes | Marking | Package            | Packaging   |
|-------------|---------|--------------------|-------------|
| STB9NK90Z   | B9NK90  | D <sup>2</sup> PAK | Tape & reel |
| STF9NK90Z   | F9NK90Z | TO-220FP           | Tube        |
| STP9NK90Z   | P9NK90Z | TO-220             | Tube        |
| STW9NK90Z   | W9NK90Z | TO-247             | Tube        |

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol                             | Parameter   | Value                               |                   | Unit |
|------------------------------------|---|-------------------------------------|-------------------|------|
|                                    |   | TO-220/D <sup>2</sup> PAK<br>TO-247 | TO-220FP          |      |
| V <sub>DS</sub>                    | Drain-source voltage (V <sub>GS</sub> = 0)  | 900                                 |                   | V    |
| V <sub>GS</sub>                    | Gate-source voltage   | ± 30                                |                   | V    |
| I <sub>D</sub>                     | Drain current (continuous) at T <sub>C</sub> = 25°C   | 8                                   | 8 <sup>(1)</sup>  | A    |
| I <sub>D</sub>                     | Drain current (continuous) at T <sub>C</sub> =100°C   | 5                                   | 5 <sup>(1)</sup>  | A    |
| I <sub>DM</sub> <sup>(2)</sup>     | Drain current (pulsed)  | 32                                  | 32 <sup>(1)</sup> | A    |
| P <sub>TOT</sub>                   | Total dissipation at T <sub>C</sub> = 25°C  | 160                                 | 40                | W    |
|                                    | Derating Factor   | 1.28                                | 0.32              | W/°C |
| Vesd(G-S)                          | G-S ESD (HBM C=100pF, R=1.5kΩ)  | 4                                   |                   | KV   |
| dv/dt <sup>(3)</sup>               | Peak diode recovery voltage slope   | 4.5                                 |                   | V/ns |
| V <sub>ISO</sub>                   | Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1s;T <sub>C</sub> =25°C) | --                                  | 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> ≤ 0A, di/dt ≤ 200A/μs, V<sub>DD</sub> ≤ V<sub>(BR)DSS</sub>, T<sub>J</sub> ≤ T<sub>JMAX</sub>

**Table 3. Thermal data**

| Symbol                | Parameter                                      | Value                        |          |        | Unit |
|-----------------------|--|------------------------------|----------|--------|------|
|                       |  | TO-220<br>D <sup>2</sup> PAK | TO-220FP | TO-247 |      |
| R <sub>thj-case</sub> | Thermal resistance junction-case max           | 0.78                         | 3.1      | 0.78   | °C/W |
| R <sub>thj-a</sub>    | Thermal resistance junction-ambient max        | 62.5                         |          | 50     | °C/W |
| T <sub>I</sub>        | Maximum lead temperature for soldering purpose | 300                          |          |        | °C   |

**Table 4. Avalanche characteristics**

| Symbol          | Parameter  | Value | Unit |
|-----------------|--|-------|------|
| I <sub>AS</sub> | Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>J</sub> Max)  | 8     | A    |
| E <sub>AS</sub> | Single pulse avalanche energy (starting T <sub>J</sub> =25°C, I <sub>D</sub> =I <sub>AS</sub> , V <sub>DD</sub> =50V) (see Figure 22)(see Figure 23) | 220   | mJ   |

## 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                   | $I_D = 1mA, V_{GS} = 0$  | 900  |      |          | V                  |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = \text{Max rating},$<br>$V_{DS} = \text{Max rating} @ 125^{\circ}C$ |      |      | 1<br>50  | $\mu A$<br>$\mu A$ |
| $I_{GSS}$     | Gate body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 20V, V_{DS} = 0$   |      |      | $\pm 10$ | $\mu A$            |
| $V_{GS(th)}$  | 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                | $V_{GS} = 10V, I_D = 3.6A$   |      | 1.1  | 1.3      | $\Omega$           |

**Table 6. Dynamic**

| Symbol                     | Parameter                     | Test conditions                                    | Min. | Typ. | Max. | Unit |
|----------------------------|-------------------------------|--|------|------|------|------|
| $g_{fs}^{(1)}$             | Forward transconductance      | $V_{DS} = 15V, I_D = 3.6 A$                        |      | 5.75 |      | S    |
| $C_{iss}$                  | Input capacitance             | $V_{DS} = 25V, f = 1 \text{ MHz},$<br>$V_{GS} = 0$ |      | 2115 |      | pF   |
| $C_{oss}$                  | Output capacitance            |  |      | 190  |      | pF   |
| $C_{rss}$                  | Reverse transfer capacitance  |  |      | 40   |      | pF   |
| $C_{oss \text{ eq}}^{(2)}$ | Equivalent output capacitance | $V_{GS} = 0, V_{DS} = 0V \text{ to } 720V$         |      | 115  |      | pF   |
| $Q_g$                      | Total gate charge             | $V_{DD} = 720V, I_D = 8A$                          |      | 72   |      | nC   |
| $Q_{gs}$                   | Gate-source charge            | $V_{GS} = 10V$                                     |      | 14   |      | nC   |
| $Q_{gd}$                   | Gate-drain charge             | (see Figure 20)                                    |      | 38   |      | 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  | $V_{DD}=450\text{ V}$ , $I_D=4\text{ A}$ ,<br>$R_G=4.7\Omega$ , $V_{GS}=10\text{ V}$<br>(see Figure 19)<br>(see Figure 24) |      | 22<br>13 |      | ns<br>ns |
| $t_{d(off)}$<br>$t_f$ | Turn-off delay time<br>Fall time | $V_{DD}=450\text{ V}$ , $I_D=4\text{ A}$ ,<br>$R_G=4.7\Omega$ , $V_{GS}=10\text{ V}$<br>(see Figure 19)<br>(see Figure 24) |      | 55<br>28 |      | ns<br>ns |

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

| Symbol           | Parameter                     | Test conditions                       | Min. | Typ. | Max. | Unit |
|------------------|-------------------------------|---------------------------------------|------|------|------|------|
| $BV_{GSO}^{(1)}$ | Gate-source breakdown voltage | $I_{GS}=\pm 1\text{ mA}$ (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.

**Table 9. Source drain diode**

| Symbol                            | Parameter  | Test conditions  | Min | Typ.            | Max | Unit                     |
|-----------------------------------|--|--|-----|-----------------|-----|--------------------------|
| $I_{SD}$                          | Source-drain current   |  |     |                 | 8   | A                        |
| $I_{SDM}^{(1)}$                   | Source-drain current (pulsed)  |  |     |                 | 32  | A                        |
| $V_{SD}^{(2)}$                    | Forward on voltage   | $I_{SD}=8\text{ A}$ , $V_{GS}=0$   |     |                 | 1.6 | V                        |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_{SD}=8\text{ A}$ ,<br>$di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD}=50\text{ V}$ , $T_j=150^\circ\text{C}$<br>(see Figure 21) |     | 950<br>10<br>21 |     | ns<br>$\mu\text{C}$<br>A |

1. Pulse width limited by safe operating area  
2. Pulsed: pulse duration=300 $\mu\text{s}$ , duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-220/D<sup>2</sup>PAK

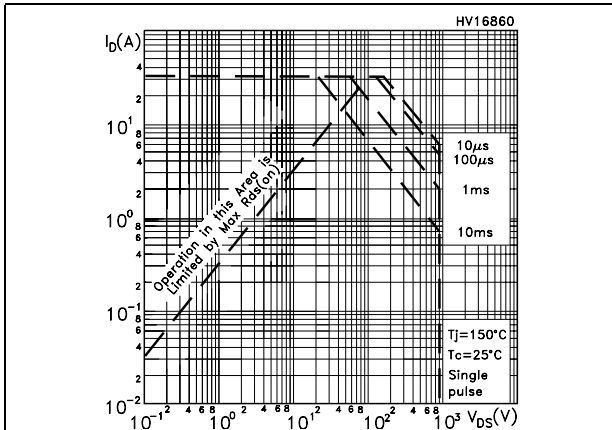


Figure 3. Thermal impedance for TO-220/D<sup>2</sup>PAK

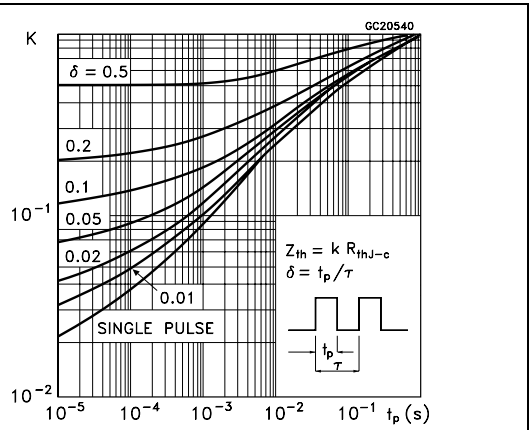


Figure 4. Safe operating area for TO-220FP

Figure 5. Thermal impedance for TO-220FP

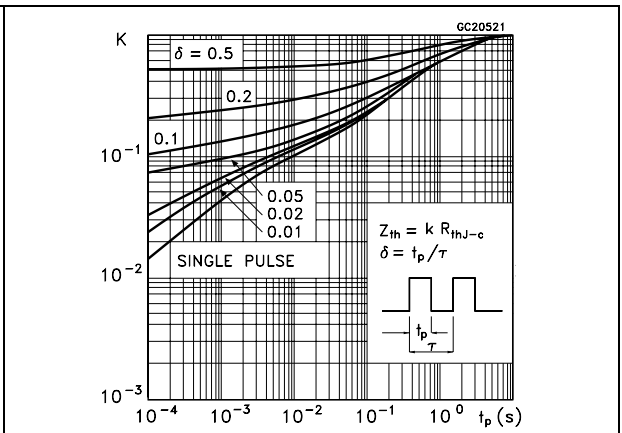
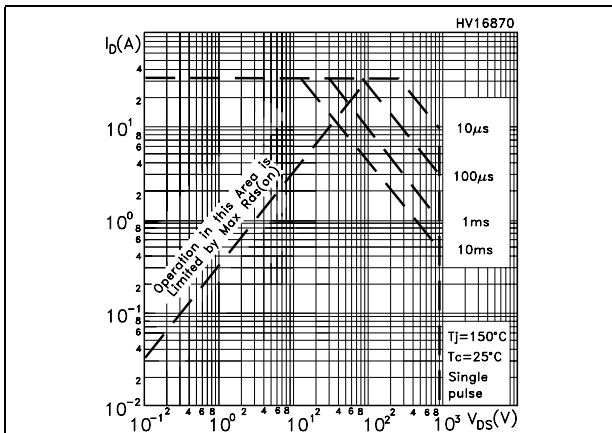


Figure 6. Safe operating area for TO-247

Figure 7. Thermal impedance for TO-247

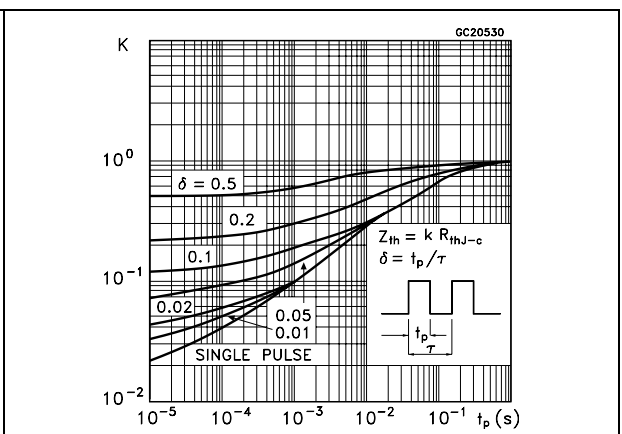
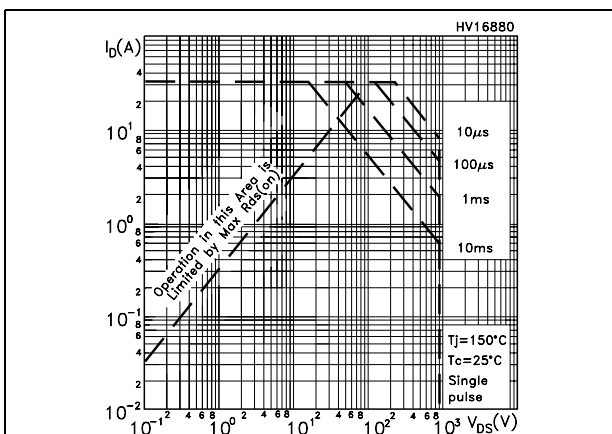


Figure 8. Output characteristics

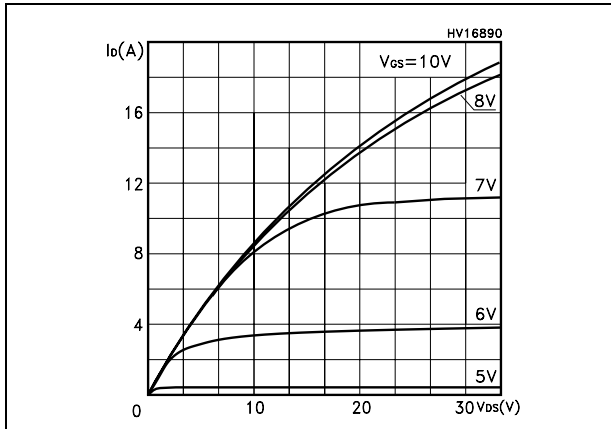


Figure 9. Transfer characteristics

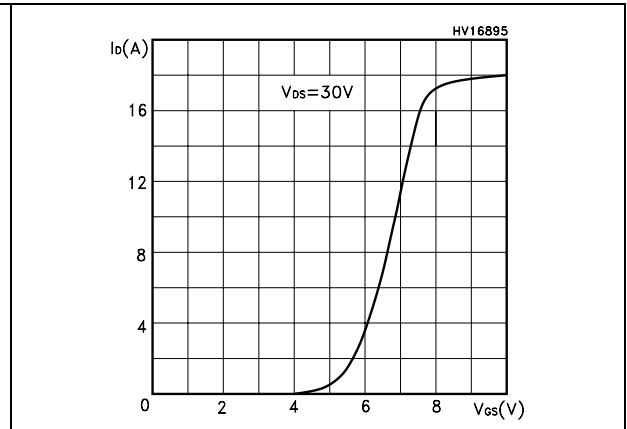


Figure 10. Transconductance

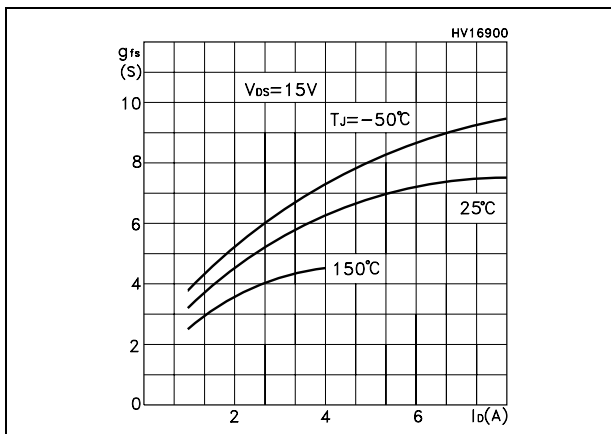


Figure 11. Static drain-source on resistance

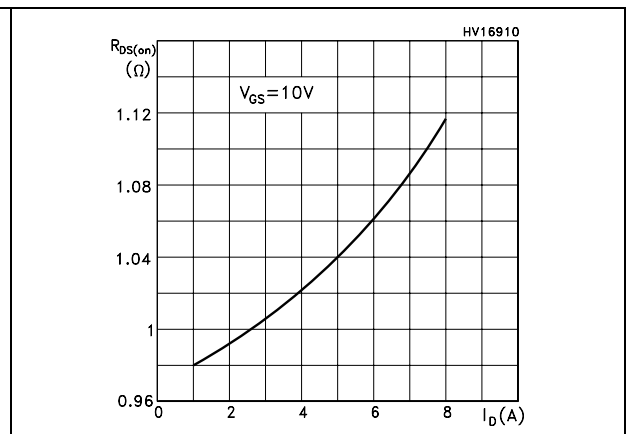


Figure 12. Gate charge vs gate-source voltage Figure 13. Capacitance variations

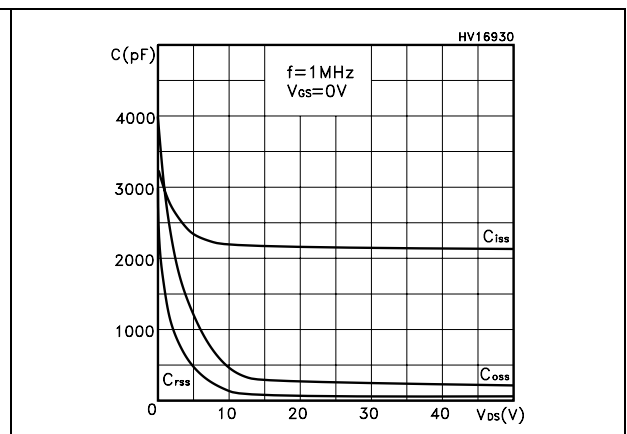
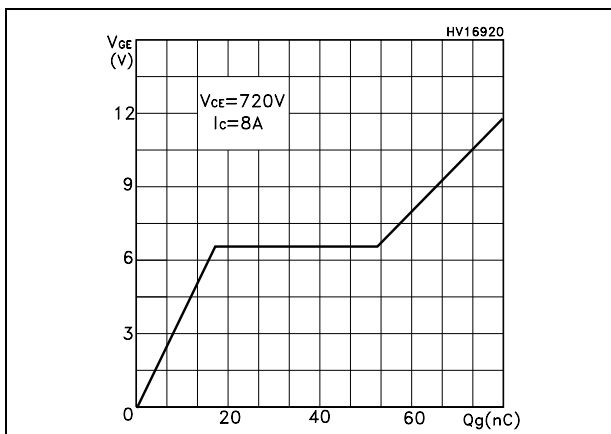


Figure 14. Normalized gate threshold voltage vs temperature

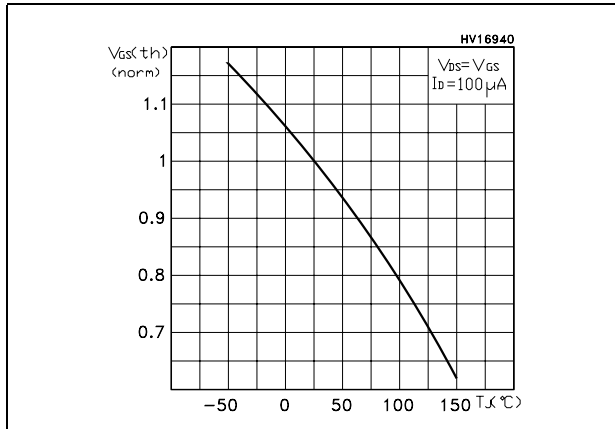


Figure 15. Normalized on resistance vs temperature

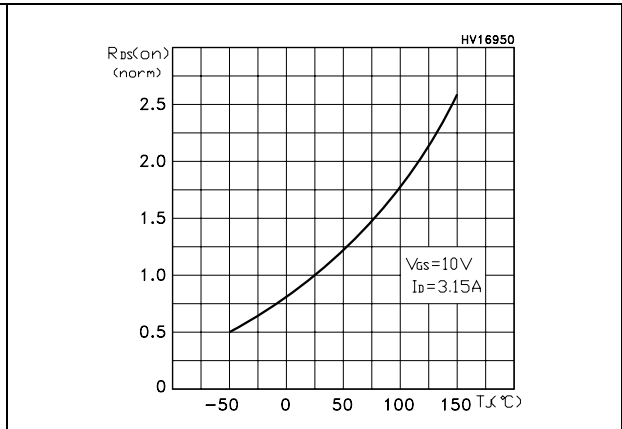


Figure 16. Source-drain diode forward characteristics

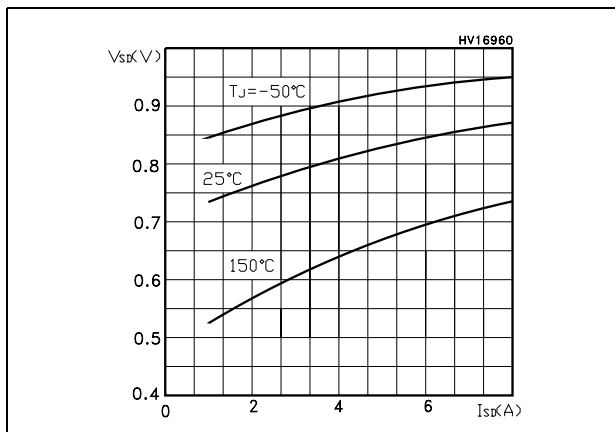


Figure 17. Normalized B<sub>VDSS</sub> vs temperature

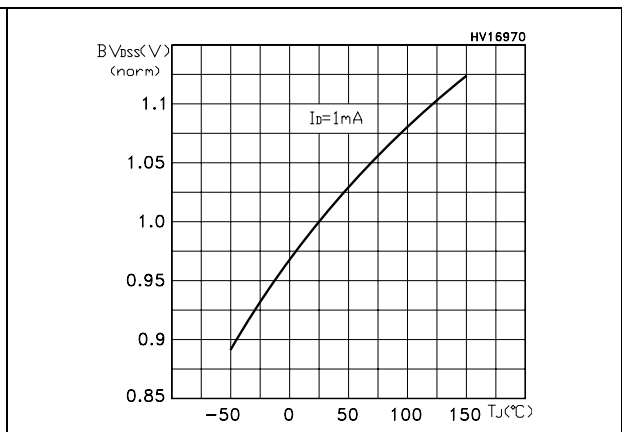
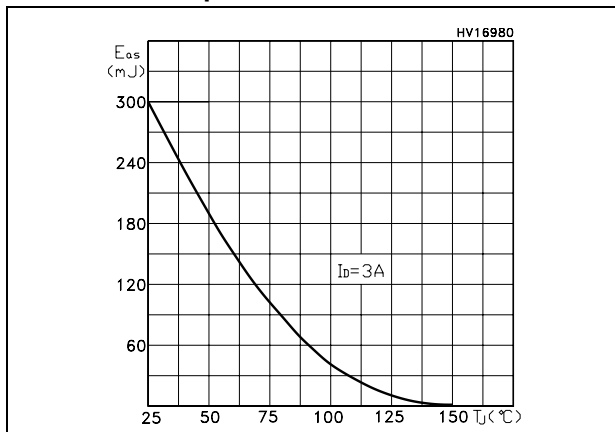


Figure 18. Maximum avalanche energy vs temperature





### 3 Test circuit

Figure 19. Switching times test circuit for resistive load

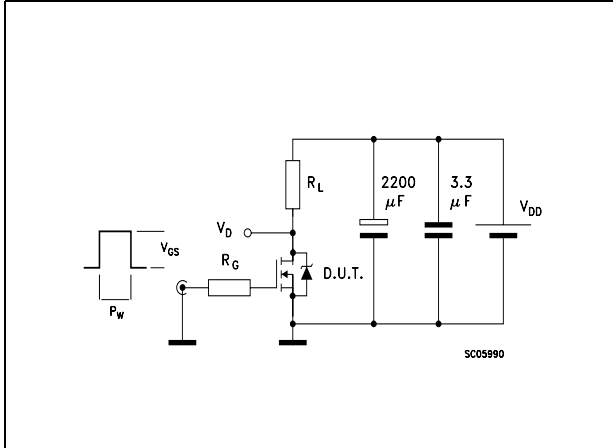


Figure 20. Gate charge test circuit



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

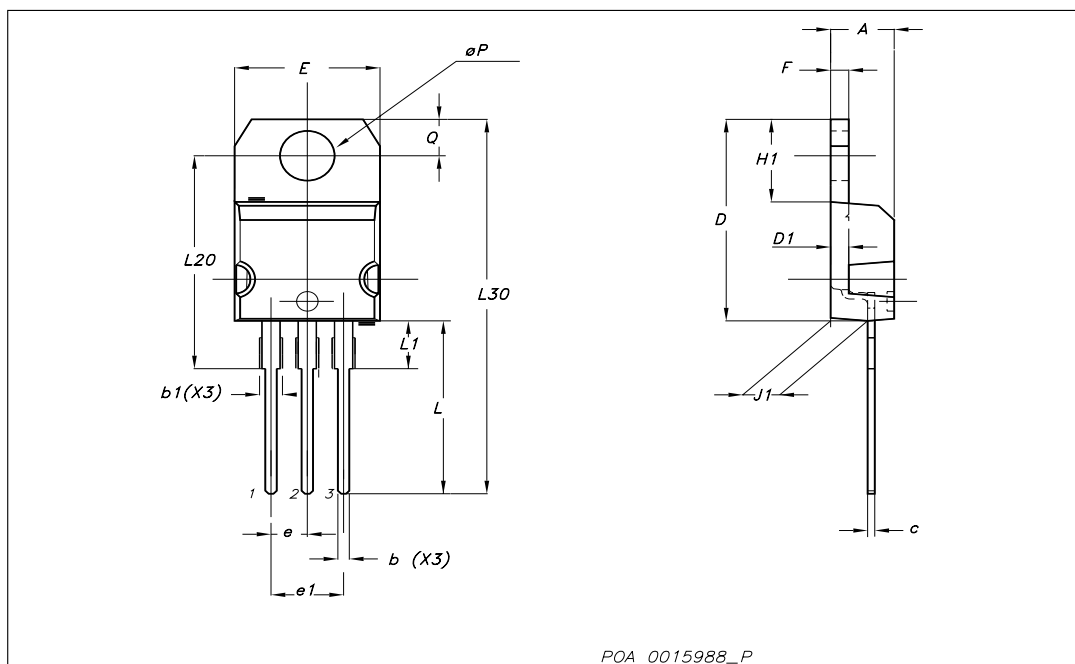


## 4 Package mechanical data

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)

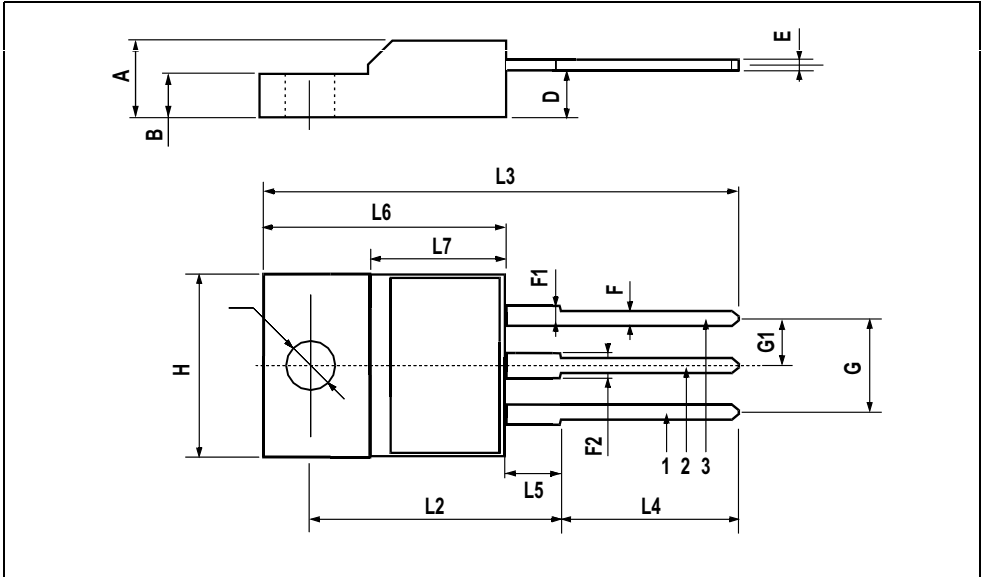
## TO-220 mechanical data

| 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  | 1.14  |       | 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 |       |
| ∅P  | 3.75  |       | 3.85  | 0.147 |       | 0.151 |
| Q   | 2.65  |       | 2.95  | 0.104 |       | 0.116 |



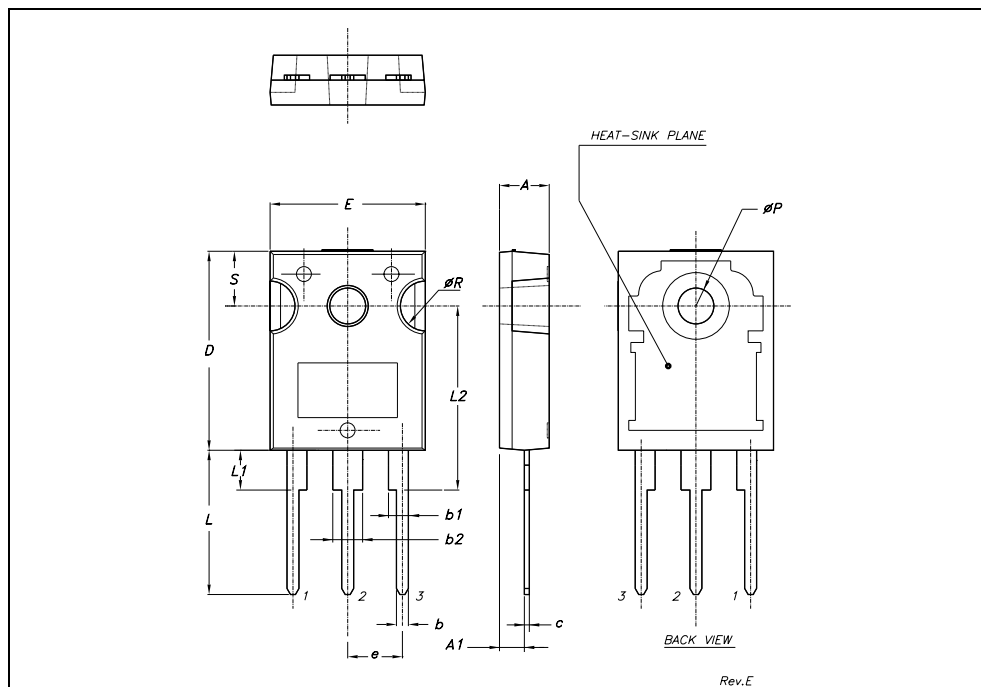
**TO-220FP MECHANICAL DATA**

| 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 |



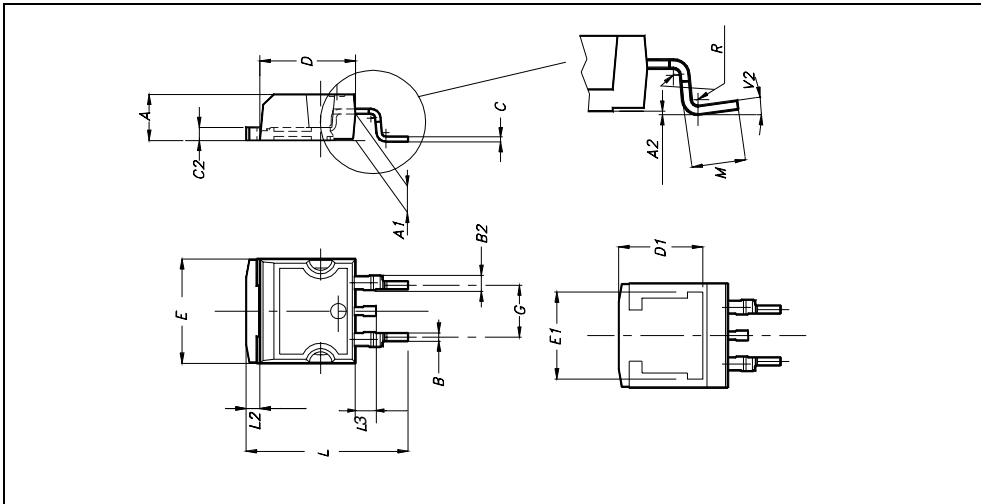
**TO-247 MECHANICAL DATA**

| 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 |       |



**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°    |       |       |       |



# 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     |

10 pitches cumulative tolerance on tape +/- 0.2 mm

Center line of cavity

User Direction of Feed

FEED DIRECTION

Bending radius R min.

\* on sales type

## 6 Revision history

**Table 10. Revision history**

| Date        | Revision | Changes   |
|-------------|----------|---|
| 08-Sep-2005 | 2        | Complete version  |
| 27-Oct-2005 | 3        | Inserted ecopack indication                               |
| 20-Jul-2006 | 4        | New template, no content change                           |
| 20-Mar-2007 | 5        | Typo mistake on cover page                                |
| 13-Jul-2007 | 6        | Corrected unit on <a href="#">Table 5.: On/off states</a> |



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