



# STP11NM60 - STP11NM60FP STB11NM60 - STB11NM60-1

N-CHANNEL 600V - 0.4Ω-11A TO-220/TO-220FP/D<sup>2</sup>PAK/I<sup>2</sup>PAK  
MDmesh™ Power MOSFET

| TYPE        | V <sub>DSS</sub> | R <sub>DS(on)</sub> | I <sub>D</sub> |
|-------------|------------------|---------------------|----------------|
| STP11NM60   | 600 V            | < 0.45 Ω            | 11 A           |
| STP11NM60FP | 600 V            | < 0.45 Ω            | 11 A           |
| STB11NM60   | 600 V            | < 0.45 Ω            | 11 A           |
| STB11NM60-1 | 600 V            | < 0.45 Ω            | 11 A           |

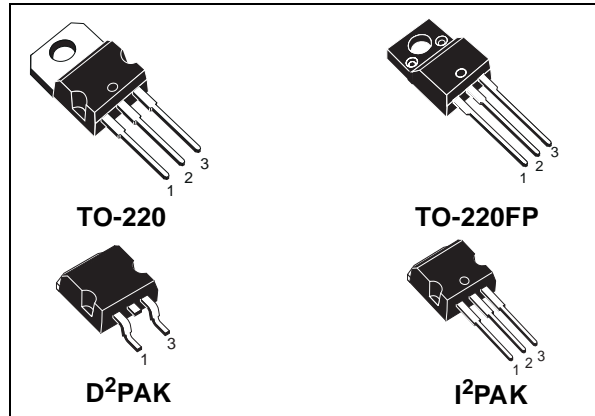
- TYPICAL R<sub>DS(on)</sub> = 0.4Ω
- HIGH dv/dt AND AVALANCHE CAPABILITIES
- 100% AVALANCHE TESTED
- LOW INPUT CAPACITANCE AND GATE CHARGE
- LOW GATE INPUT RESISTANCE

## DESCRIPTION

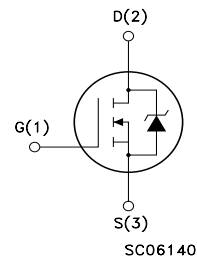
The MDmesh™ is a new revolutionary MOSFET technology that associates the Multiple Drain process with the Company's PowerMESH™ horizontal layout. The resulting product has an outstanding low on-resistance, impressively high dv/dt and excellent avalanche characteristics. The adoption of the Company's proprietary strip technique yields overall dynamic performance that is significantly better than that of similar competition's products.

## APPLICATIONS

The MDmesh™ family is very suitable for increasing power density of high voltage converters allowing system miniaturization and higher efficiencies.



## INTERNAL SCHEMATIC DIAGRAM



## ABSOLUTE MAXIMUM RATINGS

| Symbol              | Parameter  | Value            |             | Unit |
|---------------------|--|------------------|-------------|------|
|                     |  | STP(B)11NM60(-1) | STP11NM60FP |      |
| V <sub>DS</sub>     | Drain-source Voltage (V <sub>GS</sub> = 0)           | 600              |             | V    |
| V <sub>DGR</sub>    | Drain-gate Voltage (R <sub>GS</sub> = 20 kΩ)         | 600              |             | V    |
| V <sub>GS</sub>     | Gate- source Voltage                                 | ±30              |             | V    |
| I <sub>D</sub>      | Drain Current (continuous) at T <sub>C</sub> = 25°C  | 11               | 11 (*)      | A    |
| I <sub>D</sub>      | Drain Current (continuous) at T <sub>C</sub> = 100°C | 7                | 7 (*)       | A    |
| I <sub>DM</sub> (•) | Drain Current (pulsed)                               | 44               | 44 (*)      | A    |
| P <sub>TOT</sub>    | Total Dissipation at T <sub>C</sub> = 25°C           | 160              | 35          | W    |
|                     | Derating Factor                                      | 1.28             | 0.28        | W/°C |
| dv/dt(1)            | Peak Diode Recovery voltage slope                    | 15               |             | V/ns |
| V <sub>ISO</sub>    | Insulation Withstand Voltage (DC)                    | --               | 2500        | V    |
| T <sub>stg</sub>    | Storage Temperature                                  | -65 to 150       |             | °C   |
| T <sub>j</sub>      | Max. Operating Junction Temperature                  | 150              |             | °C   |

(•) Pulse width limited by safe operating area

August 2002

(\*) Limited only by maximum temperature allowed

(1) I<sub>SD</sub> < 11A, di/dt < 400A/μs, V<sub>DD</sub> < V<sub>(BR)DSS</sub>, T<sub>J</sub> < T<sub>JMAX</sub>

1/12

**STP11NM60 / STP11NM60FP / STB11NM60 / STB11NM60-1**

**THERMAL DATA**

|                |  |     | TO-220/D <sup>2</sup> PAK/I <sup>2</sup> PAK | TO-220FP |      |
|----------------|--|-----|--|----------|------|
| Rthj-case      | Thermal Resistance Junction-case               | Max | 0.78   | 3.57     | °C/W |
| Rthj-amb       | Thermal Resistance Junction-ambient            | Max | 62.5   |          | °C/W |
| T <sub>I</sub> | Maximum Lead Temperature For Soldering Purpose |     | 300  |          | °C   |

**AVALANCHE CHARACTERISTICS**

| Symbol          | Parameter  | Max Value | Unit |
|-----------------|--|-----------|------|
| I <sub>AR</sub> | Avalanche Current, Repetitive or Not-Repetitive (pulse width limited by T <sub>j</sub> max)                                | 5.5       | A    |
| E <sub>AS</sub> | Single Pulse Avalanche Energy (starting T <sub>j</sub> = 25 °C, I <sub>D</sub> = I <sub>AR</sub> , V <sub>DD</sub> = 50 V) | 350       | mJ   |

**ELECTRICAL CHARACTERISTICS (T<sub>CASE</sub> = 25 °C UNLESS OTHERWISE SPECIFIED)**

OFF

| Symbol               | Parameter   | Test Conditions   | Min. | Typ. | Max.    | Unit     |
|----------------------|---|---|------|------|---------|----------|
| V <sub>(BR)DSS</sub> | Drain-source Breakdown Voltage                        | I <sub>D</sub> = 250 μA, V <sub>GS</sub> = 0  | 600  |      |         | 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>10 | μA<br>μA |
| I <sub>GSS</sub>     | Gate-body Leakage Current (V <sub>DS</sub> = 0)       | V <sub>GS</sub> = ±30V  |      |      | ±100    | nA       |

ON (1)

| Symbol              | Parameter                         | Test Conditions  | Min. | Typ. | Max. | Unit |
|---------------------|-----------------------------------|--|------|------|------|------|
| V <sub>GS(th)</sub> | Gate Threshold Voltage            | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250μA | 3    | 4    | 5    | V    |
| R <sub>DS(on)</sub> | Static Drain-source On Resistance | V <sub>GS</sub> = 10V, I <sub>D</sub> = 5.5A               |      | 0.4  | 0.45 | Ω    |

**DYNAMIC**

| Symbol                   | Parameter                     | Test Conditions  | Min. | Typ. | Max. | Unit |
|--------------------------|-------------------------------|--|------|------|------|------|
| g <sub>fs</sub> (1)      | Forward Transconductance      | V <sub>DS</sub> > I <sub>D(on)</sub> × R <sub>DS(on)max</sub> ,<br>I <sub>D</sub> = 5.5A |      | 5.2  |      | S    |
| C <sub>iss</sub>         | Input Capacitance             | V <sub>DS</sub> = 25V, f = 1 MHz, V <sub>GS</sub> = 0                                    |      | 1000 |      | pF   |
| C <sub>oss</sub>         | Output Capacitance            |  |      | 230  |      | pF   |
| C <sub>rss</sub>         | Reverse Transfer Capacitance  |  |      | 25   |      | pF   |
| C <sub>oss eq.</sub> (2) | Equivalent Output Capacitance | V <sub>GS</sub> = 0V, V <sub>DS</sub> = 0V to 480V                                       |      | 100  |      | pF   |
| R <sub>G</sub>           | Gate Input Resistance         | f=1 MHz Gate DC Bias = 0<br>Test Signal Level = 20mV<br>Open Drain                       |      | 1.6  |      | Ω    |

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

2. C<sub>oss eq.</sub> is defined as a constant equivalent capacitance giving the same charging time as C<sub>oss</sub> when V<sub>DS</sub> increases from 0 to 80% V<sub>DSS</sub>.

**ELECTRICAL CHARACTERISTICS (CONTINUED)**  
SWITCHING ON

| Symbol      | Parameter          | Test Conditions   | Min. | Typ. | Max. | Unit |
|-------------|--------------------|---|------|------|------|------|
| $t_{d(on)}$ | Turn-on Delay Time | $V_{DD} = 300V, I_D = 5.5A$                                     |      | 20   |      | ns   |
| $t_r$       | Rise Time          | $R_G = 4.7\Omega, V_{GS} = 10V$<br>(see test circuit, Figure 3) |      | 20   |      | ns   |
| $Q_g$       | Total Gate Charge  | $V_{DD} = 400V, I_D = 11A,$<br>$V_{GS} = 10V$                   |      | 30   |      | nC   |
| $Q_{gs}$    | Gate-Source Charge |   |      | 10   |      | nC   |
| $Q_{gd}$    | Gate-Drain Charge  |   |      | 15   |      | nC   |

SWITCHING OFF

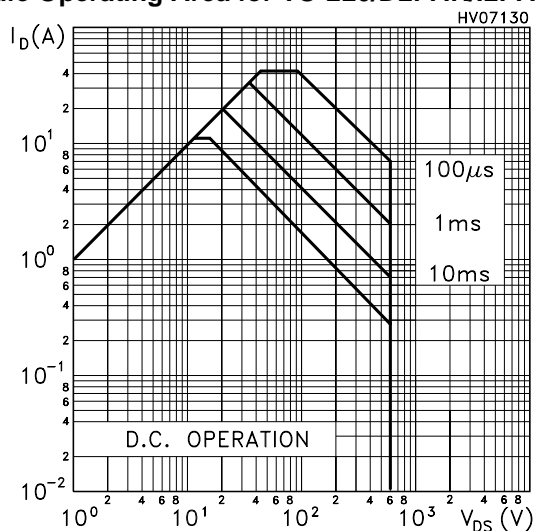
| Symbol        | Parameter             | Test Conditions  | Min. | Typ. | Max. | Unit |
|---------------|-----------------------|--|------|------|------|------|
| $t_{r(voff)}$ | Off-voltage Rise Time | $V_{DD} = 400V, I_D = 11A,$<br>$R_G = 4.7\Omega, V_{GS} = 10V$ |      | 6    |      | ns   |
| $t_f$         | Fall Time             | (see test circuit, Figure 5)                                   |      | 11   |      | ns   |
| $t_c$         | Cross-over Time       |  |      | 19   |      | ns   |

SOURCE DRAIN DIODE

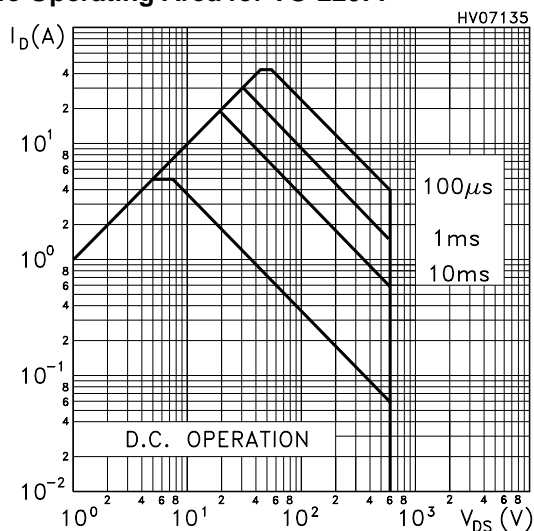
| Symbol        | Parameter                     | Test Conditions   | Min. | Typ. | Max. | Unit    |
|---------------|-------------------------------|---|------|------|------|---------|
| $I_{SD}$      | Source-drain Current          |   |      |      | 11   | A       |
| $I_{SDM} (2)$ | Source-drain Current (pulsed) |   |      |      | 44   | A       |
| $V_{SD} (1)$  | Forward On Voltage            | $I_{SD} = 11A, V_{GS} = 0$  |      |      | 1.5  | V       |
| $t_{rr}$      | Reverse Recovery Time         | $I_{SD} = 11A, di/dt = 100A/\mu s,$<br>$V_{DD} = 100V, T_j = 25^\circ C$  |      | 390  |      | ns      |
| $Q_{rr}$      | Reverse Recovery Charge       | (see test circuit, Figure 5)  |      | 3.8  |      | $\mu C$ |
| $I_{rrm}$     | Reverse Recovery Current      |   |      | 19.5 |      | A       |
| $t_{rr}$      | Reverse Recovery Time         | $I_{SD} = 11A, di/dt = 100A/\mu s,$<br>$V_{DD} = 100V, T_j = 150^\circ C$ |      | 570  |      | ns      |
| $Q_{rr}$      | Reverse Recovery Charge       | (see test circuit, Figure 5)  |      | 5.7  |      | $\mu C$ |
| $I_{rrm}$     | Reverse Recovery Current      |   |      | 20   |      | A       |

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

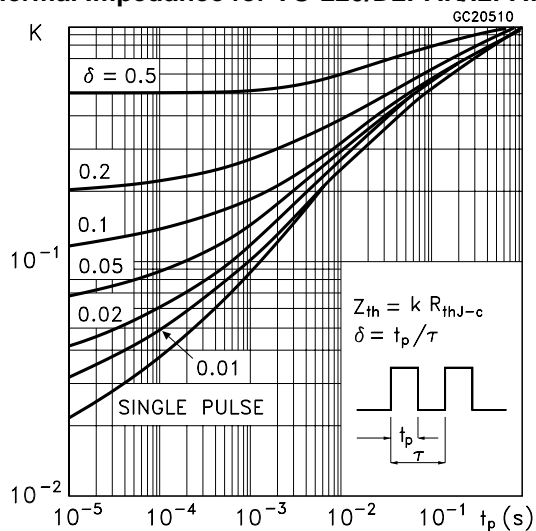
**Safe Operating Area for TO-220/D2PAK/I2PAK**



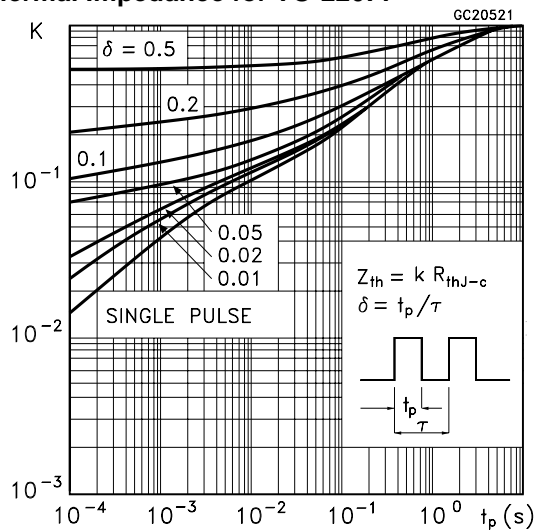
**Safe Operating Area for TO-220FP**



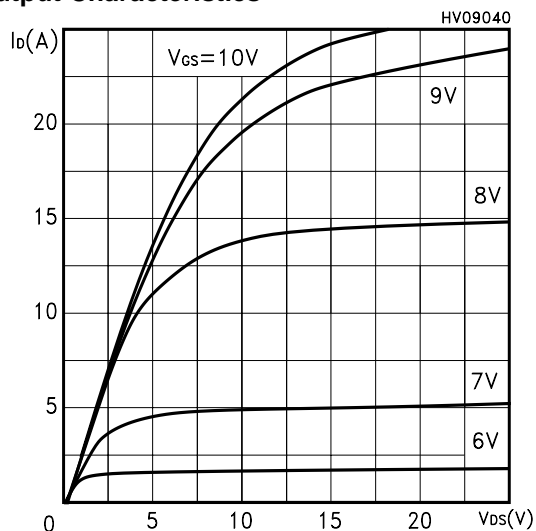
Thermal Impedance for TO-220/D2PAK/I2PAK



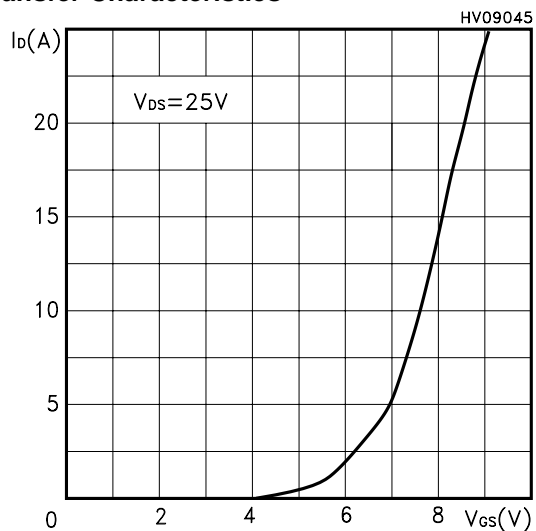
Thermal Impedance for TO-220FP



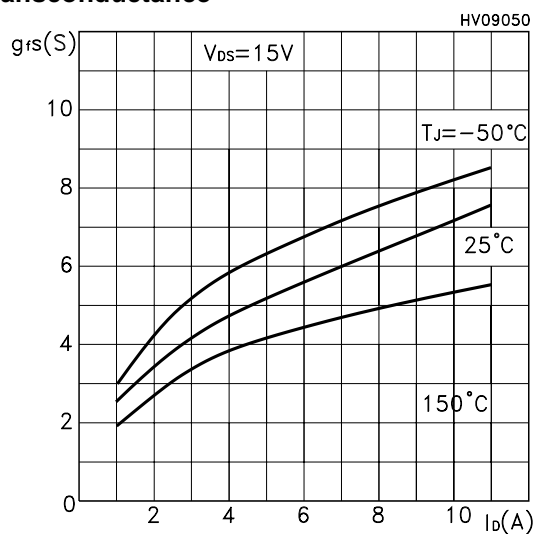
Output Characteristics



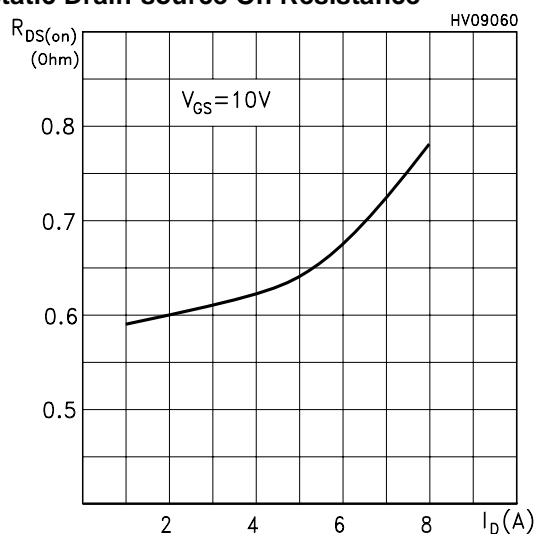
Transfer Characteristics



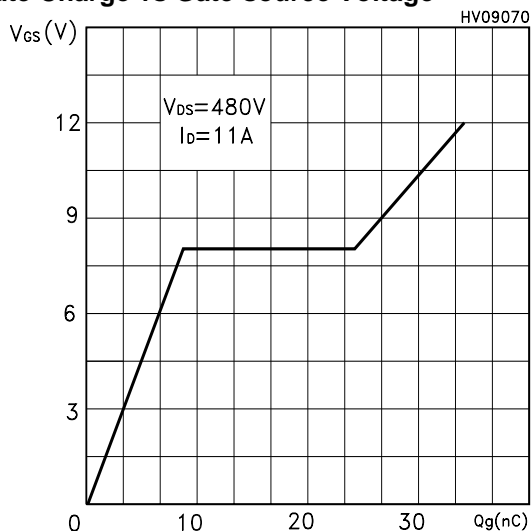
Transconductance



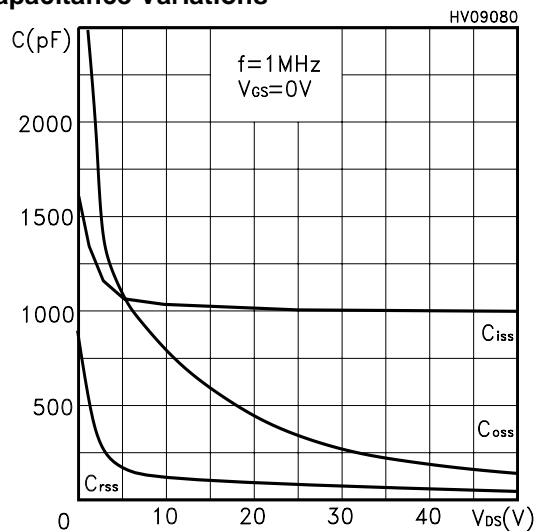
Static Drain-source On Resistance



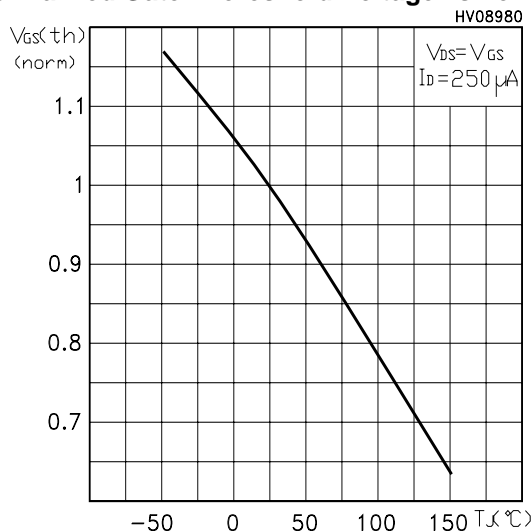
Gate Charge vs Gate-source Voltage



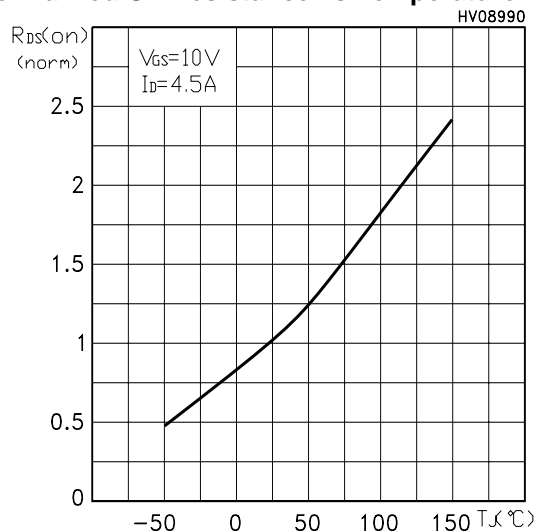
Capacitance Variations



Normalized Gate Threshold Voltage vs Temp.



Normalized On Resistance vs Temperature



Source-drain Diode Forward Characteristics

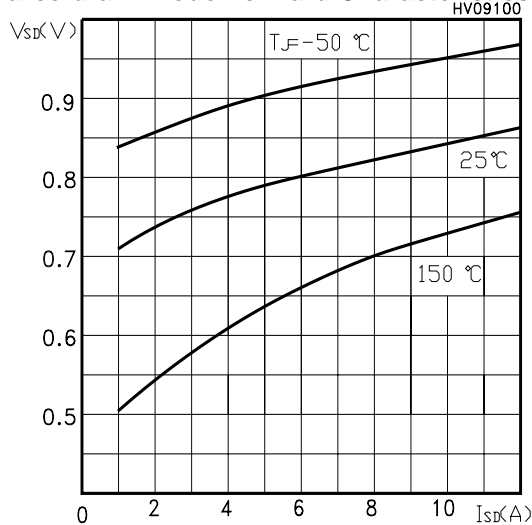


Fig. 1: Unclamped Inductive Load Test Circuit

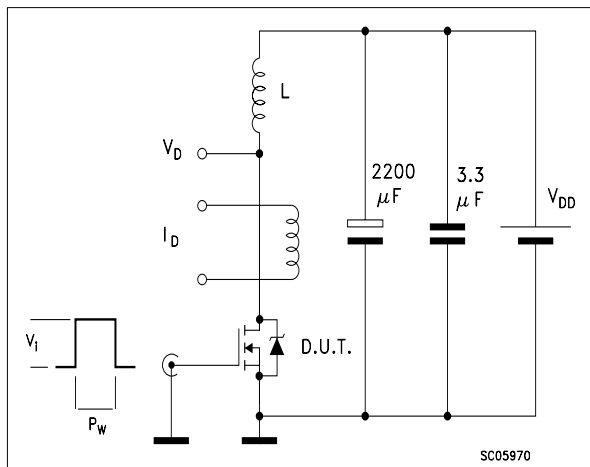


Fig. 2: Unclamped Inductive Waveform

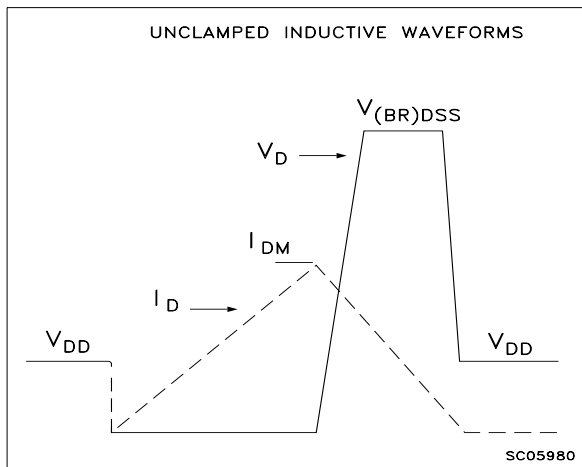


Fig. 3: Switching Times Test Circuit For Resistive Load

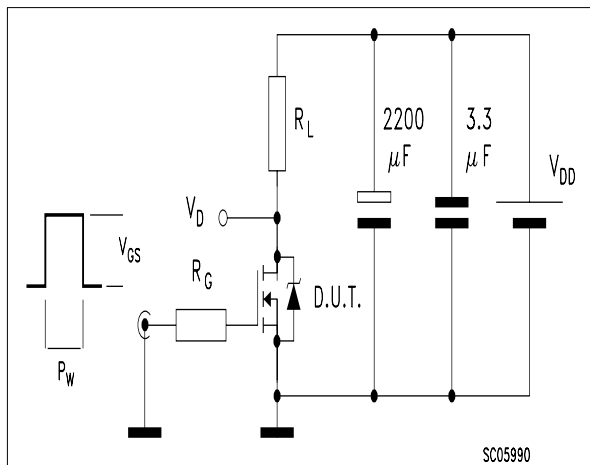


Fig. 4: Gate Charge test Circuit

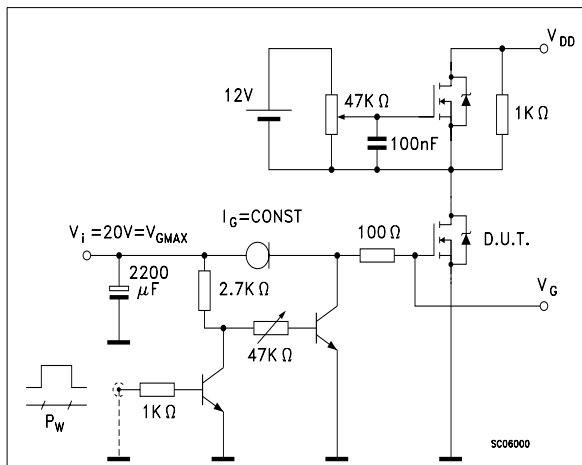
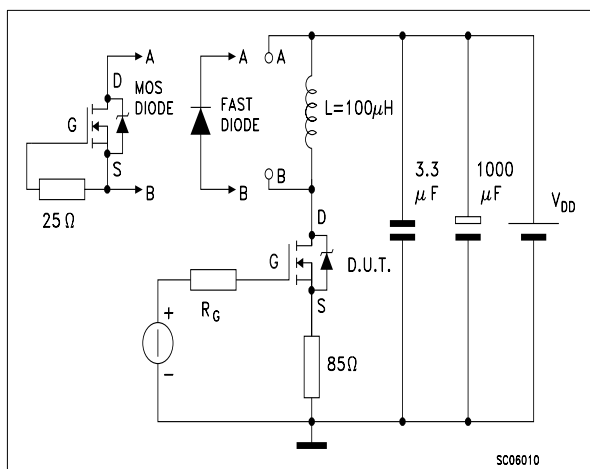
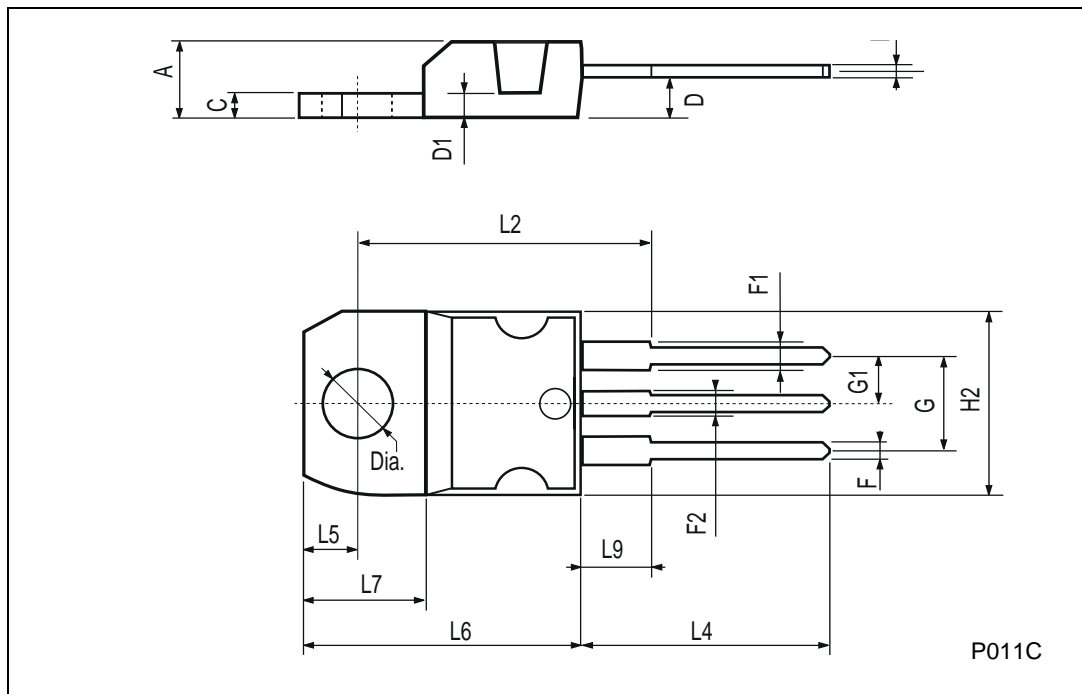


Fig. 5: Test Circuit For Inductive Load Switching And Diode Recovery Times



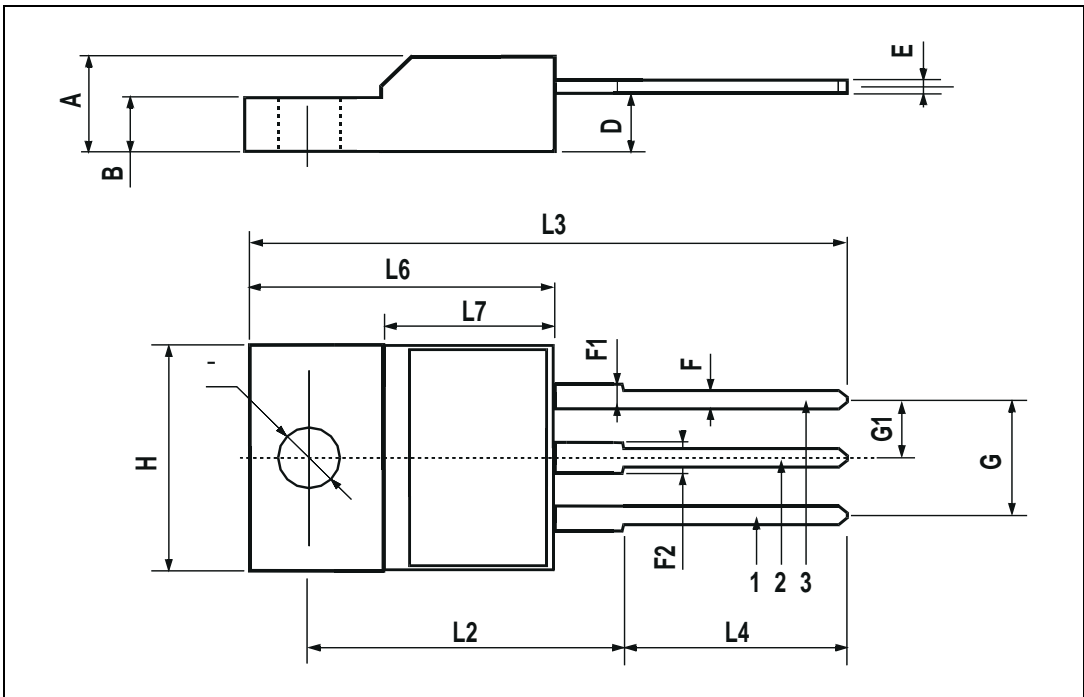
TO-220 MECHANICAL DATA

| DIM. | mm    |      |       | inch  |       |       |
|------|-------|------|-------|-------|-------|-------|
|      | MIN.  | TYP. | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 4.40  |      | 4.60  | 0.173 |       | 0.181 |
| C    | 1.23  |      | 1.32  | 0.048 |       | 0.051 |
| D    | 2.40  |      | 2.72  | 0.094 |       | 0.107 |
| D1   |       | 1.27 |       |       | 0.050 |       |
| E    | 0.49  |      | 0.70  | 0.019 |       | 0.027 |
| F    | 0.61  |      | 0.88  | 0.024 |       | 0.034 |
| F1   | 1.14  |      | 1.70  | 0.044 |       | 0.067 |
| F2   | 1.14  |      | 1.70  | 0.044 |       | 0.067 |
| G    | 4.95  |      | 5.15  | 0.194 |       | 0.203 |
| G1   | 2.4   |      | 2.7   | 0.094 |       | 0.106 |
| H2   | 10.0  |      | 10.40 | 0.393 |       | 0.409 |
| L2   |       | 16.4 |       |       | 0.645 |       |
| L4   | 13.0  |      | 14.0  | 0.511 |       | 0.551 |
| L5   | 2.65  |      | 2.95  | 0.104 |       | 0.116 |
| L6   | 15.25 |      | 15.75 | 0.600 |       | 0.620 |
| L7   | 6.2   |      | 6.6   | 0.244 |       | 0.260 |
| L9   | 3.5   |      | 3.93  | 0.137 |       | 0.154 |
| DIA. | 3.75  |      | 3.85  | 0.147 |       | 0.151 |



**TO-220FP MECHANICAL DATA**

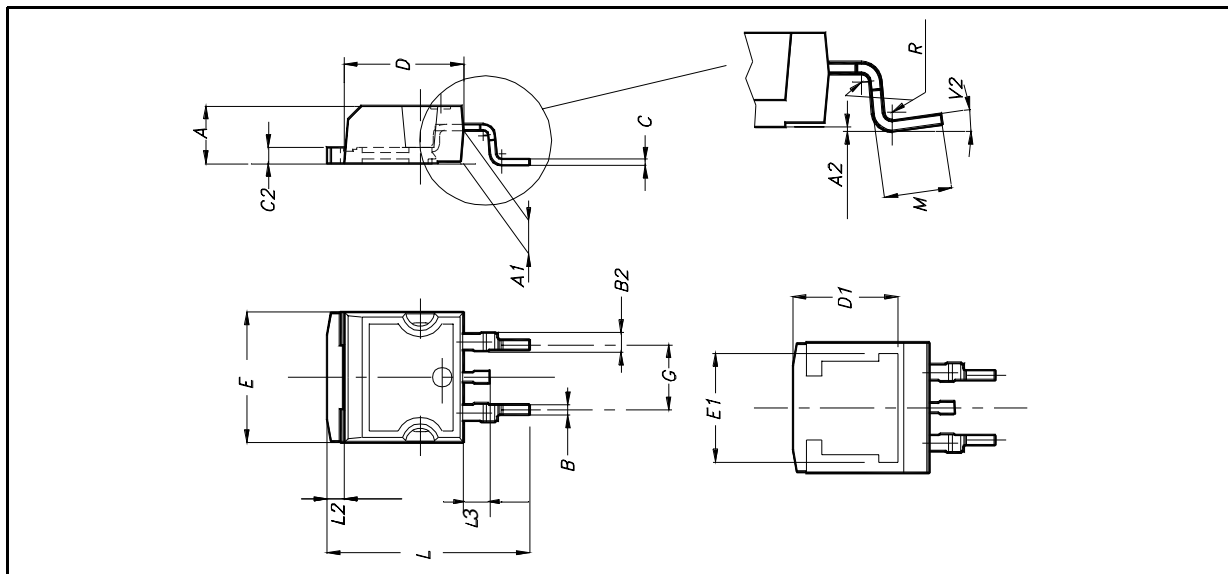
| DIM. | mm   |      |      | inch  |       |       |
|------|------|------|------|-------|-------|-------|
|      | MIN. | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A    | 4.4  |      | 4.6  | 0.173 |       | 0.181 |
| B    | 2.5  |      | 2.7  | 0.098 |       | 0.106 |
| D    | 2.5  |      | 2.75 | 0.098 |       | 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 | 0.385 |       | 0.417 |
| L6   | 15.9 |      | 16.4 | 0.626 |       | 0.645 |
| L7   | 9    |      | 9.3  | 0.354 |       | 0.366 |
| ∅    | 3    |      | 3.2  | 0.118 |       | 0.126 |





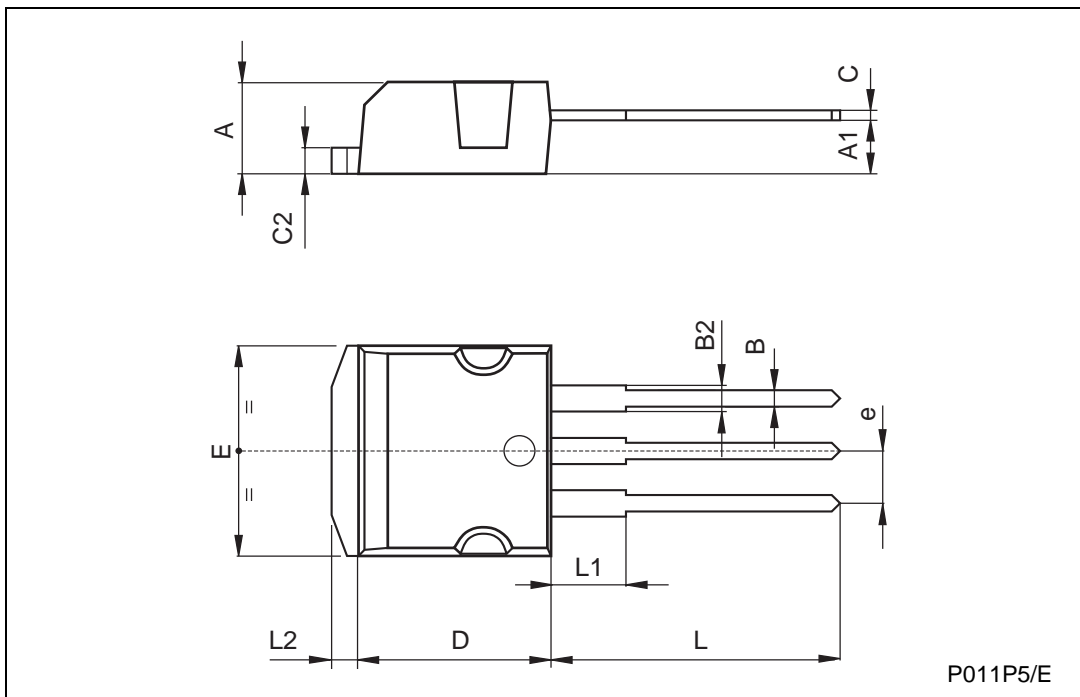
**D<sup>2</sup>PAK MECHANICAL DATA**

| 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°   |     | 8°    |       |       |       |



TO-262 (I<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 |
| 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 |
| e    | 2.4  |      | 2.7  | 0.094 |      | 0.106 |
| E    | 10   |      | 10.4 | 0.393 |      | 0.409 |
| L    | 13.1 |      | 13.6 | 0.515 |      | 0.531 |
| L1   | 3.48 |      | 3.78 | 0.137 |      | 0.149 |
| L2   | 1.27 |      | 1.4  | 0.050 |      | 0.055 |





Information furnished is believed to be accurate and reliable. However, STMicroelectronics assumes no responsibility for the consequences of use of such information nor for any infringement of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of STMicroelectronics. Specifications mentioned in this publication are subject to change without notice. This publication supersedes and replaces all information previously supplied. STMicroelectronics products are not authorized for use as critical components in life support devices or systems without express written approval of STMicroelectronics.

© The ST logo is a registered trademark of STMicroelectronics

© 2002 STMicroelectronics - Printed in Italy - All Rights Reserved  
STMicroelectronics GROUP OF COMPANIES

Australia - Brazil - Canada - China - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco  
Singapore - Spain - Sweden - Switzerland - United Kingdom - United States.

© <http://www.st.com>