



# STP10NK70ZFP STP10NK70Z

N-CHANNEL 700V - 0.75Ω - 8.6A - TO220-TO220FP  
Zener-Protected SuperMESH™ MOSFET

## General features

| Type         | V <sub>DSS</sub> | R <sub>DS(on)</sub> | I <sub>D</sub> | P <sub>w</sub> |
|--------------|------------------|---------------------|----------------|----------------|
| STP10NK70Z   | 700 V            | <0.85 Ω             | 8.6 A          | 110 W          |
| STP10NK70ZFP | 700 V            | <0.85 Ω             | 8.6 A          | 35 W           |

- EXTREMELY HIGH dv/dt CAPABILITY
- IMPROVED ESD CAPABILITY
- 100% AVALANCHE TESTED
- GATE CHARGE MINIMIZED
- VERY LOW INTRINSIC CAPACITANCES
- VERY GOOD MANUFACTURING REPEATABILITY

## 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.

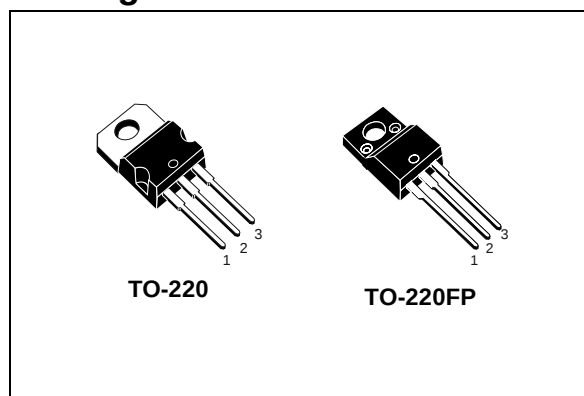
## Applications

- HIGH CURRENT, HIGH SPEED SWITCHING
- IDEAL FOR OFF-LINE POWER SUPPLIES, ADAPTOR AND PFC

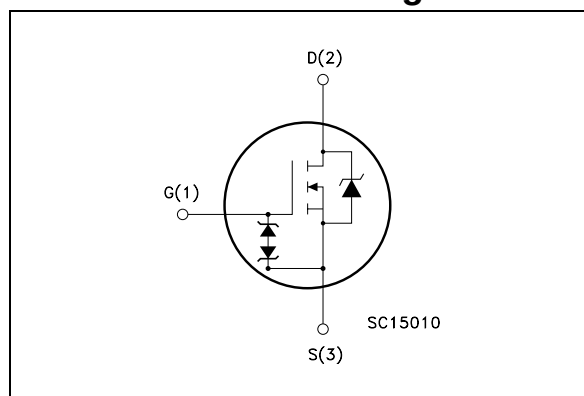
## Order codes

| Sales Type   | Marking    | Package  | Packaging |
|--------------|------------|----------|-----------|
| STP10NK70Z   | P10NK70Z   | TO-220   | TUBE      |
| STP10NK70ZFP | P10NK70ZFP | TO-220FP | TUBE      |

## Package



## Internal schematic diagram



# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol                    | Parameter                                               | Value      |              | Unit |
|---------------------------|---------------------------------------------------------|------------|--------------|------|
|                           |                                                         | TO-220     | TO-220FP     |      |
| $V_{DS}$                  | Drain-Source Voltage ( $V_{GS} = 0$ )                   | 700        |              | V    |
| $V_{DGR}$                 | Drain-gate Voltage ( $R_{GS} = 20k\Omega$ )             | 700        |              | V    |
| $V_{GS}$                  | Gate-Source Voltage                                     | $\pm 30$   |              | V    |
| $I_D$                     | Drain Current (continuous) at $T_C = 25^\circ\text{C}$  | 8.6        | 8.6 (Note 3) | A    |
| $I_D$                     | Drain Current (continuous) at $T_C = 100^\circ\text{C}$ | 5.4        | 5.4 (Note 3) | A    |
| $I_{DM}$ Note 2           | Drain Current (pulsed)                                  | 34         | 34 (Note 3)  | A    |
| $P_{TOT}$                 | Total Dissipation at $T_C = 25^\circ\text{C}$           | 150        | 35           | W    |
|                           | Derating Factor                                         | 1.20       | 0.28         | W/°C |
| Vesd(G-S)                 | G-S ESD (HBM C=100pF, R=1.5kΩ)                          | 4000       |              | V    |
| $\frac{dv}{dt}$<br>Note 1 | 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   |

**Table 2. Thermal data**

|           |                                                | TO-220 | TO-220FP | Unit |
|-----------|------------------------------------------------|--------|----------|------|
| Rthj-case | Thermal Resistance Junction-case Max           | 0.83   | 3.6      | °C/W |
| Rthj-amb  | Thermal Resistance Junction-amb Max            | 62.5   |          | °C/W |
| $T_I$     | Maximum Lead Temperature For Soldering Purpose | 300    |          | °C   |

**Table 3. Avalanche characteristics**

| Symbol   | Parameter                                                                                             | Max Value | Unit |
|----------|-------------------------------------------------------------------------------------------------------|-----------|------|
| $I_{AR}$ | Avalanche Current, repetitive or Not-Repetitive (pulse width limited by $T_j$ max)                    | 8.6       | A    |
| $E_{AS}$ | Single Pulse Avalanche Energy (starting $T_j=25^\circ\text{C}$ , $I_D=I_{AR}$ , $V_{DD}=50\text{V}$ ) | 350       | mJ   |

## 2 Electrical characteristics

(T<sub>CASE</sub> = 25 °C unless otherwise specified)

**Table 4. On/off states**

| Symbol               | Parameter                                             | Test Conditions                                                                       | Min. | Typ. | Max.    | Unit     |
|----------------------|-------------------------------------------------------|---------------------------------------------------------------------------------------|------|------|---------|----------|
| V <sub>(BR)DSS</sub> | Drain-Source Breakdown Voltage                        | I <sub>D</sub> = 1mA, V <sub>GS</sub> = 0                                             | 700  |      |         | V        |
| I <sub>DSS</sub>     | Zero Gate Voltage Drain Current (V <sub>GS</sub> = 0) | V <sub>DS</sub> = Max Rating,<br>V <sub>DS</sub> = Max Rating, T <sub>c</sub> = 125°C |      |      | 1<br>50 | μA<br>μA |
| I <sub>GSS</sub>     | Gate Body Leakage Current (V <sub>DS</sub> = 0)       | V <sub>GS</sub> = ±20V, V <sub>DS</sub> = 0                                           |      |      | ±10     | μA       |
| V <sub>GS(th)</sub>  | Gate Threshold Voltage                                | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 100 μA                           | 3    | 3.75 | 4.5     | V        |
| R <sub>DS(on)</sub>  | Static Drain-Source On Resistance                     | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 4.5 A                                        |      | 0.75 | 0.85    | Ω        |

**Table 5. Dynamic**

| Symbol                             | Parameter                     | Test Conditions                                       | Min. | Typ. | Max. | Unit |
|------------------------------------|-------------------------------|-------------------------------------------------------|------|------|------|------|
| g <sub>fs</sub> <i>Note 4</i>      | Forward Transconductance      | V <sub>DS</sub> = 15V, I <sub>D</sub> = 4.5A          |      | 7.7  |      | S    |
| C <sub>iss</sub>                   | Input Capacitance             | V <sub>DS</sub> = 25V, f = 1 MHz, V <sub>GS</sub> = 0 |      | 2000 |      | pF   |
| C <sub>oss</sub>                   | Output Capacitance            |                                                       |      | 190  |      | pF   |
| C <sub>rss</sub>                   | Reverse Transfer Capacitance  |                                                       |      | 41   |      | pF   |
| C <sub>oss</sub> eq. <i>Note 5</i> | Equivalent Output Capacitance | V <sub>GS</sub> = 0, V <sub>DS</sub> = 0V to 560V     |      | 98   |      | pF   |
| Q <sub>g</sub>                     | Total Gate Charge             | V <sub>DD</sub> = 560V, I <sub>D</sub> = 9 A          |      | 64   | 90   | nC   |
| Q <sub>gs</sub>                    | Gate-Source Charge            | V <sub>GS</sub> = 10V                                 |      | 12   |      | nC   |
| Q <sub>gd</sub>                    | Gate-Drain Charge             | (see Figure 17)                                       |      | 33   |      | nC   |

**Table 6. Switching times**

| Symbol                                                   | Parameter                                             | Test Conditions                                                                                                     | Min. | Typ.           | Max. | Unit           |
|----------------------------------------------------------|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|------|----------------|------|----------------|
| t <sub>d(on)</sub><br>t <sub>r</sub>                     | Turn-on Delay Time<br>Rise Time                       | V <sub>DD</sub> = 350 V, I <sub>D</sub> = 4.5 A,<br>R <sub>G</sub> = 4.7Ω, V <sub>GS</sub> = 10V<br>(see Figure 18) |      | 22<br>19       |      | ns<br>ns       |
| t <sub>d(off)</sub><br>t <sub>f</sub>                    | Turn-off Delay Time<br>Fall Time                      | V <sub>DD</sub> = 350 V, I <sub>D</sub> = 4.5A,<br>R <sub>G</sub> = 4.7Ω, V <sub>GS</sub> = 10V<br>(see Figure 18)  |      | 46<br>19       |      | ns<br>ns       |
| t <sub>r(Voff)</sub><br>t <sub>f</sub><br>t <sub>c</sub> | Off-voltage Rise Time<br>Fall Time<br>Cross-over Time | V <sub>DD</sub> = 560 V, I <sub>D</sub> = 9A,<br>R <sub>G</sub> = 4.7Ω, V <sub>GS</sub> = 10V<br>(see Figure 18)    |      | 11<br>10<br>22 |      | ns<br>ns<br>ns |

**Table 7. Source drain diode**

| Symbol                           | Parameter                     | Test Conditions                                                                                              | Min. | Typ. | Max. | Unit          |
|----------------------------------|-------------------------------|--------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $I_{SD}$                         | Source-drain Current          |                                                                                                              |      |      | 8.6  | A             |
| $I_{SDM}$ <a href="#">Note 2</a> | Source-drain Current (pulsed) |                                                                                                              |      |      | 34   | A             |
| $V_{SD}$ <a href="#">Note 4</a>  | Forward on Voltage            | $I_{SD}=8.6\text{ A}$ , $V_{GS}=0$                                                                           |      |      | 1.6  | V             |
| $t_{rr}$                         | Reverse Recovery Time         | $I_{SD}=9\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD}=35\text{ V}$ , $T_j=150^\circ\text{C}$ |      | 720  |      | ns            |
| $Q_{rr}$                         | Reverse Recovery Charge       |                                                                                                              |      | 5.4  |      | $\mu\text{C}$ |
| $I_{RRM}$                        | Reverse Recovery Current      |                                                                                                              |      | 15   |      | A             |

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

| Symbol                               | Parameter                     | Test Conditions                          | Min. | Typ. | Max. | Unit |
|--------------------------------------|-------------------------------|------------------------------------------|------|------|------|------|
| $BV_{GSO}$<br><a href="#">Note 6</a> | Gate-Source Breakdown Voltage | $I_{GS}=\pm 1\text{ mA}$<br>(Open Drain) | 30   |      |      | V    |

(1)  $I_{SD} \leq 8.6\text{ A}$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_j \leq T_{JMAX}$

(2) Pulse width limited by safe operating area

(3) Limited only by maximum temperature allowed

(4) Pulsed: pulse duration = 300 $\mu\text{s}$ , duty cycle 1.5%

(5)  $C_{OSS\text{eq}}$  is defined as a constant equivalent capacitance giving the same charging time as  $C_{OSS}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DSS}$

(6) 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 1. Safe Operating Area for TO-220

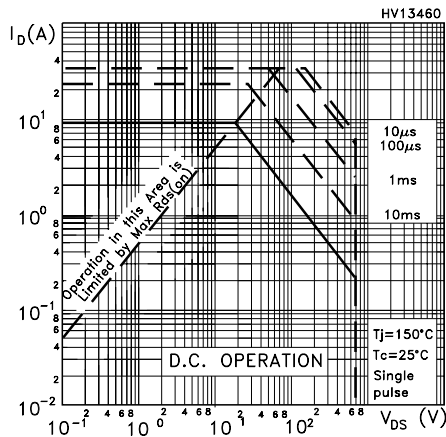


Figure 2. Thermal Impedance for TO-220

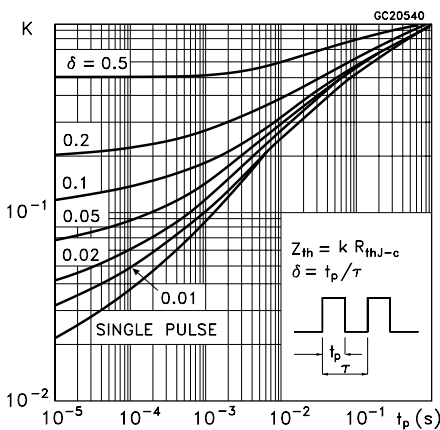


Figure 3. Safe Operating Area for TO-220FP

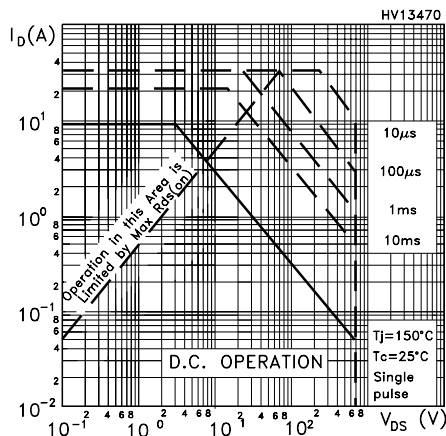


Figure 4. Thermal Impedance for TO-220FP

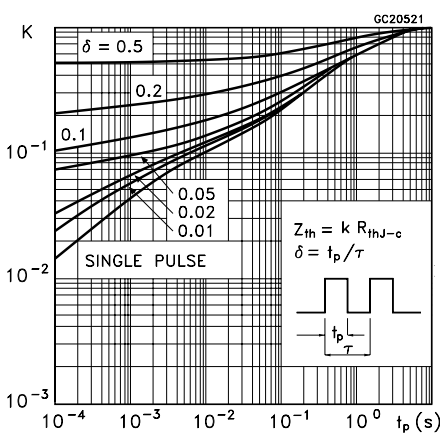


Figure 5. Output Characteristics

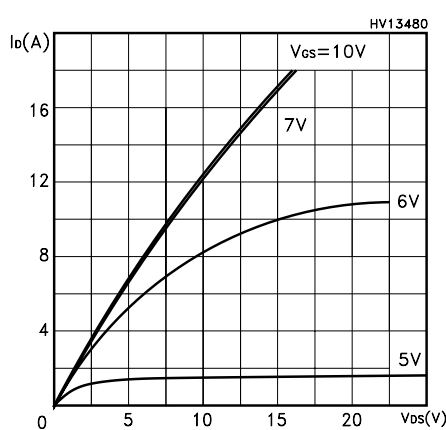


Figure 6. Transfer Characteristics

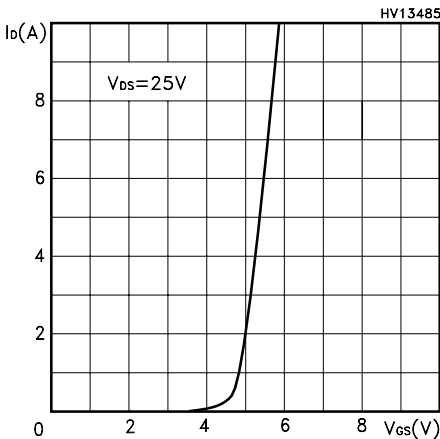


Figure 7. Transconductance

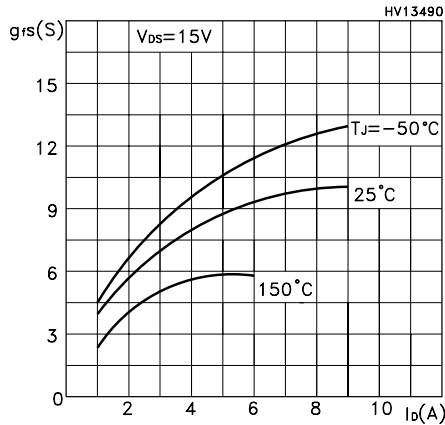


Figure 8. Static Drain-Source on Resistance

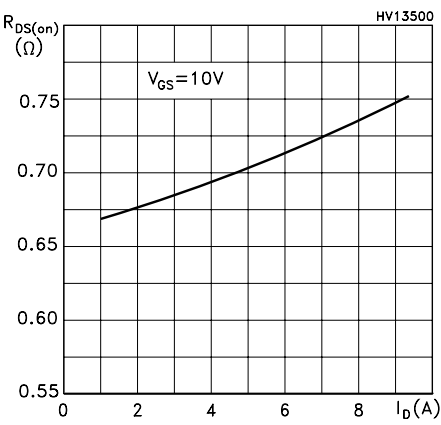


Figure 9. Gate Charge vs Gate -Source Voltage

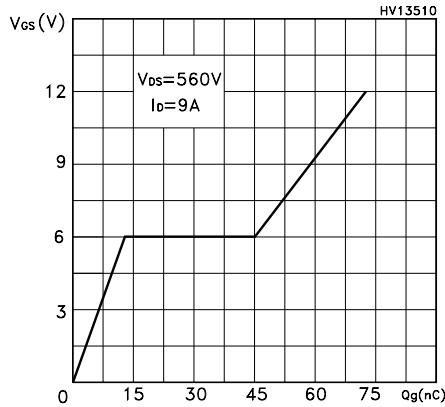


Figure 11. Capacitance Variations

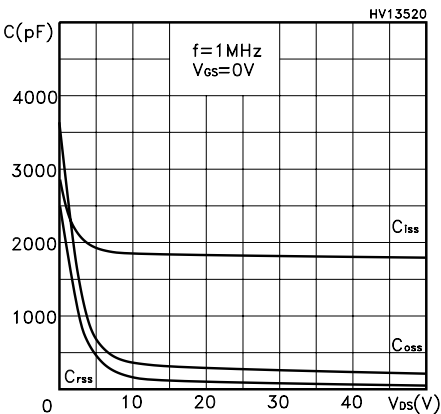


Figure 10. Normalized Gate Threshold Voltage vs Temperature

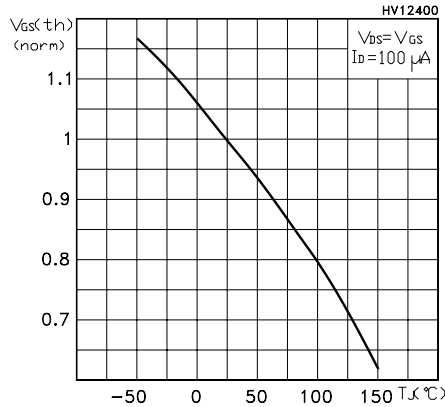


Figure 12. Normalized on Resistance vs Temperature

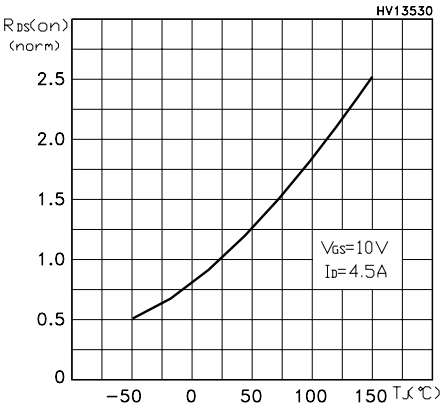


Figure 13. Source-drain Diode Forward Characteristics

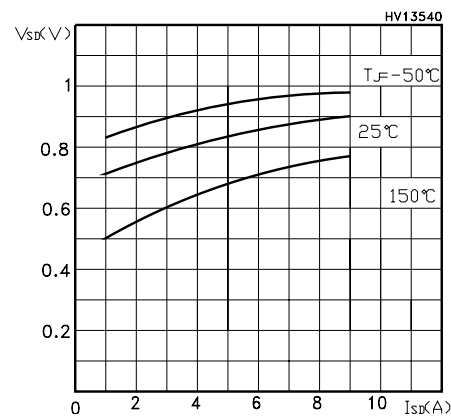


Figure 14. Normalized BVDSS vs Temperature

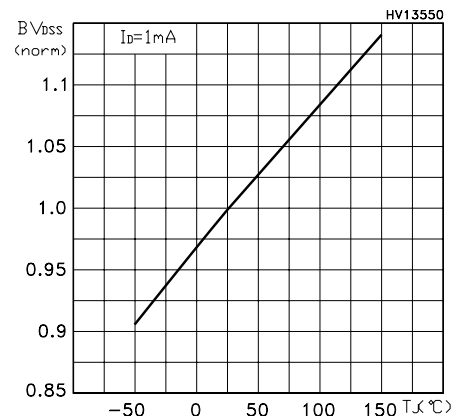
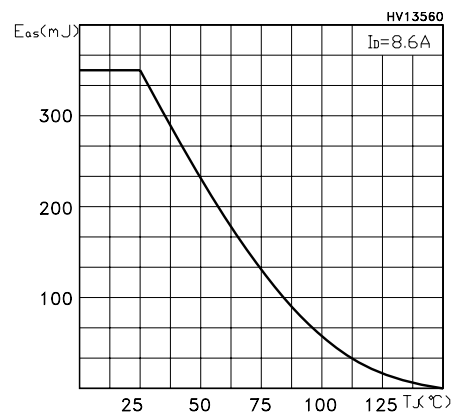
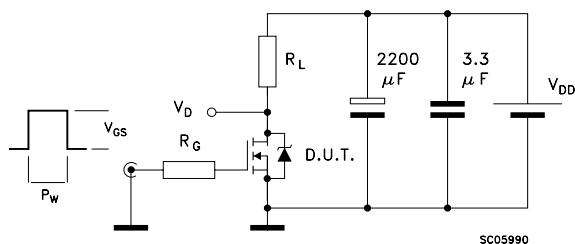


Figure 15. Maximum Avalanche Energy vs Temperature

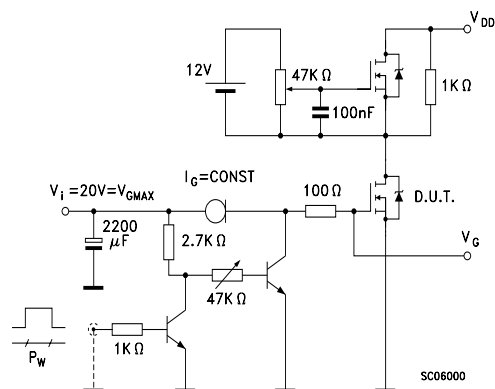


### 3 Test circuits

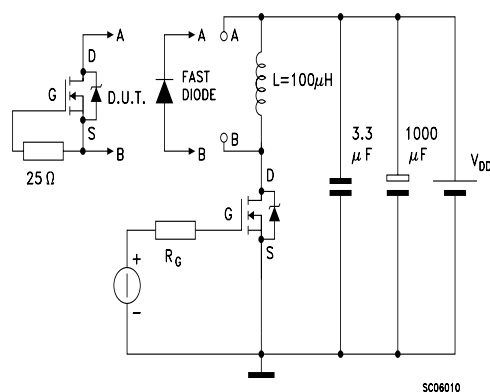
**Figure 16. Switching Times Test Circuit For Resistive Load**



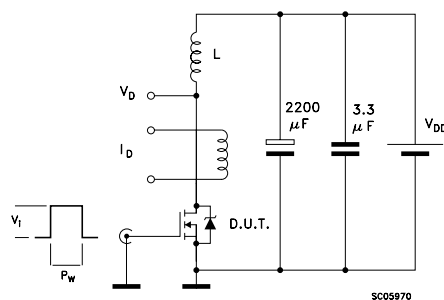
**Figure 17. Gate Charge Test Circuit**



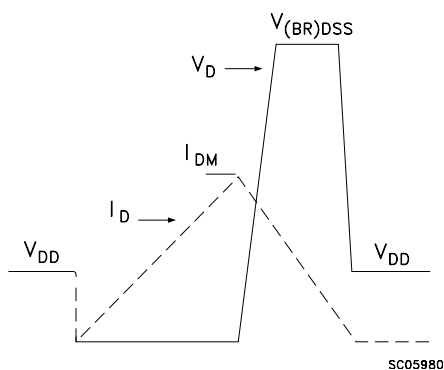
**Figure 18. Test Circuit For Inductive Load Switching and Diode Recovery Times**



**Figure 20. Unclamped Inductive Load Test Circuit**



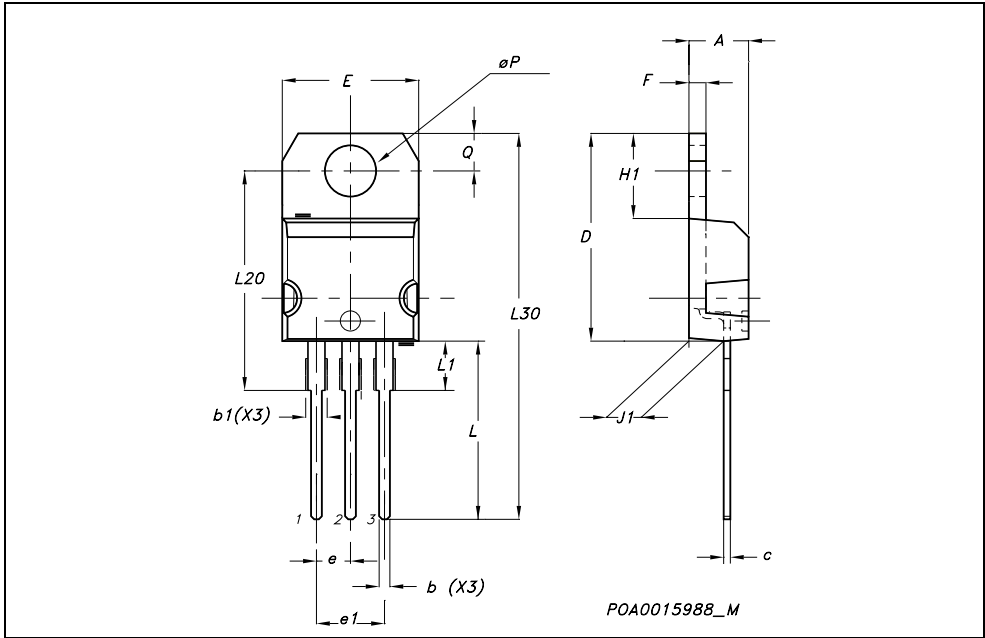
**Figure 19. Unclamped Inductive Waveform**



## 4 Package mechanical data

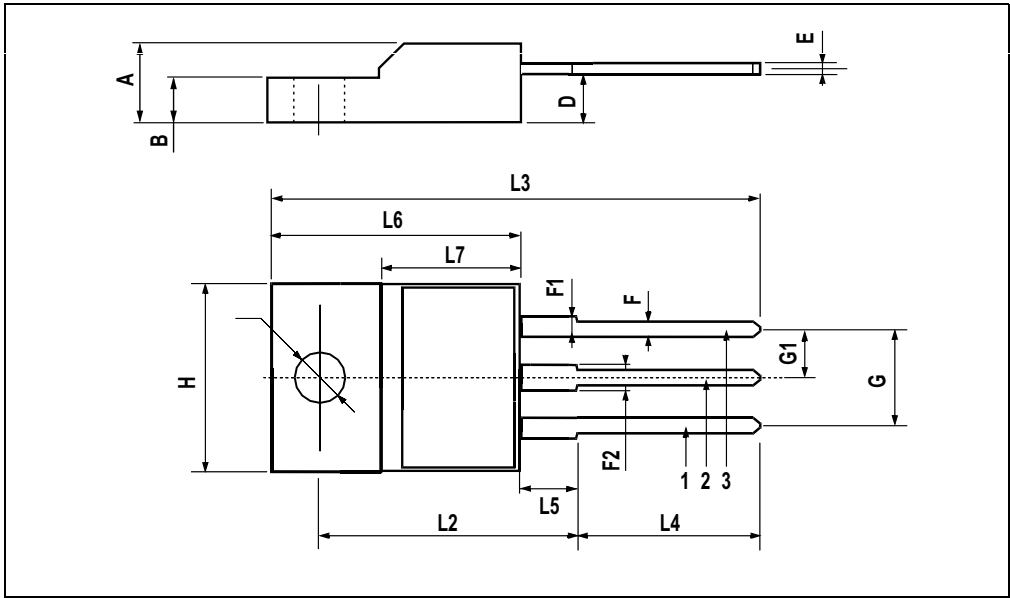
In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect . The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings 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                     | 1.15  |       | 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 |



## 5 Revision History

| Date        | Revision | Changes                     |
|-------------|----------|-----------------------------|
| 22-Aug-2005 | 2        | Inserted Ecopack indication |

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