



# STB60NF06L STP60NF06L - STP60NF06LFP

N-channel 60V - 0.012Ω - 60A - TO-220/D<sup>2</sup>PAK/TO-220FP  
STripFET™ II Power MOSFET

## General features

| Type         | V <sub>DSS</sub> | R <sub>DS(on)</sub> | I <sub>D</sub>     |
|--------------|------------------|---------------------|--------------------|
| STB60NF06L   | 60V              | <0.014Ω             | 60                 |
| STP60NF06L   | 60V              | <0.014Ω             | 60A                |
| STP60NF06LFP | 60V              | <0.014Ω             | 60A <sup>(1)</sup> |

1. Refer to SOA for the max allowable current values on FP-type due to R<sub>th</sub> value

- Exceptional dv/dt capability
- 100% avalanche tested
- Application oriented characterization
- 175°C operating range
- Low threshold drive

## Description

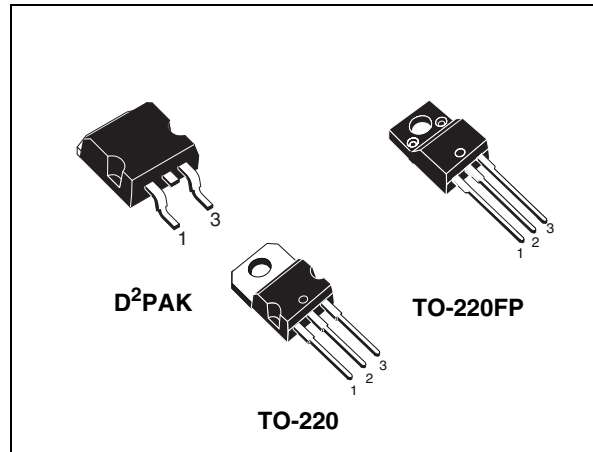
This Power MOSFET series realized with STMicroelectronics unique STripFET process has specifically been designed to minimize input capacitance and gate charge. It is therefore suitable as primary switch in advanced high-efficiency isolated DC-DC converters for Telecom and Computer application. It is also intended for any application with low gate charge drive requirements.

## Applications

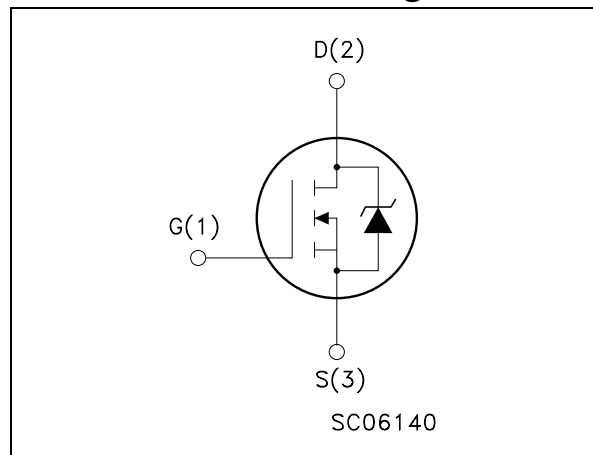
- Switching application

## Order codes

| Part number  | Marking    | Package            | Packaging   |
|--------------|------------|--------------------|-------------|
| STB60NF06LT4 | B60NF06L   | D <sup>2</sup> PAK | Tape & reel |
| STP60NF06L   | P60NF06L   | TO-220             | Tube        |
| STP60NF06LFP | P60NF06LFP | TO-220FP           | Tube        |



## Internal schematic diagram



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# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol                         | Parameter  | Value                        |                    | Unit |
|--------------------------------|--|------------------------------|--------------------|------|
|                                |  | D <sup>2</sup> PAK<br>TO-220 | TO-220FP           |      |
| V <sub>DS</sub>                | Drain-source voltage (V <sub>GS</sub> = 0)           | 60                           |                    | V    |
| V <sub>DGR</sub>               | Drain-gate voltage (R <sub>GS</sub> = 20 kΩ)         | 60                           |                    | V    |
| V <sub>GS</sub>                | Gate- source voltage                                 | ± 15                         |                    | V    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 25°C  | 60                           | 60 <sup>(1)</sup>  | A    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 100°C | 42                           | 42 <sup>(1)</sup>  | A    |
| I <sub>DM</sub> <sup>(2)</sup> | Drain current (pulsed)                               | 240                          | 240 <sup>(1)</sup> | A    |
| P <sub>tot</sub>               | Total dissipation at T <sub>C</sub> = 25°C           | 110                          | 30                 | W    |
|                                | Derating Factor                                      | 0.73                         | 0.2                | W/°C |
| dv/dt <sup>(3)</sup>           | Peak diode recovery voltage slope                    | 20                           |                    | V/ns |
| E <sub>AS</sub> <sup>(4)</sup> | Single pulse avalanche energy                        | 320                          |                    | mJ   |
| V <sub>ISO</sub>               | Insulation withstand voltage (DC)                    | --                           | 2000               | V    |
| T <sub>stg</sub>               | Storage temperature                                  | -65 to 175                   |                    | °C   |
| T <sub>j</sub>                 | Max. operating junction temperature                  |                              |                    |      |

1. Refer to SOA for the max allowable current values on FP-type due to R<sub>th</sub> value
2. Pulse width limited by safe operating area.
3. I<sub>SD</sub> ≤ 60A, di/dt ≤ 600A/μs, V<sub>DD</sub> ≤ 48V, T<sub>j</sub> ≤ T<sub>JMAX</sub>
4. Starting T<sub>j</sub> = 25 °C, I<sub>D</sub> = 30A, V<sub>DD</sub> = 30V

**Table 2. Thermal data**

|                       |  |     | D <sup>2</sup> PAK<br>TO-220 | TO-220FP |      |
|-----------------------|--|-----|------------------------------|----------|------|
| R <sub>thj-case</sub> | Thermal resistance junction-case               | Max | 1.36                         | 5.0      | °C/W |
| R <sub>thj-amb</sub>  | Thermal resistance junction-ambient            | Max | 62.5<br>35<br>300            |          | °C/W |
| R <sub>thj-pcb</sub>  | Thermal resistance junction-pcb <sup>(1)</sup> | Max |                              |          | °C/W |
| T <sub>l</sub>        | Maximum lead temperature for soldering purpose |     |                              |          | °C   |

1. Only for SMD, When mounted on 1 inch<sup>2</sup> FR-4 board, 2 oz of Cu.

## 2 Electrical characteristics

( $T_{CASE}=25^{\circ}\text{C}$  unless otherwise specified)

**Table 3. On/off states**

| Symbol        | Parameter  | Test conditions   | Min. | Typ.           | Max.           | Unit                           |
|---------------|--|---|------|----------------|----------------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage                   | $I_D = 250\mu\text{A}$ , $V_{GS} = 0$   | 60   |                |                | V                              |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = \text{Max rating}$<br>$V_{DS} = \text{Max rating}$ ,<br>$T_C = 125^{\circ}\text{C}$ |      |                | 1<br>10        | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$     | Gate-body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 15\text{V}$   |      |                | $\pm 100$      | nA                             |
| $V_{GS(th)}$  | Gate threshold voltage                           | $V_{DS} = V_{GS}$ , $I_D = 250\mu\text{A}$  | 1    |                |                | V                              |
| $R_{DS(on)}$  | Static drain-source on resistance                | $V_{GS} = 5\text{V}$ , $I_D = 30\text{A}$<br>$V_{GS} = 10\text{V}$ , $I_D = 30\text{A}$       |      | 0.014<br>0.012 | 0.016<br>0.014 | $\Omega$<br>$\Omega$           |

**Table 4. Dynamic**

| Symbol  | Parameter   | Test conditions  | Min. | Typ.                  | Max. | Unit                 |
|---|---|--|------|-----------------------|------|----------------------|
| $g_{fs}^{(1)}$                                | Forward transconductance  | $V_{DS} = 15\text{V}$ , $I_D = 30\text{A}$   |      | 20                    |      | S                    |
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$           | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{DS} = 25\text{V}$ , $f = 1\text{MHz}$ ,<br>$V_{GS} = 0$  |      | 2000<br>360<br>125    |      | pF<br>pF<br>pF       |
| $t_{d(on)}$<br>$t_r$<br>$t_{d(off)}$<br>$t_f$ | Turn-on delay time<br>Rise time<br>Turn-off delay time<br>Fall time     | $V_{DD} = 30\text{V}$ , $I_D = 30\text{A}$<br>$R_G = 4.7\Omega$ , $V_{GS} = 4.5\text{V}$<br>(see <a href="#">Figure 15</a> )   |      | 35<br>220<br>55<br>30 |      | 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            | $V_{DD} = 48\text{V}$ , $I_D = 60\text{A}$ ,<br>$V_{GS} = 4.5\text{V}$ , $R_G = 4.7\Omega$<br>(see <a href="#">Figure 16</a> ) |      | 35<br>10<br>20        | 66   | nC<br>nC<br>nC       |

1. Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5 %.

**Table 5. Source drain diode**

| Symbol                            | Parameter  | Test conditions   | Min. | Typ.              | Max.      | Unit          |
|-----------------------------------|--|---|------|-------------------|-----------|---------------|
| $I_{SD}$<br>$I_{SDM}^{(1)}$       | Source-drain current<br>Source-drain current<br>(pulsed)                     |   |      |                   | 60<br>240 | A<br>A        |
| $V_{SD}^{(2)}$                    | Forward on voltage   | $I_{SD} = 60A$ , $V_{GS} = 0$   |      |                   | 1.3       | V             |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_{SD} = 60A$ , $di/dt = 100A/\mu s$ ,<br>$V_{DD} = 30V$ , $T_j = 150^\circ C$<br>(see <a href="#">Figure 17</a> ) |      | 110<br>250<br>4.5 |           | ns<br>nC<br>A |

1. Pulse width limited by safe operating area.

2. Pulsed: Pulse duration = 300  $\mu s$ , duty cycle 1.5 %

## 2.1 Electrical characteristics (curves)

Figure 1. Safe operating area

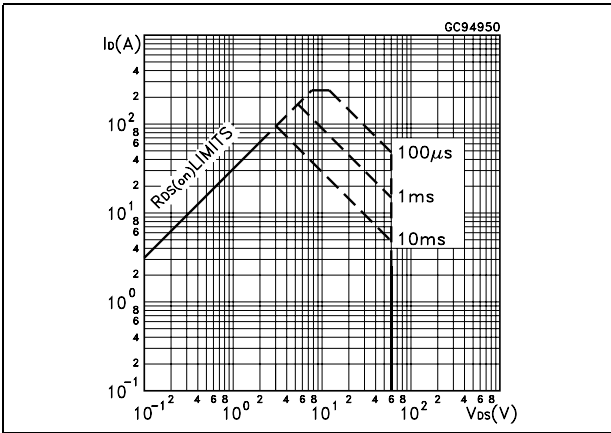


Figure 2. Thermal impedance

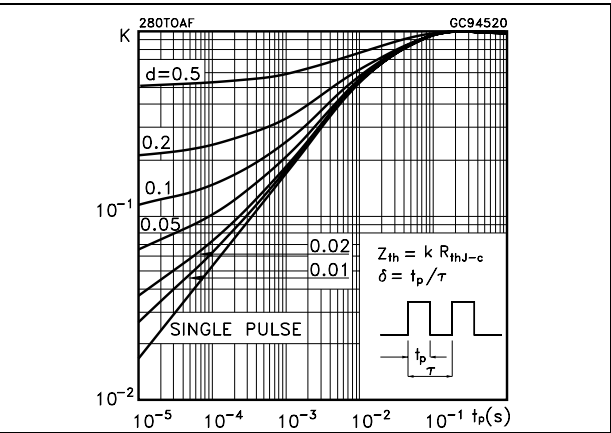


Figure 3. Safe operating area for TO-220FP

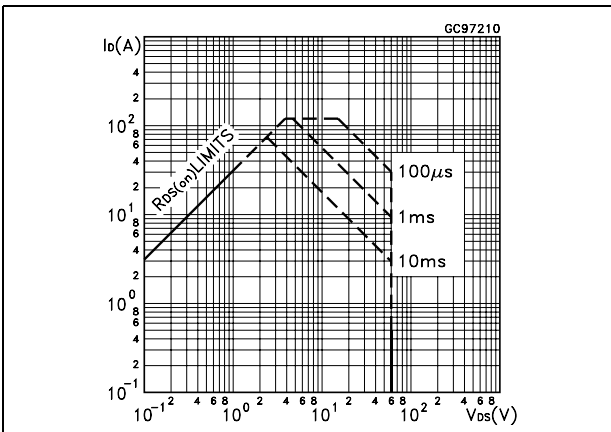


Figure 4. Thermal impedance for TO-220FP

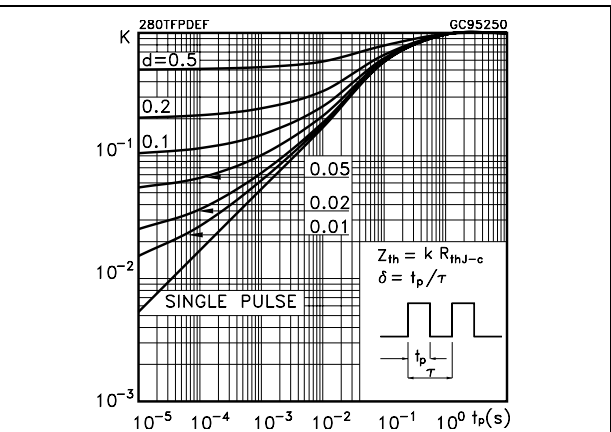


Figure 5. Output characteristics

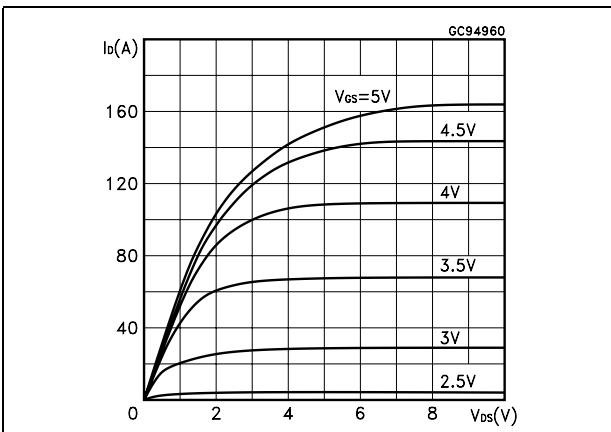


Figure 6. Transfer characteristics

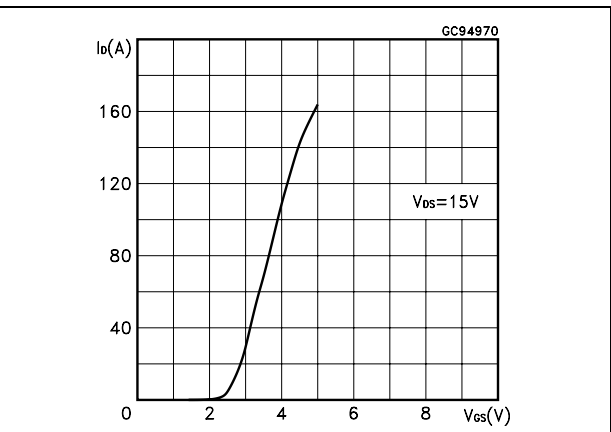


Figure 7. Transconductance

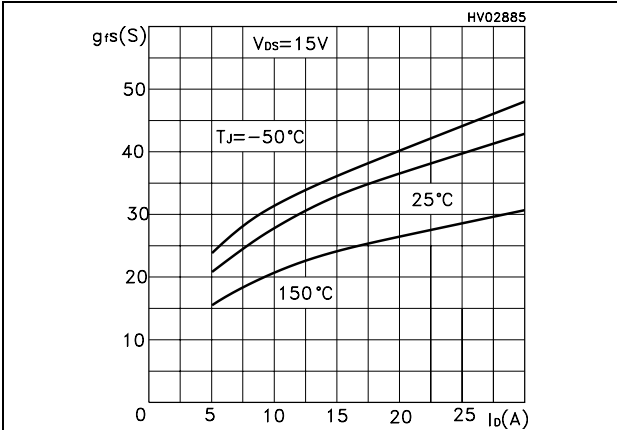


Figure 8. Static drain-source on resistance

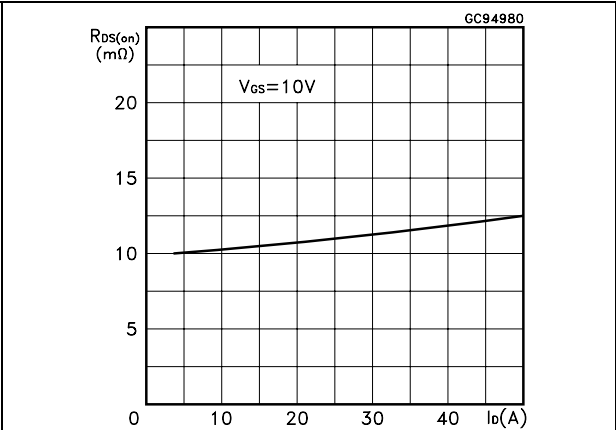


Figure 9. Gate charge vs gate-source voltage

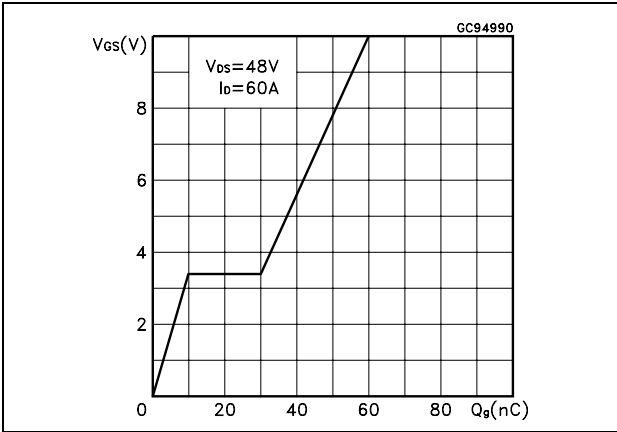


Figure 10. Capacitance variations

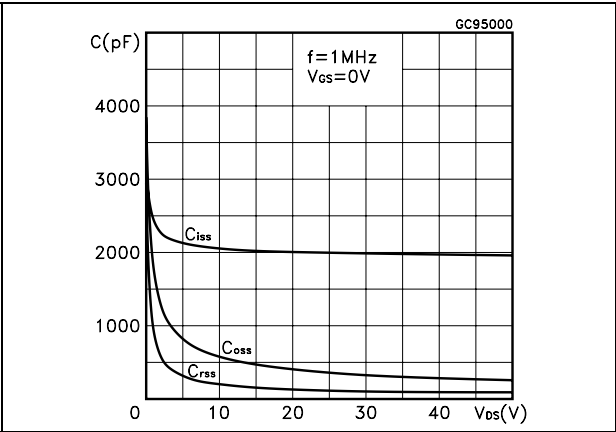


Figure 11. Normalized gate threshold voltage vs temperature

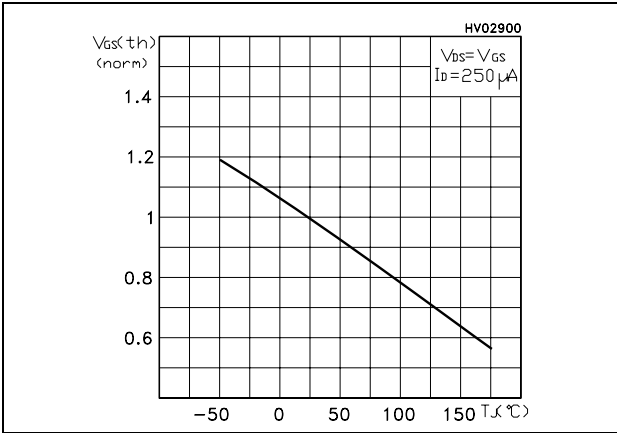


Figure 12. Normalized on resistance vs temperature

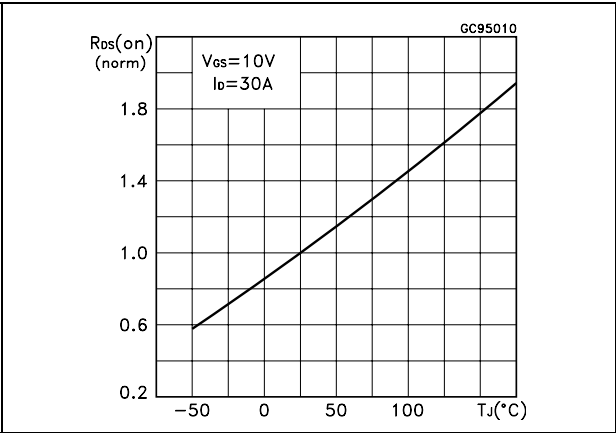


Figure 13. Source-drain diode forward characteristics

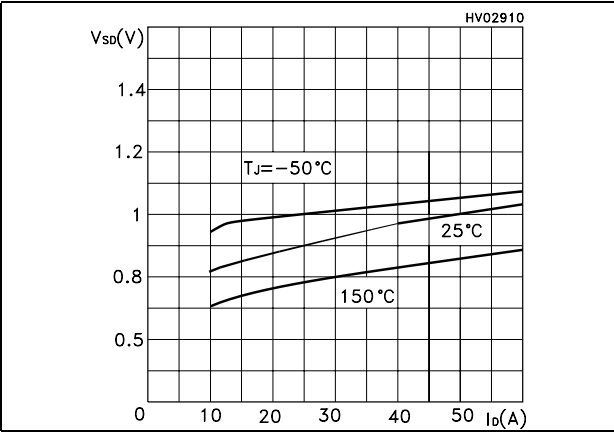
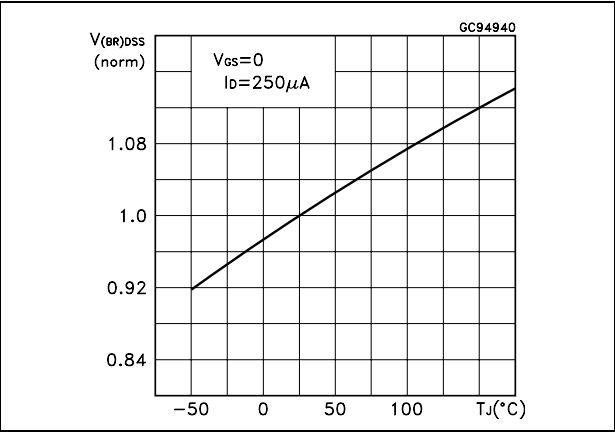
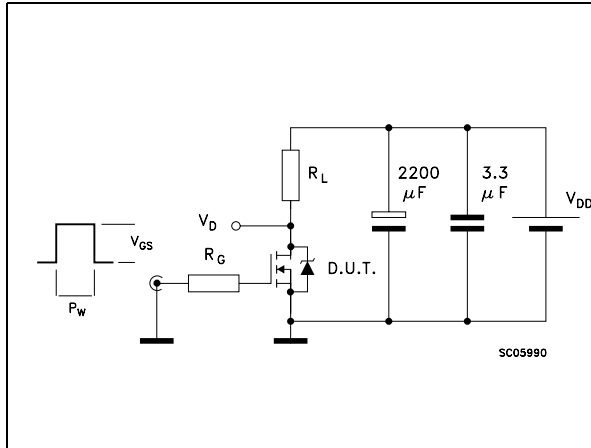


Figure 14. Normalized breakdown voltage temperature

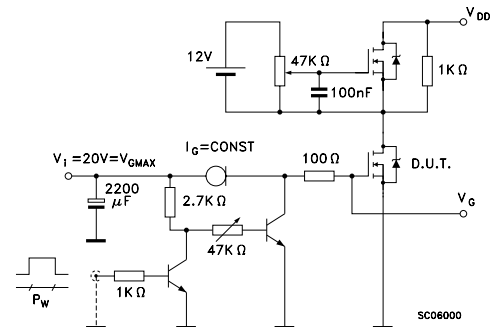


### 3 Test circuit

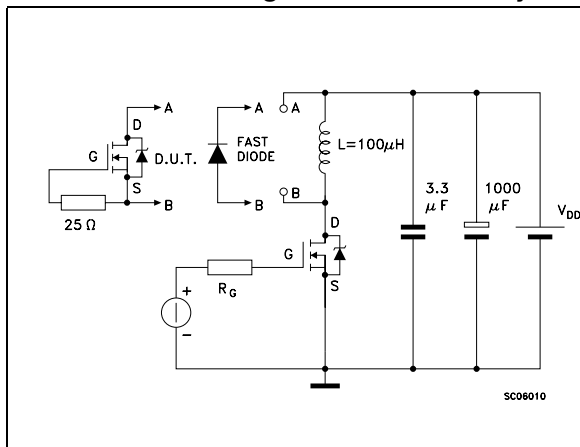
**Figure 15. Switching times test circuit for resistive load**



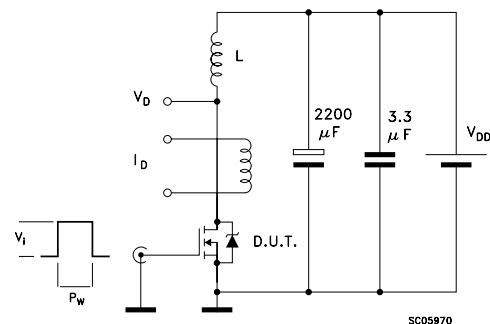
**Figure 16. Gate charge test circuit**



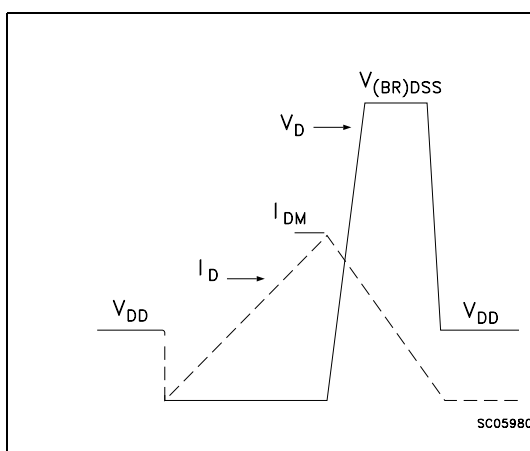
**Figure 17. Test circuit for inductive load switching and diode recovery times**



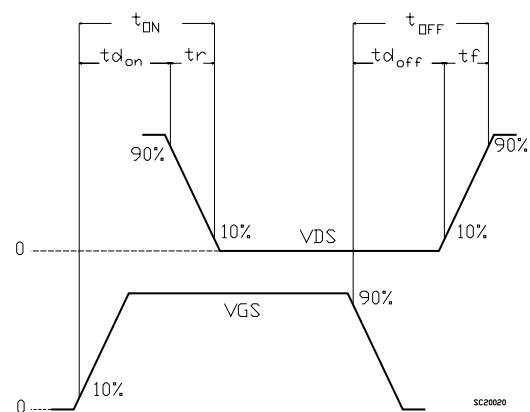
**Figure 18. Unclamped Inductive load test circuit**



**Figure 19. Unclamped inductive waveform**



**Figure 20. Switching time waveform**

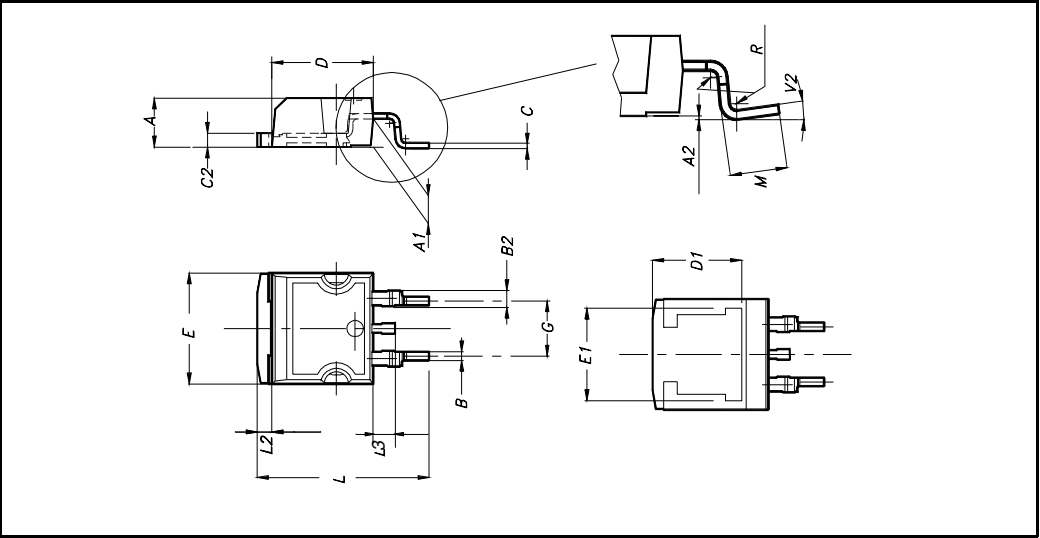


## 4 Package mechanical data

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)

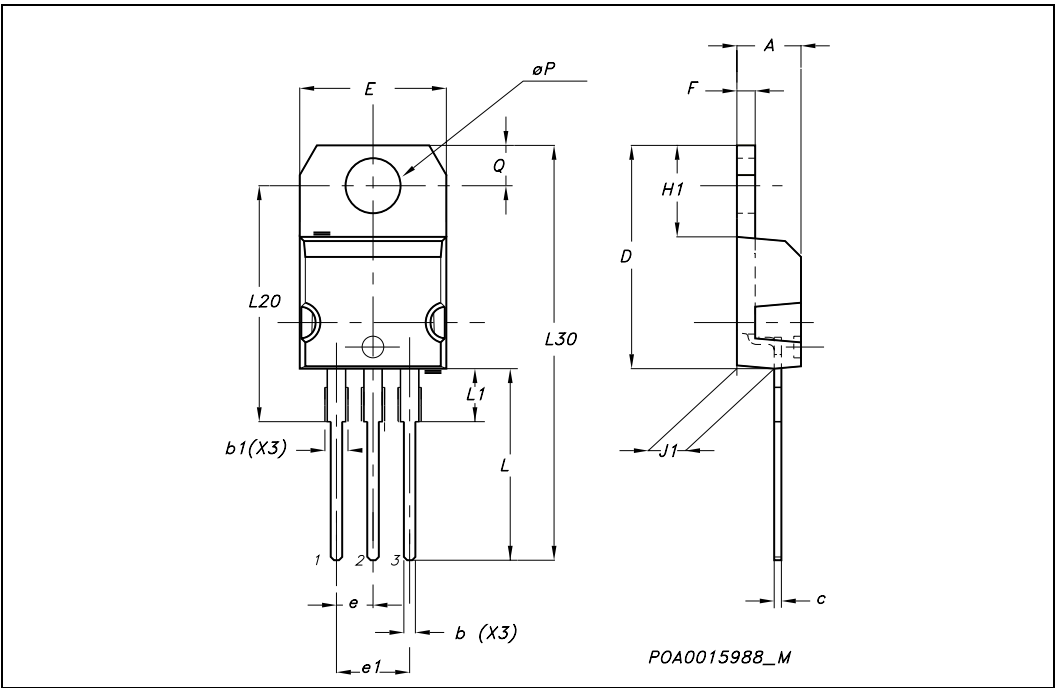
D<sup>2</sup>PAK MECHANICAL DATA

| 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°    |       |       |       |



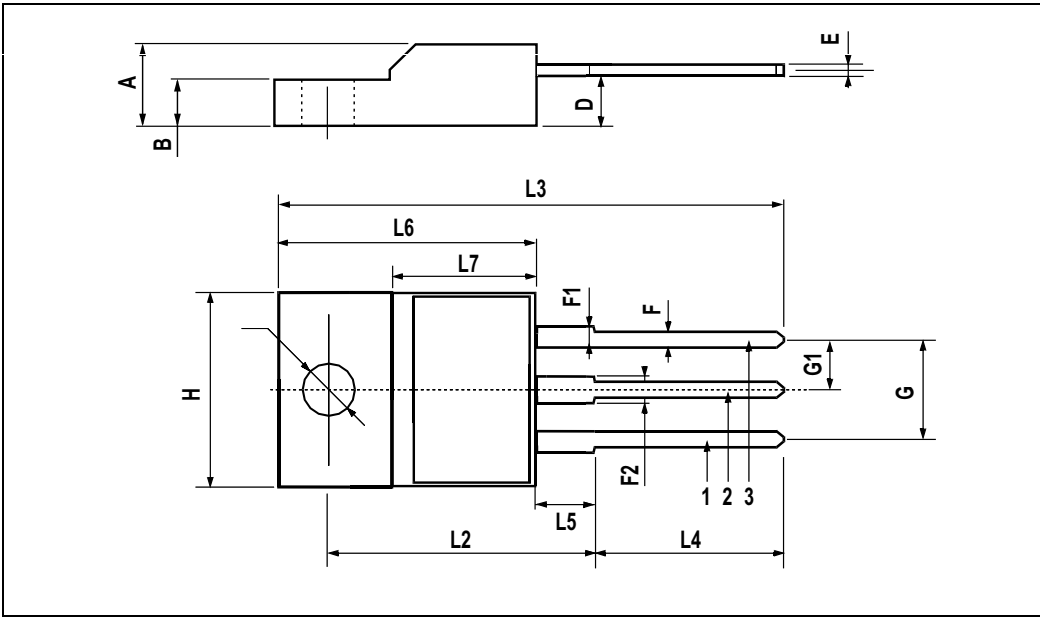
TO-220 MECHANICAL DATA

| 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 |



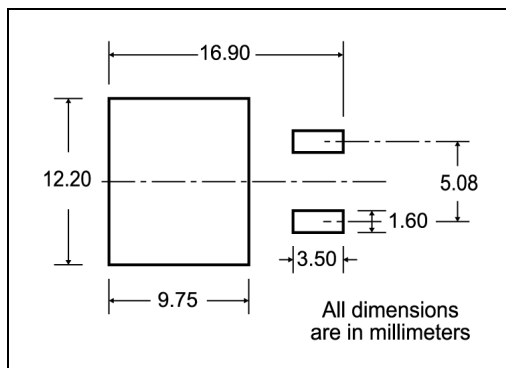
TO-220FP MECHANICAL DATA

| 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 |

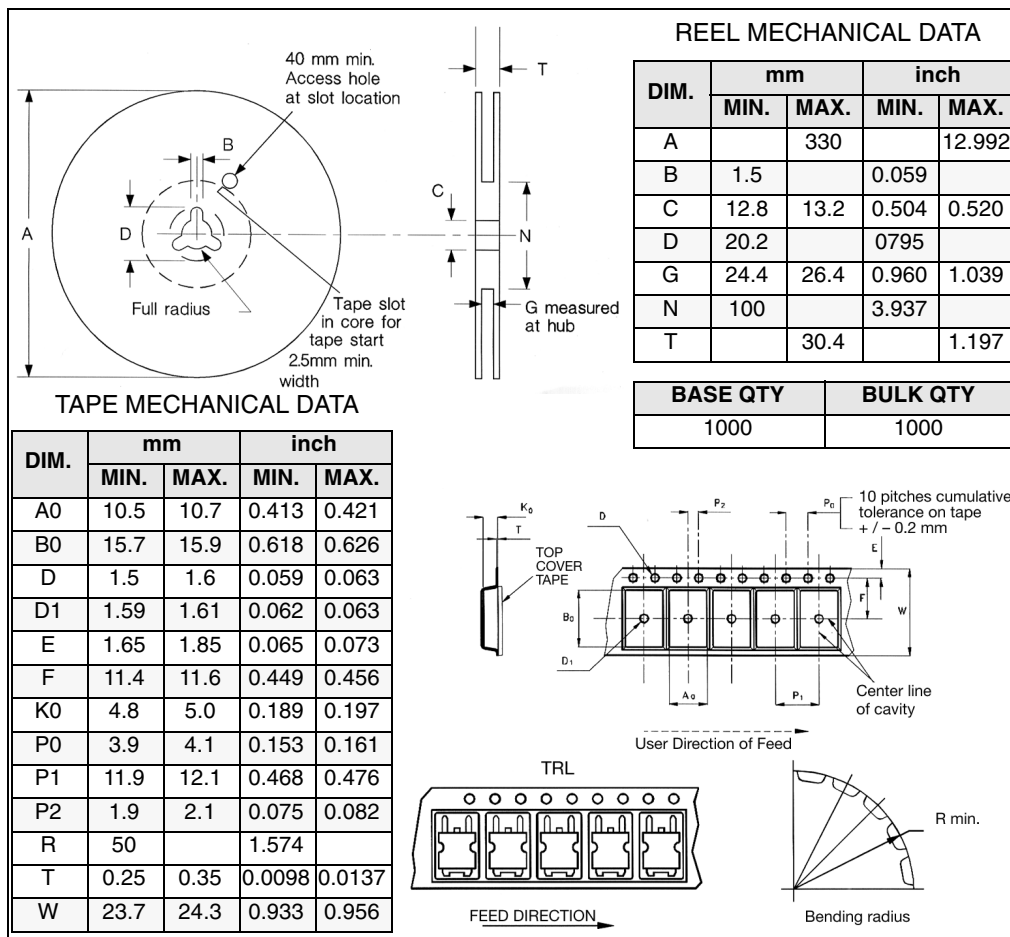


## 5 Packing mechanical data

### D<sup>2</sup>PAK FOOTPRINT



### TAPE AND REEL SHIPMENT



\* on sales type

## 6 Revision history

**Table 6. Revision history**

| Date        | Revision | Changes                         |
|-------------|----------|---------------------------------|
| 21-Jun-2004 | 2        | Complete version                |
| 26-Jun-2006 | 3        | New template, no content change |

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