



# STP11NM60A

## STP11NM60AFP - STB11NM60A-1

N-CHANNEL 600V - 0.4Ω - 11A TO-220/TO-220FP/I<sup>2</sup>PAK

MDmesh™ Power MOSFET

| TYPE         | V <sub>DSS</sub> | R <sub>DS(on)</sub> | I <sub>D</sub> |
|--------------|------------------|---------------------|----------------|
| STP11NM60A   | 600 V            | <0.45Ω              | 11 A           |
| STP11NM60AFP | 600 V            | <0.45Ω              | 11 A           |
| STB11NM60A-1 | 600 V            | <0.45Ω              | 11 A           |

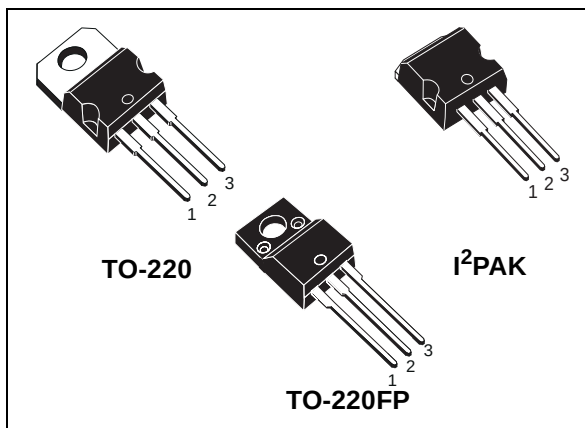
- TYPICAL R<sub>DS(on)</sub> = 0.4Ω
- HIGH dv/dt
- LOW INPUT CAPACITANCE AND GATE CHARGE
- LOW GATE INPUT RESISTANCE

### DESCRIPTION

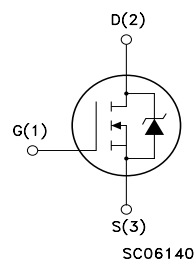
The MDmesh™ is a new revolutionary MOSFET technology that associates the Multiple Drain process with the Company's PowerMESH™ horizontal layout. The resulting product has an outstanding low on-resistance, impressively high dv/dt. The adoption of the Company's proprietary strip technique yields overall 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



### ORDERING INFORMATION

| SALES TYPE   | MARKING    | PACKAGE            | PACKAGING |
|--------------|------------|--------------------|-----------|
| STP11NM60A   | P11NM60A   | TO-220             | TUBE      |
| STP11NM60AFP | P11NM60AFP | TO-220FP           | TUBE      |
| STB11NM60A-1 | B11NM60A   | I <sup>2</sup> PAK | TUBE      |

## STP11NM60A/STP11NM60AFP/STB11NM60A-1

### ABSOLUTE MAXIMUM RATINGS

| Symbol            | Parameter                                               | Value                      |              | Unit                |
|-------------------|---------------------------------------------------------|----------------------------|--------------|---------------------|
|                   |                                                         | STP11NM60A<br>STB11NM60A-1 | STP11NM60AFP |                     |
| $V_{DS}$          | Drain-source Voltage ( $V_{GS} = 0$ )                   | 600                        |              | V                   |
| $V_{DGR}$         | Drain-gate Voltage ( $R_{GS} = 20\text{ k}\Omega$ )     | 600                        |              | V                   |
| $V_{GS}$          | Gate- source Voltage                                    | $\pm 30$                   |              | V                   |
| $I_D$             | Drain Current (continuous) at $T_C = 25^\circ\text{C}$  | 11                         | 11 (*)       | A                   |
| $I_D$             | Drain Current (continuous) at $T_C = 100^\circ\text{C}$ | 7                          | 7 (*)        | A                   |
| $I_{DM}(\bullet)$ | Drain Current (pulsed)                                  | 44                         | 44 (*)       | A                   |
| $P_{TOT}$         | Total Dissipation at $T_C = 25^\circ\text{C}$           | 110                        | 35           | W                   |
|                   | Derating Factor                                         | 0.88                       | 0.28         | W/ $^\circ\text{C}$ |
| $dv/dt(1)$        | Peak Diode Recovery voltage slope                       | 15                         |              | V/ns                |
| $V_{ISO}$         | Insulation Withstand Voltage (DC)                       | -                          | 2500         | V                   |
| $T_j$             | Operating Junction Temperature                          | -55 to 150                 |              | $^\circ\text{C}$    |
| $T_{stg}$         | Storage Temperature                                     | -55 to 150                 |              | $^\circ\text{C}$    |

(●) Pulse width limited by safe operating area

(1)  $I_{SD} \leq 11\text{A}$ ,  $di/dt \leq 200\text{A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_j \leq T_{JMAX}$ .

(\*) Limited only by maximum temperature allowed

### THERMAL DATA

|           |                                                | TO-220 / I <sup>2</sup> PAK | TO-220-FP |                           |
|-----------|------------------------------------------------|-----------------------------|-----------|---------------------------|
| Rthj-case | Thermal Resistance Junction-case Max           | 1.13                        | 3.57      | $^\circ\text{C}/\text{W}$ |
| Rthj-amb  | Thermal Resistance Junction-ambient Max        | 62.5                        |           | $^\circ\text{C}/\text{W}$ |
| $T_l$     | Maximum Lead Temperature For Soldering Purpose | 300                         |           | $^\circ\text{C}$          |

### ON/OFF

| Symbol        | Parameter                                        | Test Conditions                                                                          | Min. | Typ. | Max.      | Unit                           |
|---------------|--------------------------------------------------|------------------------------------------------------------------------------------------|------|------|-----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source Breakdown Voltage                   | $I_D = 250\text{ }\mu\text{A}$ , $V_{GS} = 0$                                            | 600  |      |           | V                              |
| $I_{DSS}$     | Zero Gate Voltage Drain Current ( $V_{GS} = 0$ ) | $V_{DS} = \text{Max Rating}$<br>$V_{DS} = \text{Max Rating}$ , $T_C = 125^\circ\text{C}$ |      |      | 1<br>10   | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$     | Gate-body Leakage Current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 20\text{V}$                                                                |      |      | $\pm 100$ | nA                             |
| $V_{GS(th)}$  | Gate Threshold Voltage                           | $V_{DS} = V_{GS}$ , $I_D = 250\mu\text{A}$                                               | 2    | 3    | 4         | V                              |
| $R_{DS(on)}$  | Static Drain-source On Resistance                | $V_{GS} = 10\text{V}$ , $I_D = 5.5\text{ A}$                                             |      | 0.4  | 0.45      | $\Omega$                       |

**ELECTRICAL CHARACTERISTICS** (TCASE = 25°C UNLESS OTHERWISE SPECIFIED)**DYNAMIC**

| Symbol                              | Parameter                                                               | Test Conditions                                                               | Min. | Typ.              | Max. | Unit           |
|-------------------------------------|-------------------------------------------------------------------------|-------------------------------------------------------------------------------|------|-------------------|------|----------------|
| $g_{fs}$ (1)                        | Forward Transconductance                                                | $V_{DS} = 15\text{ V}$ , $I_D = 5.5\text{ A}$                                 |      | 10                |      | S              |
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$ | Input Capacitance<br>Output Capacitance<br>Reverse Transfer Capacitance | $V_{DS} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$                    |      | 1211<br>248<br>21 |      | pF<br>pF<br>pF |
| $C_{oss\text{ eq.}}$ (3)            | Equivalent Output Capacitance                                           | $V_{GS} = 0\text{ V}$ , $V_{DS} = 0\text{ V to } 480\text{ V}$                |      | 116               |      | pF             |
| $R_G$                               | Gate Input Resistance                                                   | $f = 1\text{ MHz}$ Gate DC Bias = 0<br>Test Signal Level = 20mV<br>Open Drain |      | 1.9               |      | $\Omega$       |

**SWITCHING ON**

| Symbol                        | Parameter                                                    | Test Conditions                                                                                                                | Min. | Typ.          | Max. | Unit           |
|-------------------------------|--------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|------|---------------|------|----------------|
| $t_{d(on)}$<br>$t_r$          | Turn-on Delay Time<br>Rise Time                              | $V_{DD} = 300\text{ V}$ , $I_D = 5.5\text{ A}$<br>$R_G = 4.7\Omega$ , $V_{GS} = 10\text{ V}$<br>(Resistive Load see, Figure 3) |      | 14<br>15      |      | ns<br>ns       |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$ | Total Gate Charge<br>Gate-Source Charge<br>Gate-Drain Charge | $V_{DD} = 480\text{ V}$ , $I_D = 11\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$                                                      |      | 35<br>9<br>14 | 49   | nC<br>nC<br>nC |

**SWITCHING OFF**

| Symbol                          | Parameter                                             | Test Conditions                                                                                                                 | Min. | Typ.           | Max. | Unit           |
|---------------------------------|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|------|----------------|------|----------------|
| $t_{r(Voff)}$<br>$t_f$<br>$t_c$ | Off-voltage Rise Time<br>Fall Time<br>Cross-over Time | $V_{DD} = 480\text{ V}$ , $I_D = 11\text{ A}$ ,<br>$R_G = 4.7\Omega$ , $V_{GS} = 10\text{ V}$<br>(Inductive Load see, Figure 5) |      | 39<br>10<br>20 |      | ns<br>ns<br>ns |

**SOURCE DRAIN DIODE**

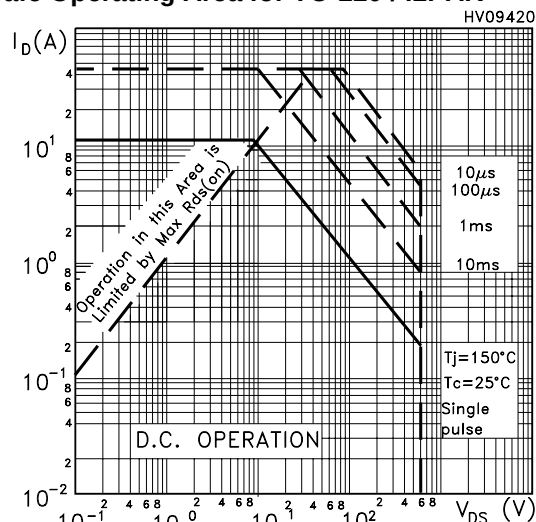
| Symbol                            | Parameter                                                                    | Test Conditions                                                                                                                                    | Min. | Typ.               | Max.     | Unit                     |
|-----------------------------------|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|------|--------------------|----------|--------------------------|
| $I_{SD}$<br>$I_{SDM}$ (2)         | Source-drain Current<br>Source-drain Current (pulsed)                        |                                                                                                                                                    |      |                    | 11<br>44 | A<br>A                   |
| $V_{SD}$ (1)                      | Forward On Voltage                                                           | $I_{SD} = 11\text{ A}$ , $V_{GS} = 0$                                                                                                              |      |                    | 1.5      | V                        |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse Recovery Time<br>Reverse Recovery Charge<br>Reverse Recovery Current | $I_{SD} = 11\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 100\text{ V}$ , $T_j = 150^\circ\text{C}$<br>(see test circuit, Figure 5) |      | 560<br>5.7<br>20.5 |          | ns<br>$\mu\text{C}$<br>A |

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

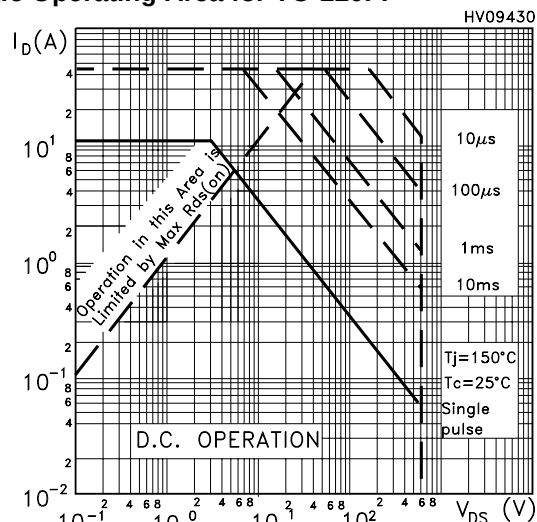
2. Pulse width limited by safe operating area.

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

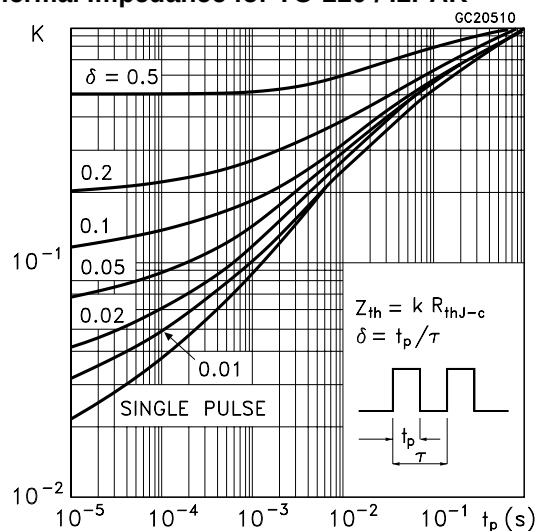
Safe Operating Area for TO-220 / I2PAK



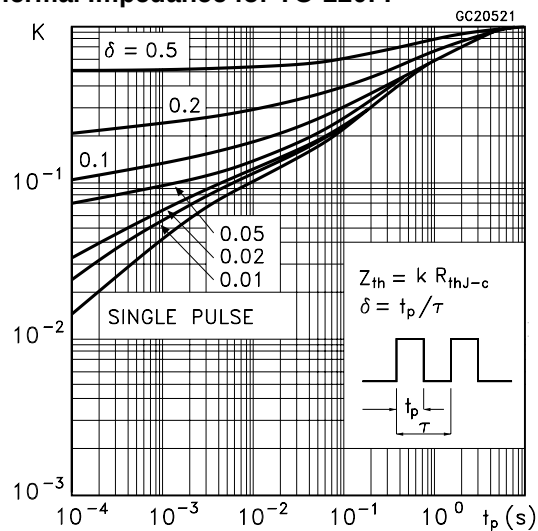
Safe Operating Area for TO-220FP



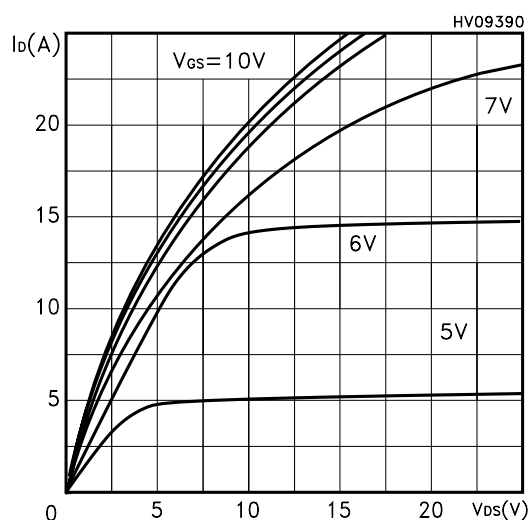
Thermal Impedance for TO-220 / I2PAK



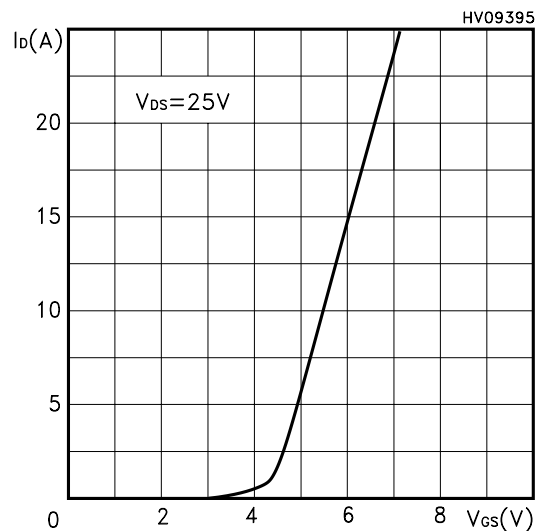
Thermal Impedance for TO-220FP



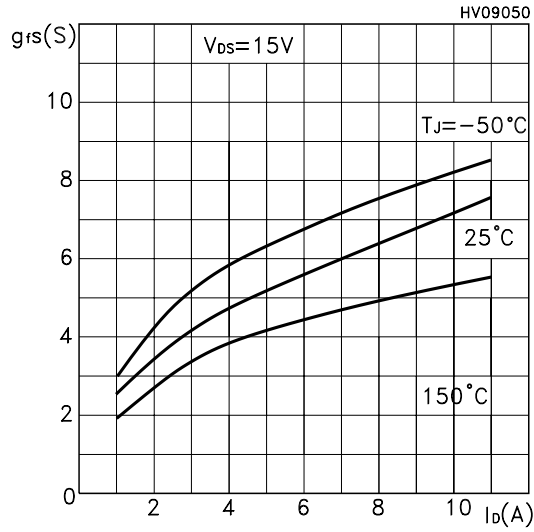
Output Characteristics



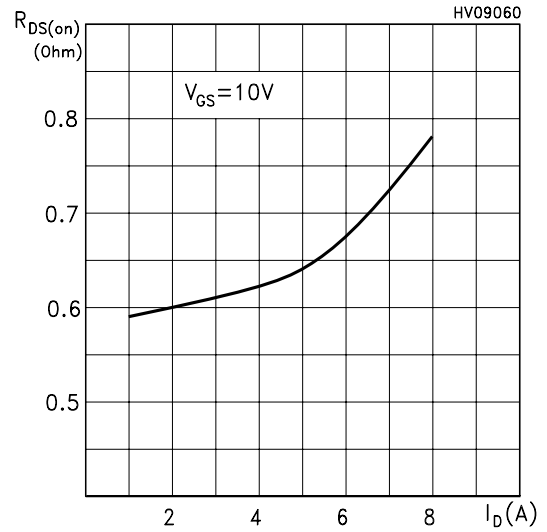
Transfer Characteristics



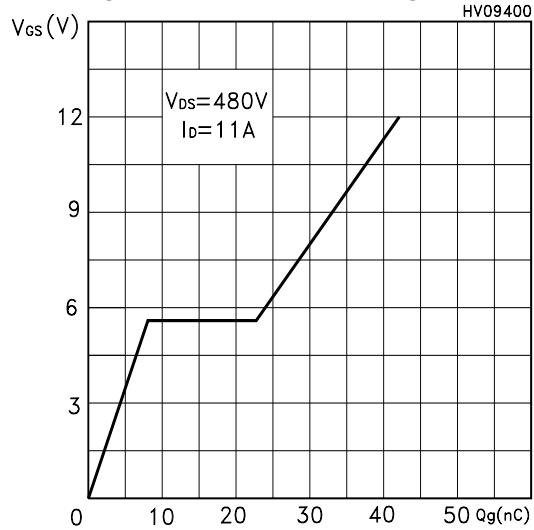
Transconductance



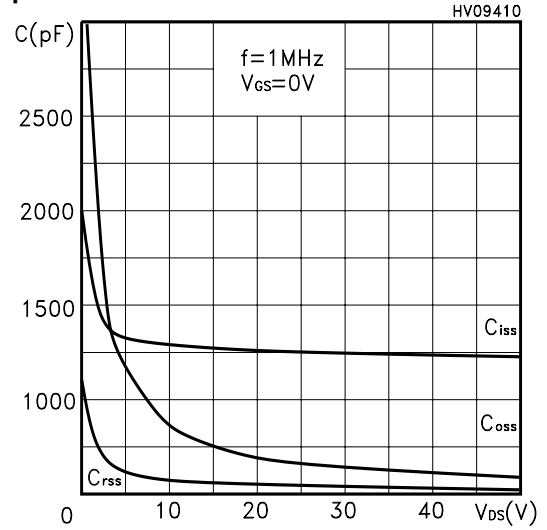
Static Drain-source On Resistance



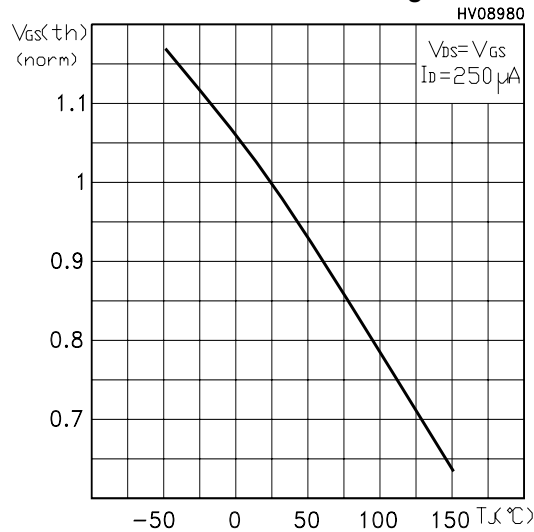
Gate Charge vs Gate-source Voltage



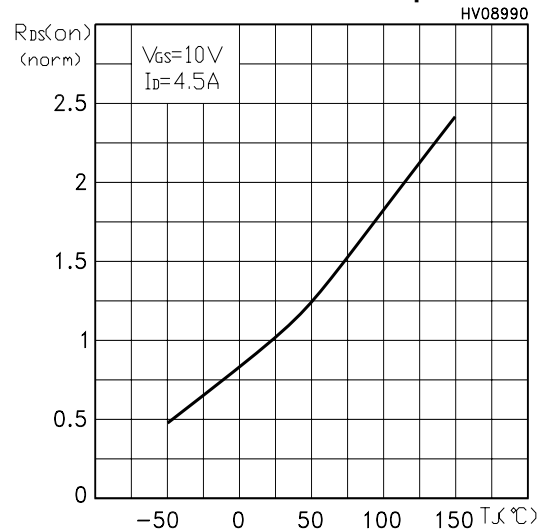
Capacitance Variations



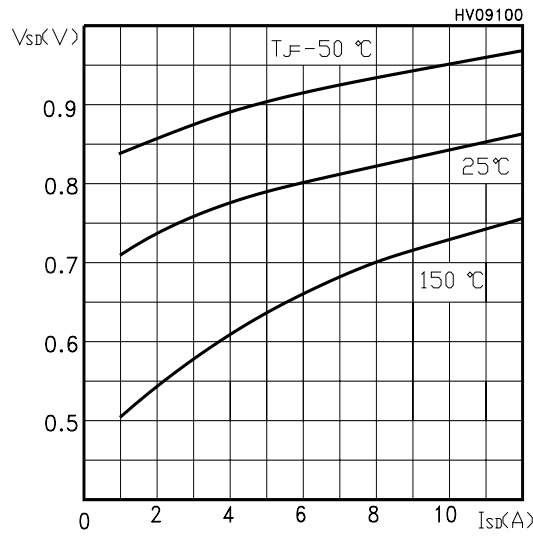
Normalized Gate Threshold Voltage vs Temp.



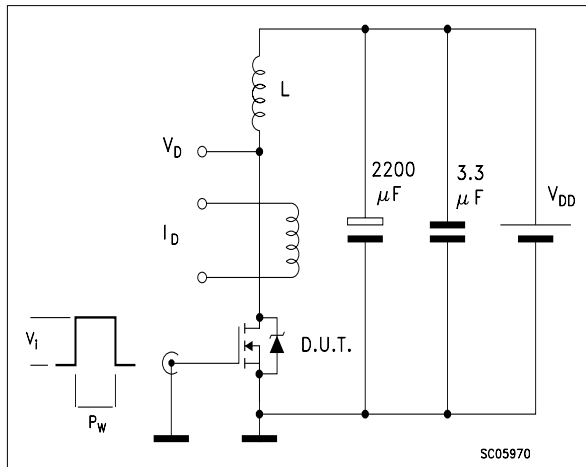
Normalized On Resistance vs Temperature



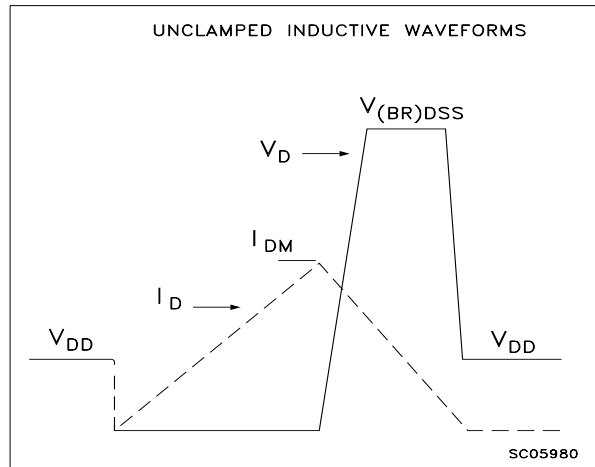
Source-drain Diode Forward Characteristics



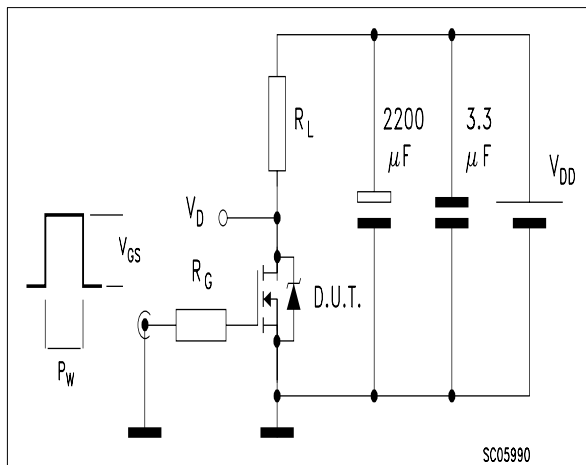
**Fig. 1: Unclamped Inductive Load Test Circuit**



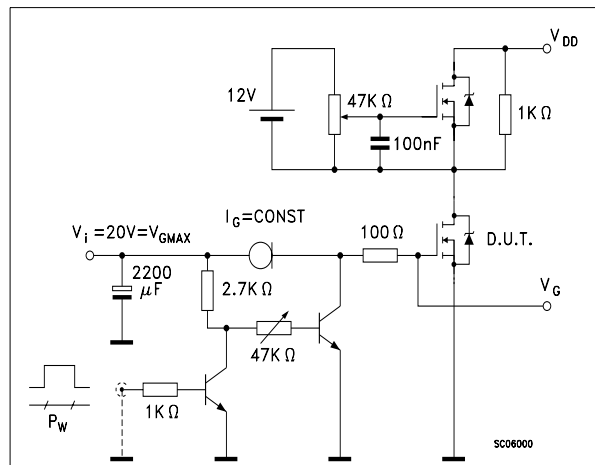
**Fig. 2: Unclamped Inductive Waveform**



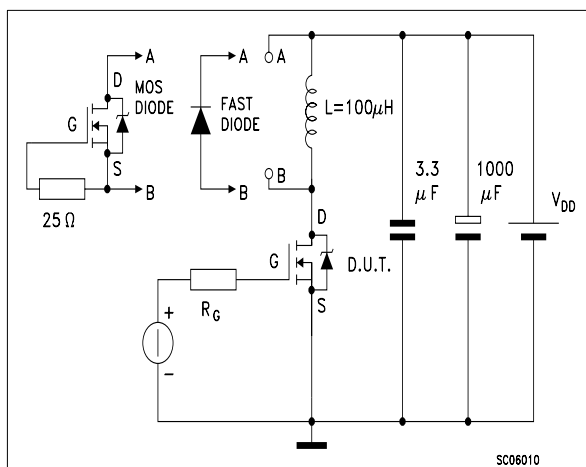
**Fig. 3: Switching Times Test Circuit For Resistive Load**



**Fig. 4: Gate Charge test Circuit**

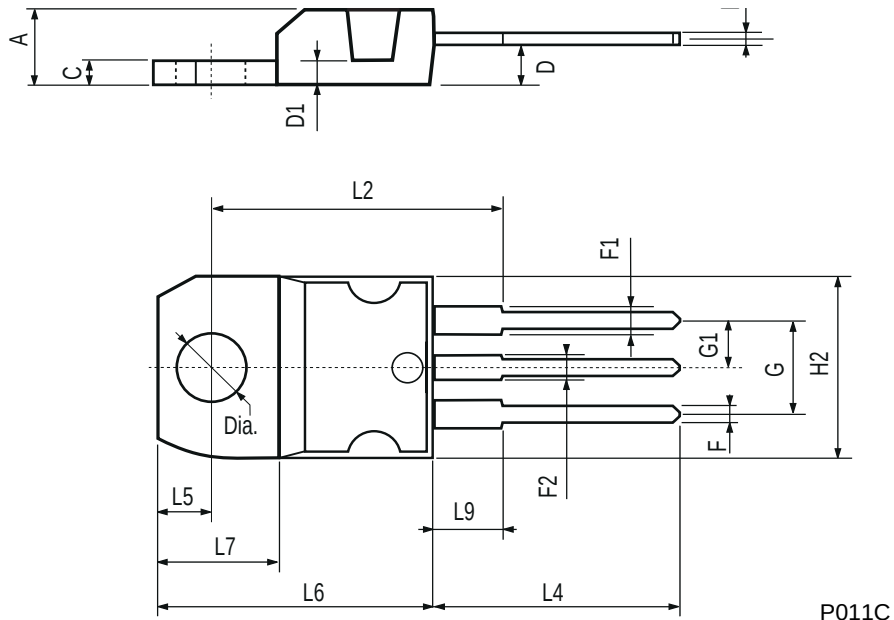


**Fig. 5: Test Circuit For Inductive Load Switching And Diode Recovery Times**



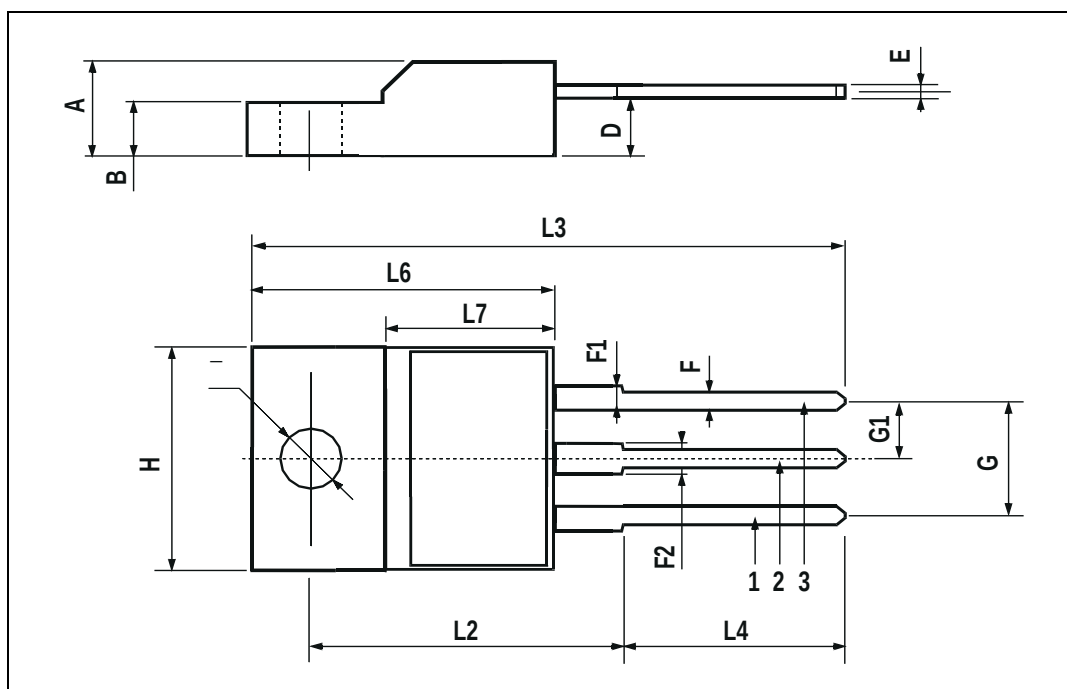
TO-220 MECHANICAL DATA

| 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 |



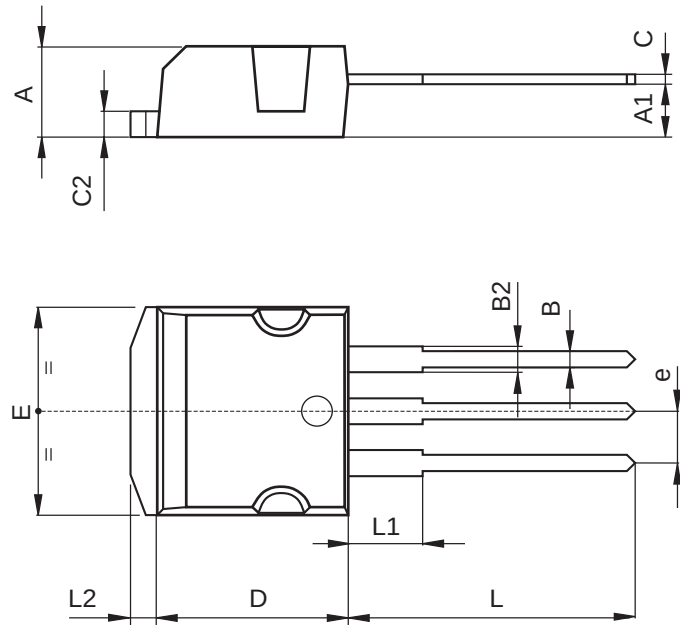
## TO-220FP MECHANICAL DATA

| 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 |
| Ø    | 3    |      | 3.2  | 0.118 |       | 0.126 |



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 |



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