



# STP60NE06L-16 STP60NE06L-16FP

N - CHANNEL 60V - 0.014Ω - 60A TO-220/TO-220FP  
STripFET™ POWER MOSFET

| TYPE            | V <sub>DSS</sub> | R <sub>DS(on)</sub> | I <sub>D</sub> |
|-----------------|------------------|---------------------|----------------|
| STP60NE06L-16   | 60 V             | < 0.016 Ω           | 60 A           |
| STP60NE06L-16FP | 60 V             | < 0.016 Ω           | 35 A           |

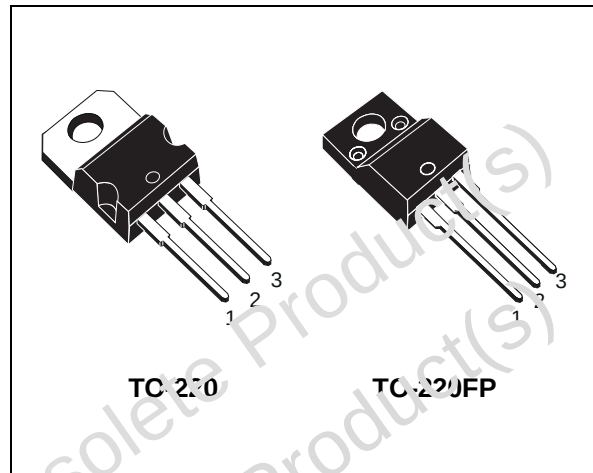
- TYPICAL R<sub>DS(on)</sub> = 0.014 Ω
- AVALANCHE RUGGED TECHNOLOGY
- LOW GATE CHARGE
- HIGH CURRENT CAPABILITY
- 175 °C OPERATING TEMPERATURE
- LOW THRESHOLD DRIVE

## DESCRIPTION

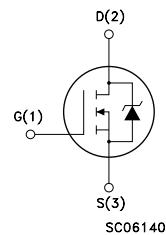
This Power Mosfet is the latest development of STMicroelectronics unique "Single Feature Size™" strip-based process. The resulting transistor shows extremely high packing density for low on-resistance, rugged avalanche characteristics and less critical alignment steps therefore a remarkable manufacturing reproducibility.

## APPLICATIONS

- HIGH CURRENT, HIGH SPEED SWITCHING
- SOLENOID AND RELAY DRIVERS
- DC-DC & DC-AC CONVERTERS
- AUTOMOTIVE ENVIRONMENT



## INTERNAL SCHEMATIC DIAGRAM



## ABSOLUTE MAXIMUM RATINGS

| Symbol              | Parameter                                             | Value         |                 | Unit |
|---------------------|-------------------------------------------------------|---------------|-----------------|------|
|                     |                                                       | STP60NE06L-16 | STP60NE06L-16FP |      |
| 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            | 35              | A    |
| I <sub>D</sub>      | Drain Current (continuous) at T <sub>c</sub> = 100 °C | 42            | 24              | A    |
| I <sub>DM</sub> (•) | Drain Current (pulsed)                                | 240           | 140             | A    |
| P <sub>tot</sub>    | Total Dissipation at T <sub>c</sub> = 25 °C           | 150           | 45              | W    |
|                     | Derating Factor                                       | 1             | 0.3             | W/°C |
| V <sub>ISO</sub>    | Insulation Withstand Voltage (DC)                     | —             | 2000            | V    |
| dv/dt               | Peak Diode Recovery voltage slope                     | 6             |                 | V/ns |
| T <sub>stg</sub>    | Storage Temperature                                   | -65 to 175    |                 | °C   |
| T <sub>j</sub>      | Max. Operating Junction Temperature                   | 175           |                 | °C   |

(•) Pulse width limited by safe operating area

(1) I<sub>SD</sub> ≤ 60 A, di/dt ≤ 300 A/μs, V<sub>DD</sub> ≤ V<sub>(BR)DSS</sub>, T<sub>j</sub> ≤ T<sub>JMAX</sub>

## THERMAL DATA

|                       |                                                | TO-220 | TO-220FP |      |
|-----------------------|------------------------------------------------|--------|----------|------|
| R <sub>thj-case</sub> | Thermal Resistance Junction-case Max           | 0.94   | 2.7      | °C/W |
| R <sub>thj-amb</sub>  | Thermal Resistance Junction-ambient Max        | 62.5   |          | °C/W |
| R <sub>thc-sink</sub> | Thermal Resistance Case-sink Typ               | 0.5    |          | °C/W |
| T <sub>l</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)                               | 60        | 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> = 25V) | 400       | 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                                          | 60   |      |         | 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> = ± 15 V                                                             |      |      | ± 100   | nA       |

## ON (\*)

| 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> = 250 μA                                 | 1    | 1.6            | 2.5            | V      |
| R <sub>DS(on)</sub> | Static Drain-source On Resistance | V <sub>GS</sub> = 5V I <sub>D</sub> = 30 A<br>V <sub>GS</sub> = 10V I <sub>D</sub> = 30 A |      | 0.014<br>0.012 | 0.016<br>0.014 | Ω<br>Ω |
| I <sub>D(on)</sub>  | On State Drain Current            | V <sub>DS</sub> > I <sub>D(on)</sub> × R <sub>DS(on)max</sub><br>V <sub>GS</sub> = 10 V   | 60   |                |                | A      |

## DYNAMIC

| Symbol              | Parameter                    | Test Conditions                                                                     | Min. | Typ. | Max. | Unit |
|---------------------|------------------------------|-------------------------------------------------------------------------------------|------|------|------|------|
| g <sub>fs</sub> (*) | Forward Transconductance     | V <sub>DS</sub> > I <sub>D(on)</sub> × R <sub>DS(on)max</sub> I <sub>D</sub> = 30 A |      | 30   |      | S    |
| C <sub>iss</sub>    | Input Capacitance            | V <sub>DS</sub> = 25 V f = 1 MHz V <sub>GS</sub> = 0                                |      | 4150 |      | pF   |
| C <sub>oss</sub>    | Output Capacitance           |                                                                                     |      | 590  |      | pF   |
| C <sub>rss</sub>    | Reverse Transfer Capacitance |                                                                                     |      | 150  |      | pF   |

**ELECTRICAL CHARACTERISTICS** (continued)**SWITCHING ON**

| Symbol      | Parameter          | Test Conditions                                                           | Min. | Typ. | Max. | Unit |
|-------------|--------------------|---------------------------------------------------------------------------|------|------|------|------|
| $t_{d(on)}$ | Turn-on Delay Time | $V_{DD} = 30\text{ V}$ $I_D = 30\text{ A}$                                |      | 50   |      | ns   |
| $t_r$       | Rise Time          | $R_G = 4.7\ \Omega$ $V_{GS} = 5\text{ V}$<br>(Resistive Load, see fig. 3) |      | 155  |      | ns   |
| $Q_g$       | Total Gate Charge  | $V_{DD} = 40\text{ V}$ $I_D = 60\text{ A}$ $V_{GS} = 5\text{ V}$          |      | 55   | 70   | nC   |
| $Q_{gs}$    | Gate-Source Charge |                                                                           |      | 15   |      | nC   |
| $Q_{gd}$    | Gate-Drain Charge  |                                                                           |      | 30   |      | nC   |

**SWITCHING OFF**

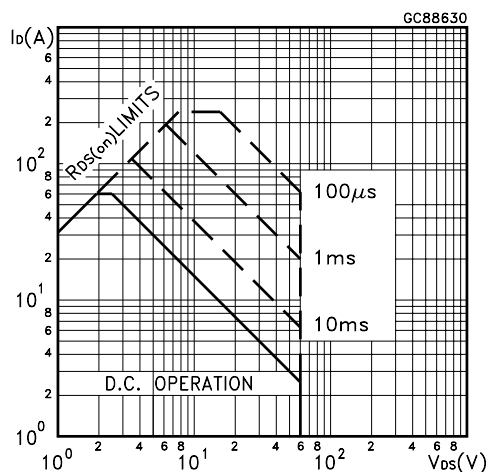
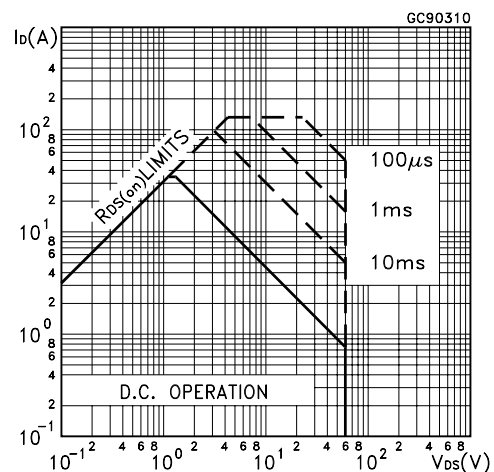
| Symbol         | Parameter             | Test Conditions                                                           | Min. | Typ. | Max. | Unit |
|----------------|-----------------------|---------------------------------------------------------------------------|------|------|------|------|
| $t_{d(off)}$   | Turn-off Delay Time   | $V_{DD} = 30\text{ V}$ $I_D = 30\text{ A}$                                |      | 125  |      | ns   |
| $t_f$          | Fall Time             | $R_G = 4.7\ \Omega$ $V_{GS} = 5\text{ V}$<br>(Resistive Load, see fig. 3) |      | 25   |      | ns   |
| $t_r(V_{off})$ | Off-voltage Rise Time | $V_{DD} = 48\text{ V}$ $I_D = 20\text{ A}$                                |      | 45   |      | ns   |
| $t_f$          | Fall Time             | $R_G = 4.7\ \Omega$ $V_{GS} = 5\text{ V}$                                 |      | 220  |      | ns   |
| $t_c$          | Cross-over Time       | (Inductive Load, see fig. 5)                                              |      | 280  |      | ns   |

**SOURCE DRAIN DIODE**

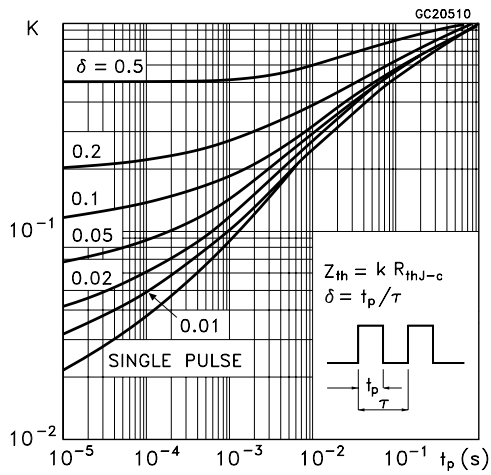
| Symbol             | Parameter                     | Test Conditions                                                                                                                                     | Min. | Typ. | Max. | Unit          |
|--------------------|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $I_{SD}$           | Source-drain Current          |                                                                                                                                                     |      |      | 60   | A             |
| $I_{SDM}(\bullet)$ | Source-drain Current (pulsed) |                                                                                                                                                     |      |      | 240  | A             |
| $V_{SD} (*)$       | Forward On Voltage            | $I_{SD} = 60\text{ A}$ $V_{GS} = 0$                                                                                                                 |      |      | 1.5  | V             |
| $t_{rr}$           | Reverse Recovery Time         | $I_{SD} = 60\text{ A}$ $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 30\text{ V}$ $T_J = 150\text{ }^\circ\text{C}$<br>(see test circuit, fig. 5) |      | 85   |      | ns            |
| $Q_{rr}$           | Reverse Recovery Charge       |                                                                                                                                                     |      | 300  |      | $\mu\text{C}$ |
| $I_{RRM}$          | Reverse Recovery Current      |                                                                                                                                                     |      | 7    |      | A             |

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

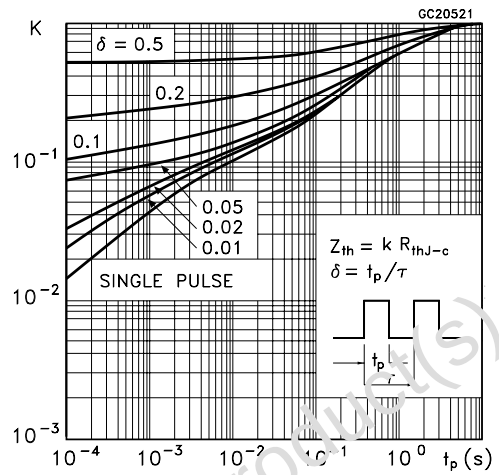
(\bullet) Pulse width limited by safe operating area

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

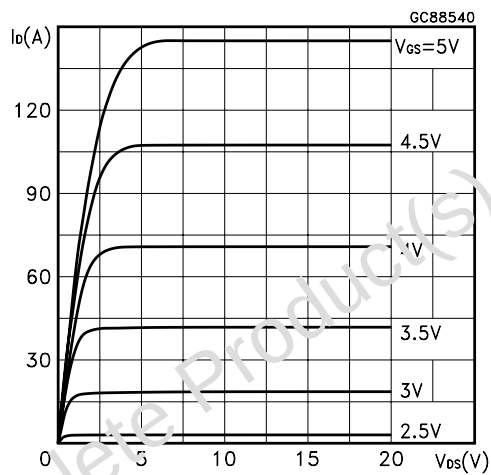
Thermal Impedance for TO-220



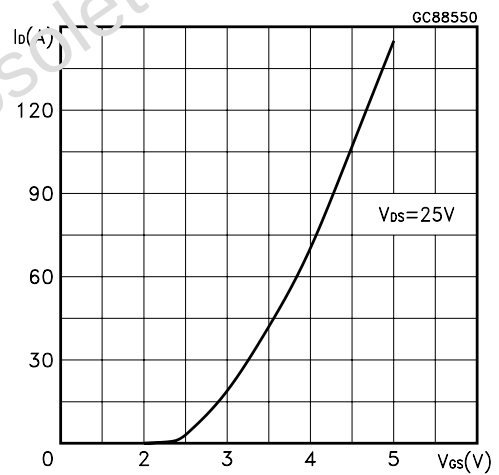
Thermal Impedance for TO-220FP



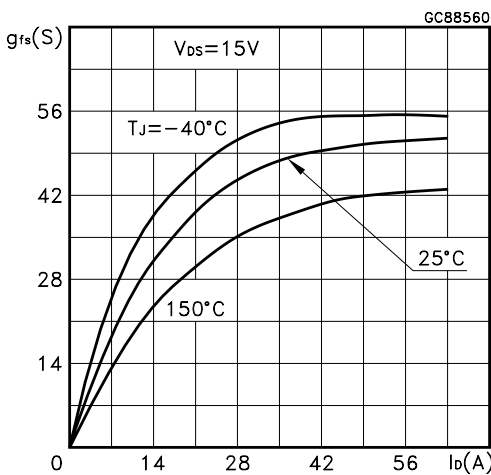
Output Characteristics



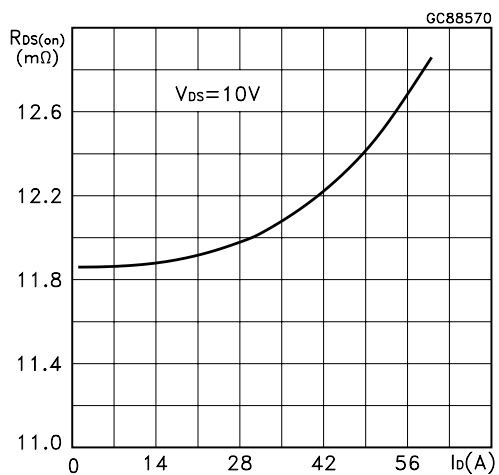
Transfer Characteristics



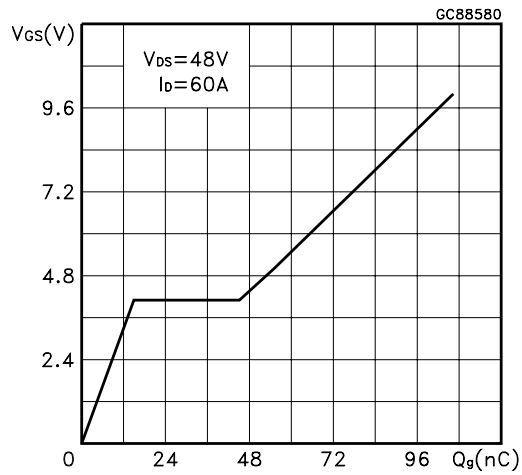
Transconductance



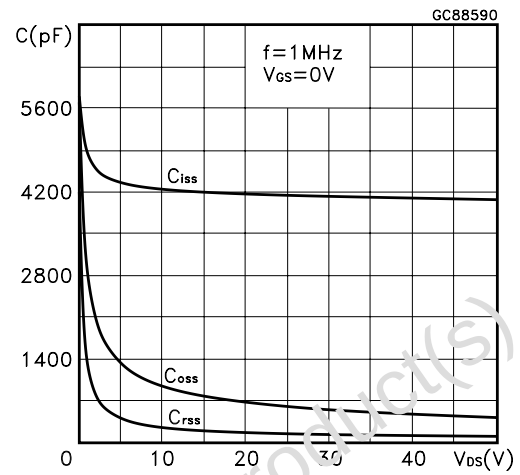
Static Drain-source On Resistance



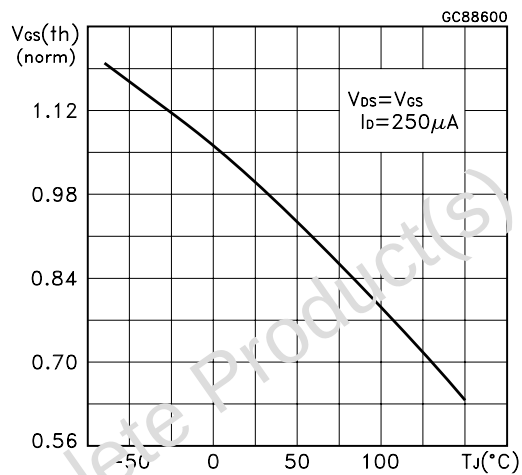
Gate Charge vs Gate-source Voltage



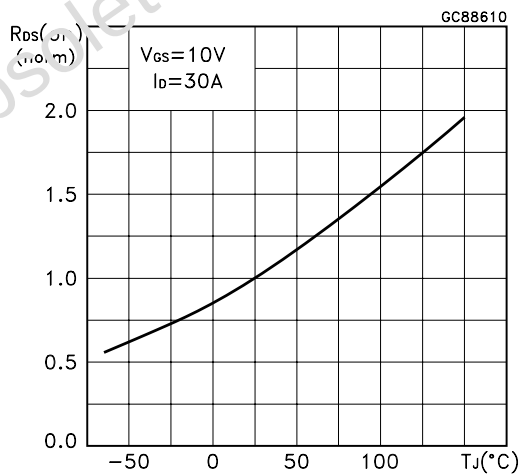
Capacitance Variations



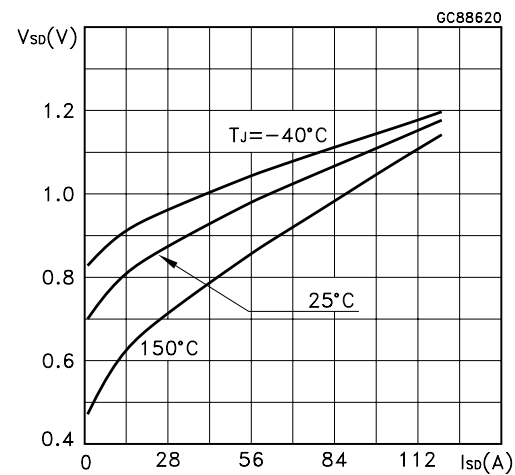
Normalized Gate Threshold Voltage vs Temperature



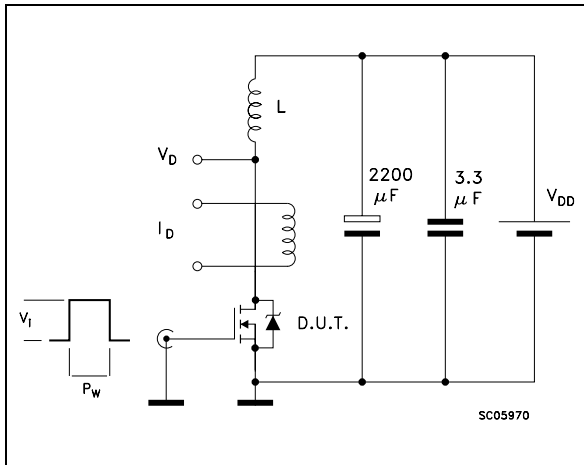
Normalized On Resistance vs Temperature



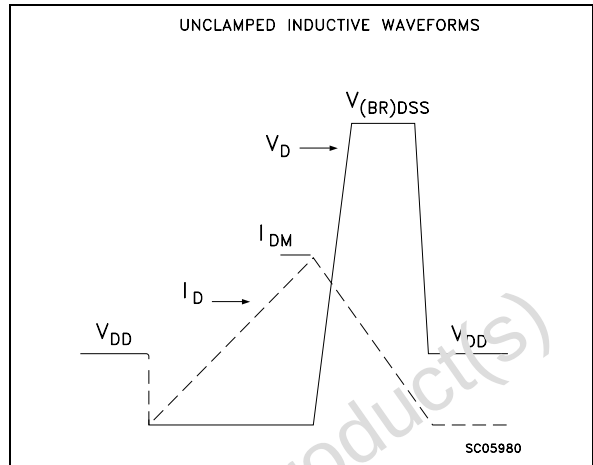
Source-drain Diode Forward Characteristics



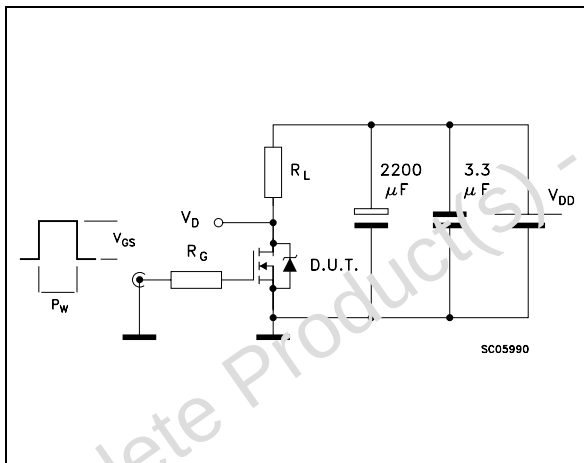
**Fig. 1:** Unclamped Inductive Load Test Circuit



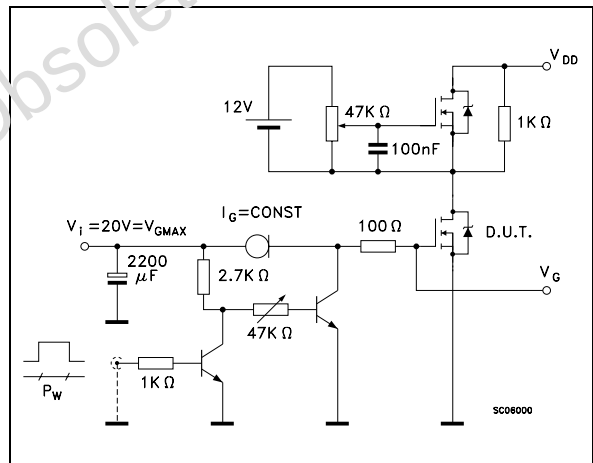
**Fig. 2:** Unclamped Inductive Waveform



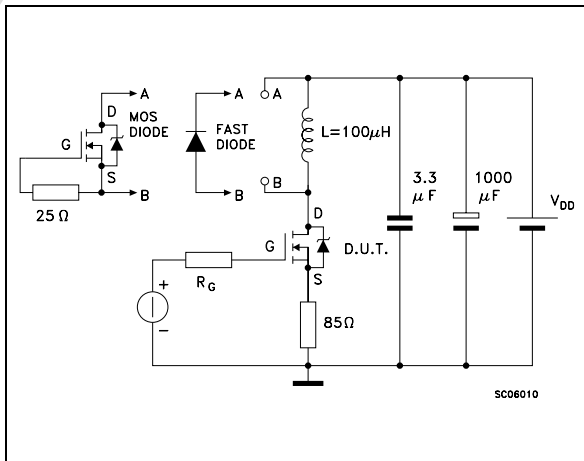
**Fig. 3:** Switching Times Test Circuits For Resistive Load



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

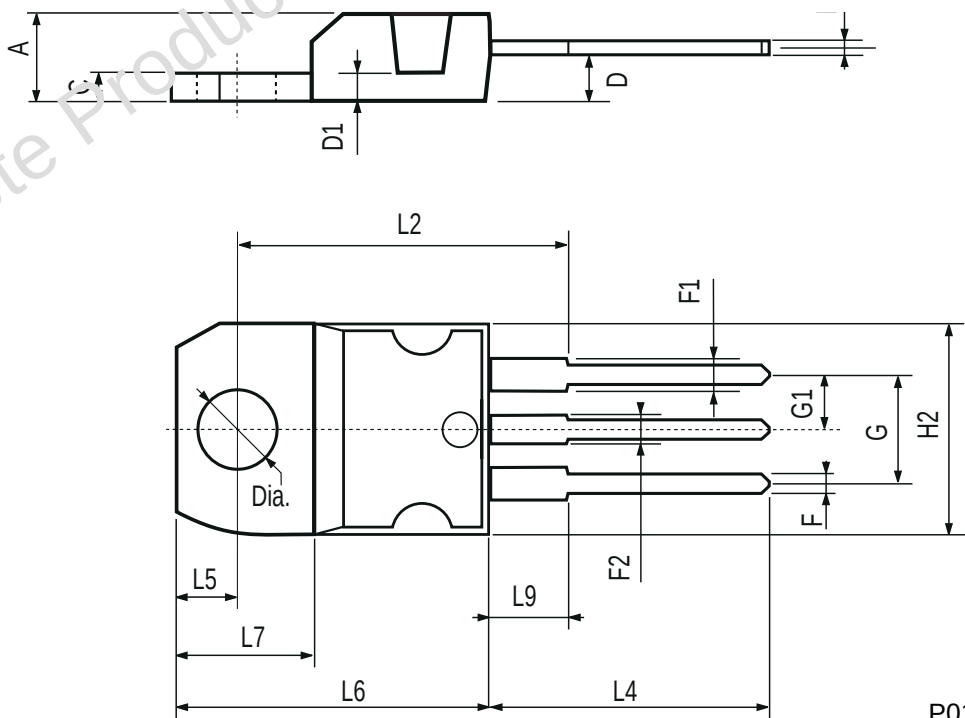


**Fig. 5:** Test Circuit For Inductive Load Switching And Diode Recovery Times



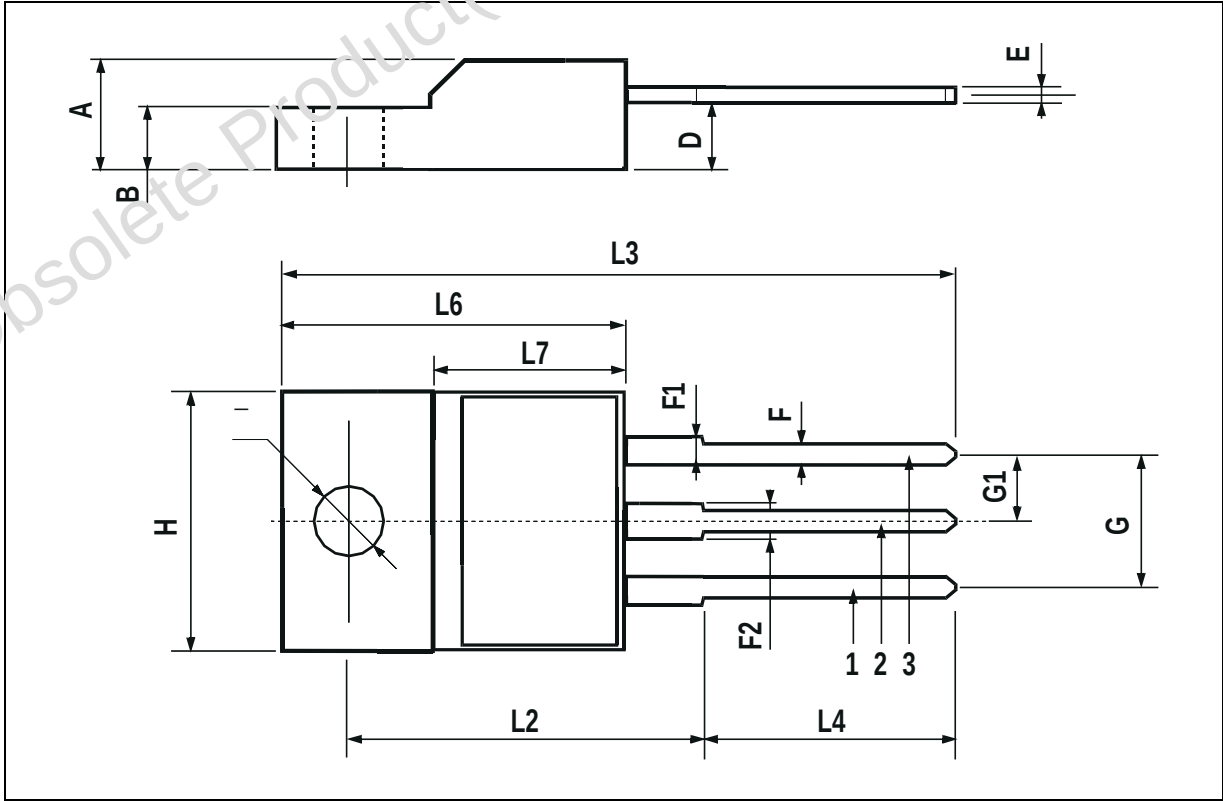
TO-220 MECHANICAL DATA

| 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 |





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