



STP9NC60 STP9NC60FP

N - CHANNEL 600V - 0.6Ω - 9A TO-220/TO-220FP PowerMESH™ II MOSFET

| TYPE | V _{DSS} | R _{DS(on)} | I _D |
|------------|------------------|---------------------|----------------|
| STP9NC60 | 600 V | < 0.75 Ω | 9.0 A |
| STP9NC60FP | 600 V | < 0.75 Ω | 5.2 A |

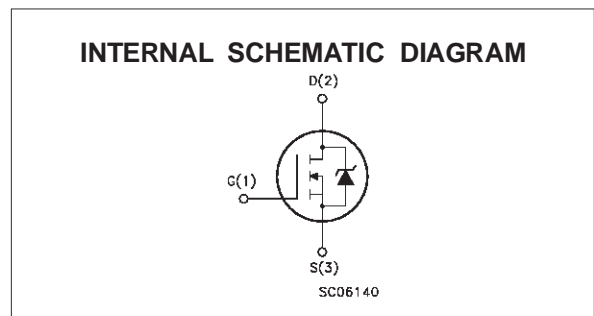
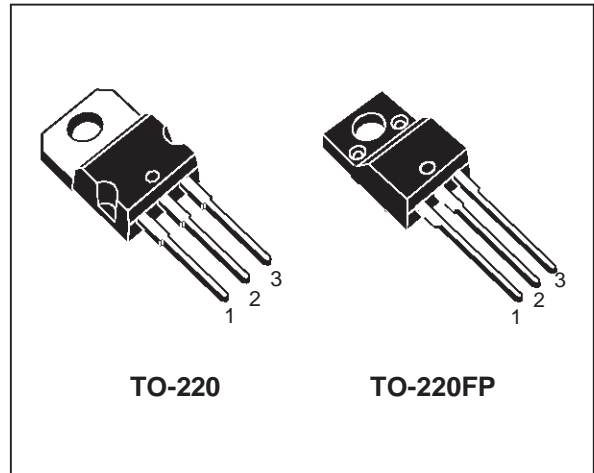
- v TYPICAL R_{DS(on)} = 0.6 Ω
- v EXTREMELY HIGH dv/dt CAPABILITY
- v 100% AVALANCHE TESTED
- v NEW HIGH VOLTAGE BENCHMARK
- v GATE CHARGE MINIMIZED

DESCRIPTION

The PowerMESH™ II is the evolution of the first generation of MESH OVERLAY™. The layout refinements introduced greatly improve the Ron*area figure of merit while keeping the device at the leading edge for what concerns switching speed, gate charge and ruggedness.

APPLICATIONS

- v HIGH CURRENT, HIGH SPEED SWITCHING
- v SWITCH MODE POWER SUPPLIES (SMPS)
- v DC-AC CONVERTERS FOR WELDING EQUIPMENT AND UNINTERRUPTIBLE POWER SUPPLIES AND MOTOR DRIVER



ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | | Unit |
|---------------------|---|------------|------------|------|
| | | STP9NC60 | STP9NC60FP | |
| V _{DS} | Drain-source Voltage (V _{GS} = 0) | 600 | | V |
| V _{DGR} | Drain- gate Voltage (R _{GS} = 20 kΩ) | 600 | | V |
| V _{GS} | Gate-source Voltage | ± 30 | | V |
| I _D | Drain Current (continuous) at T _c = 25 °C | 9.0 | 5.2 | A |
| I _D | Drain Current (continuous) at T _c = 100 °C | 5.7 | 3.3 | A |
| I _{DM} (•) | Drain Current (pulsed) | 36 | 36 | A |
| P _{tot} | Total Dissipation at T _c = 25 °C | 125 | 40 | W |
| | Derating Factor | 1.0 | 0.32 | W/°C |
| dv/dt(1) | Peak Diode Recovery voltage slope | 4.5 | 4.5 | V/ns |
| V _{ISO} | Insulation Withstand Voltage (DC) | — | 2000 | V |
| T _{stg} | Storage Temperature | -65 to 150 | | °C |
| T _j | Max. Operating Junction Temperature | 150 | | °C |

(•) Pulse width limited by safe operating area

(1) I_{SD} ≤ 9A, di/dt ≤ 200 A/μs, V_{DD} ≤ V_{(BR)DSS}, T_j ≤ T_{JMAX}

STP9NC60/FP

THERMAL DATA

| | | TO-220 | TO-220FP | | |
|----------------|--|--------|----------|------|-----------------------------|
| $R_{thj-case}$ | Thermal Resistance Junction-case | Max | 1.0 | 3.12 | $^{\circ}\text{C}/\text{W}$ |
| $R_{thj-amb}$ | Thermal Resistance Junction-ambient | Max | 62.5 | | $^{\circ}\text{C}/\text{W}$ |
| $R_{thc-sink}$ | Thermal Resistance Case-sink | Typ | 0.5 | | $^{\circ}\text{C}/\text{W}$ |
| T_l | Maximum Lead Temperature For Soldering Purpose | | 300 | | $^{\circ}\text{C}$ |

AVALANCHE CHARACTERISTICS

| Symbol | Parameter | Max Value | Unit |
|----------|--|-----------|------|
| I_{AR} | Avalanche Current, Repetitive or Not-Repetitive (pulse width limited by T_j max, $\delta < 1\%$) | 9 | A |
| E_{AS} | Single Pulse Avalanche Energy (starting $T_j = 25^{\circ}\text{C}$, $I_D = I_{AR}$, $V_{DD} = 50\text{ V}$) | 850 | mJ |

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

OFF

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---------------|--|--|------|------|-----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source Breakdown Voltage | $I_D = 250\ \mu\text{A}$ $V_{GS} = 0$ | 600 | | | V |
| I_{DSS} | Zero Gate Voltage Drain Current ($V_{GS} = 0$) | $V_{DS} = \text{Max Rating}$ $V_{DS} = \text{Max Rating}$ $T_c = 125^{\circ}\text{C}$ | | | 1 50 | μA μA |
| I_{GSS} | Gate-body Leakage Current ($V_{DS} = 0$) | $V_{GS} = \pm 30\text{ V}$ | | | ± 100 | nA |

ON (*)

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|--------------|-----------------------------------|---|------|------|------|----------|
| $V_{GS(th)}$ | 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 | $V_{GS} = 10\text{ V}$ $I_D = 4\text{ A}$ | | 0.6 | 0.75 | Ω |
| $I_{D(on)}$ | On State Drain Current | $V_{DS} > I_{D(on)} \times R_{DS(on)max}$ $V_{GS} = 10\text{ V}$ | 9.0 | | | A |

DYNAMIC

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|--------------|------------------------------|--|------|------|------|------|
| g_{fs} (*) | Forward Transconductance | $V_{DS} > I_{D(on)} \times R_{DS(on)max}$ $I_D = 4\text{ A}$ | | 10 | | S |
| C_{iss} | Input Capacitance | $V_{DS} = 25\text{ V}$ $f = 1\text{ MHz}$ $V_{GS} = 0$ | | 1400 | | pF |
| C_{oss} | Output Capacitance | | | 196 | | pF |
| C_{rss} | Reverse Transfer Capacitance | | | 31 | | pF |

ELECTRICAL CHARACTERISTICS (continued)
SWITCHING ON

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|-------------|--------------------|--|------|------|------|------|
| $t_{d(on)}$ | Turn-on Delay Time | $V_{DD} = 300\text{ V}$ $I_D = 4.5\text{ A}$ | | 28 | | ns |
| t_r | Rise Time | $R_G = 4.7\ \Omega$ $V_{GS} = 10\text{ V}$ (Resistive Load, see fig. 3) | | 15 | | ns |
| Q_g | Total Gate Charge | $V_{DD} = 480\text{ V}$ $I_D = 9.0\text{ A}$ $V_{GS} = 10\text{ V}$ | | 44 | 62 | nC |
| Q_{gs} | Gate-Source Charge | | | 10.5 | | nC |
| Q_{gd} | Gate-Drain Charge | | | 19.5 | | nC |

SWITCHING OFF

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---------------|-----------------------|--|------|------|------|------|
| $t_{d(off)}$ | Turn-off Delay Time | $V_{DD} = 300\text{ V}$ $I_D = 4.5\text{ A}$ | | 53 | | ns |
| t_f | Fall Time | $R_G = 4.7\ \Omega$ $V_{GS} = 10\text{ V}$ (Resistive Load, see fig. 3) | | 30 | | ns |
| $t_{r(Voff)}$ | Off-voltage Rise Time | $V_{DD} = 480\text{ V}$ $I_D = 9.0\text{ A}$ | | 15 | | ns |
| t_f | Fall Time | $R_G = 4.7\ \Omega$ $V_{GS} = 10\text{ V}$ | | 12 | | ns |
| t_c | Cross-over Time | (Inductive Load, see fig. 5) | | 24 | | ns |

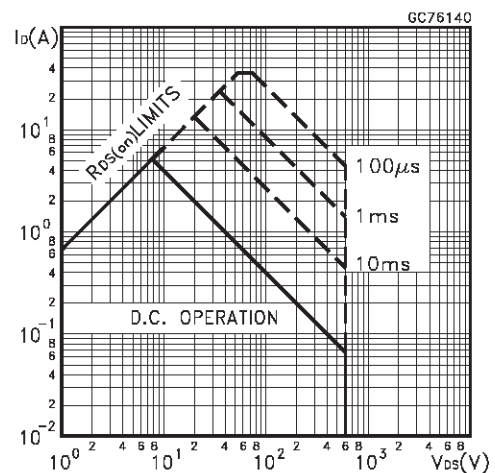
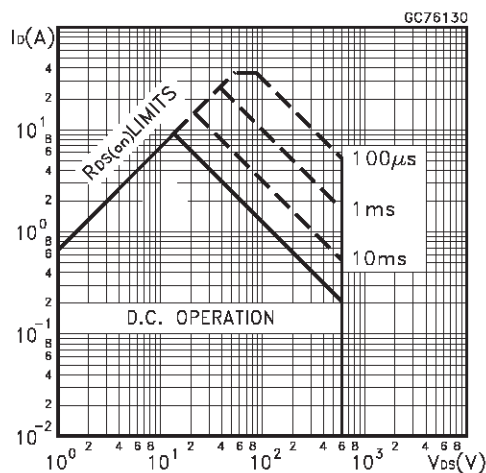
SOURCE DRAIN DIODE

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|--------------------|-------------------------------|--|------|------|------|---------------|
| I_{SD} | Source-drain Current | | | | 9.0 | A |
| $I_{SDM}(\bullet)$ | Source-drain Current (pulsed) | | | | 36 | A |
| $V_{SD} (*)$ | Forward On Voltage | $I_{SD} = 9\text{ A}$ $V_{GS} = 0$ | | | 1.6 | V |
| t_{rr} | Reverse Recovery Time | $I_{SD} = 9\text{ A}$ $V_{DD} = 100\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$ $T_j = 150\text{ }^\circ\text{C}$ (see test circuit, fig. 5) | | 610 | | ns |
| Q_{rr} | Reverse Recovery Charge | | | 5.4 | | μC |
| I_{RRM} | Reverse Recovery Current | | | 17 | | A |

(*) Pulsed: Pulse duration = 300 μs , duty cycle 1.5 %
(\bullet) Pulse width limited by safe operating area

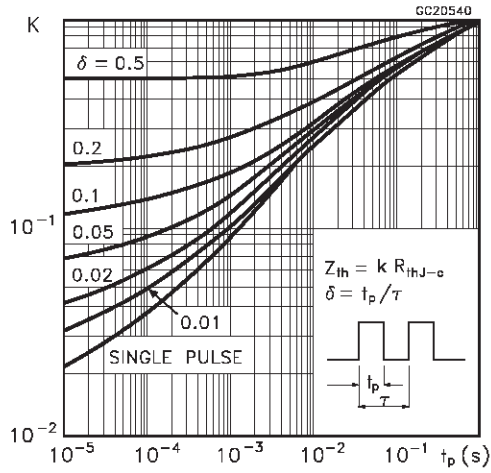
Safe Operating Area for TO-220

Safe Operating Area for TO-220FP

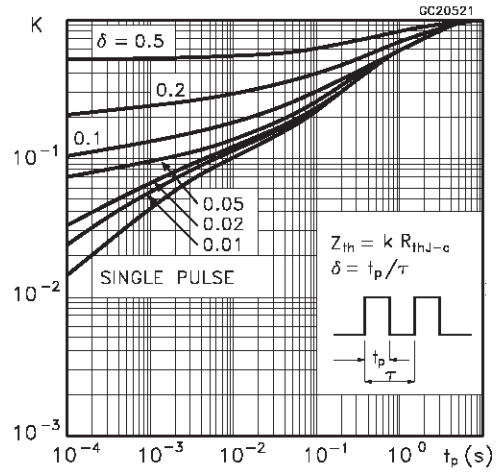


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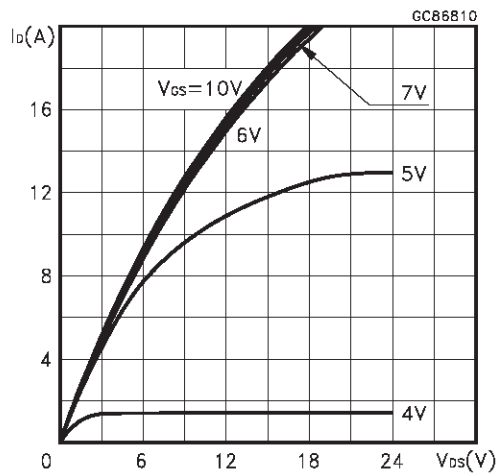
Thermal Impedance for TO-220



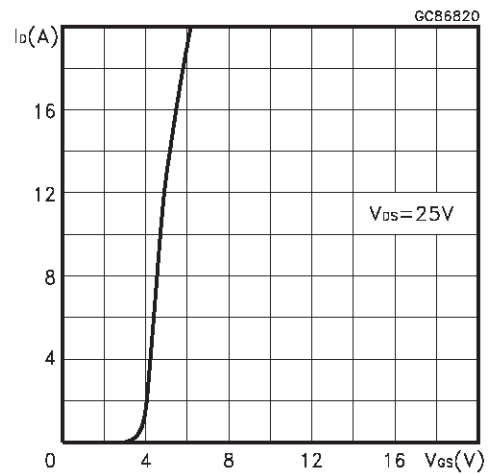
Thermal Impedance for TO-220FP



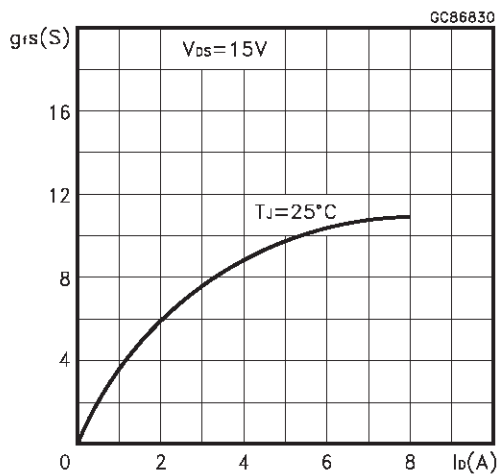
Output Characteristics



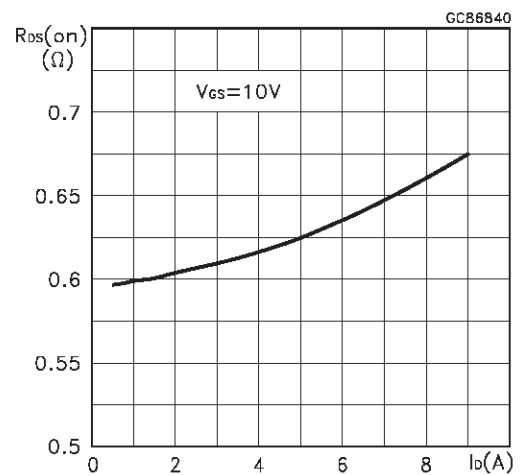
Transfer Characteristics



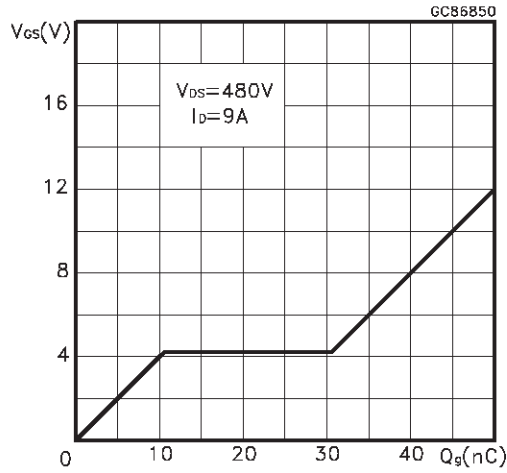
Transconductance



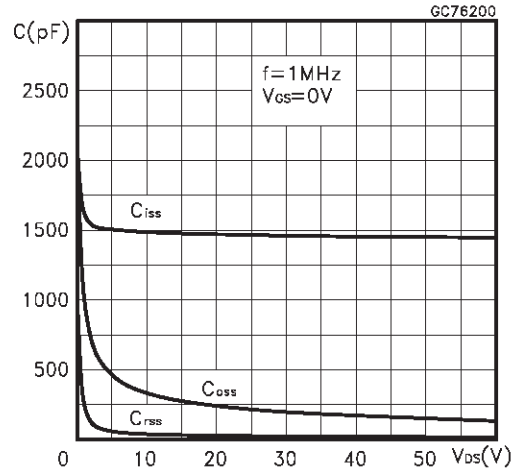
Static Drain-source On Resistance



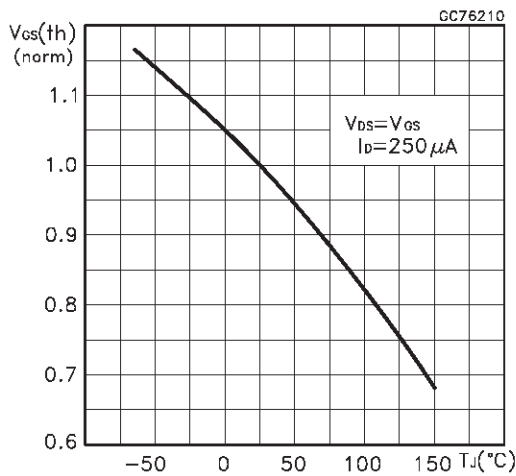
Gate Charge vs Gate-source Voltage



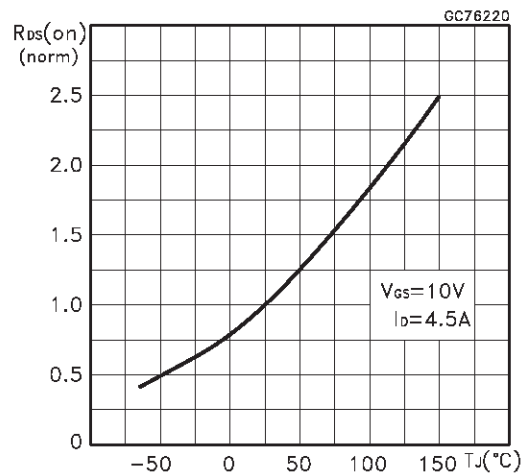
Capacitance Variations



Normalized Gate Threshold Voltage vs Temperature



Normalized On Resistance vs Temperature



Source-drain Diode Forward Characteristics

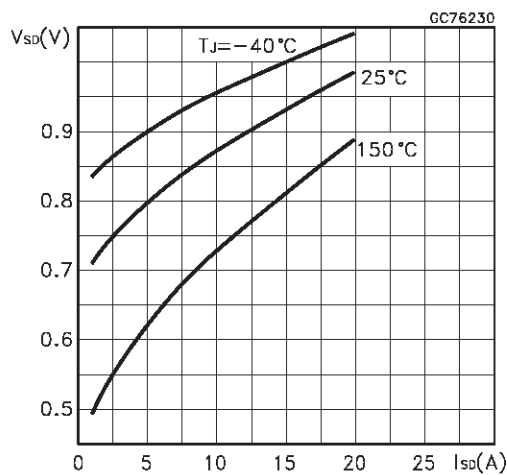


Fig. 1: Unclamped Inductive Load Test Circuit

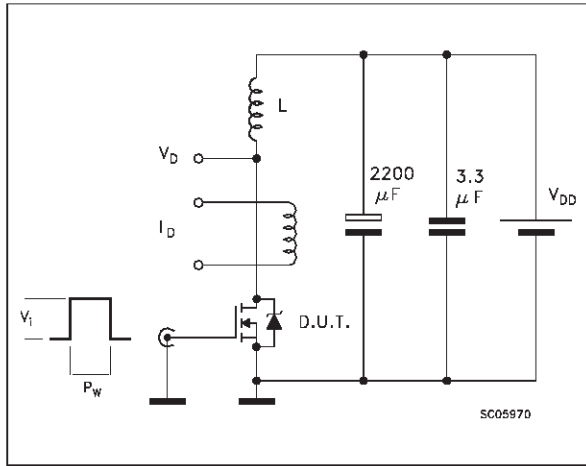


Fig. 2: Unclamped Inductive Waveform

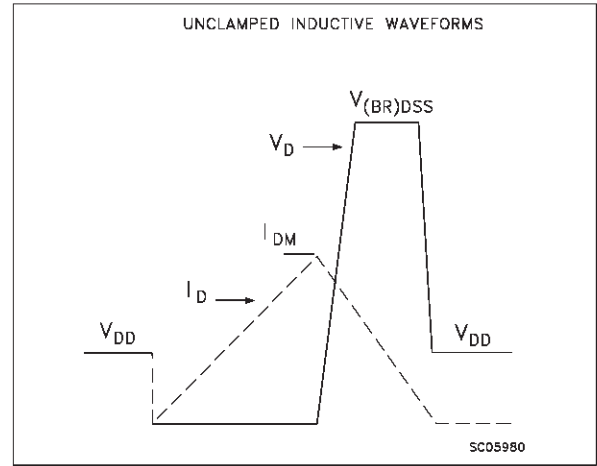


Fig. 3: Switching Times Test Circuits For Resistive Load

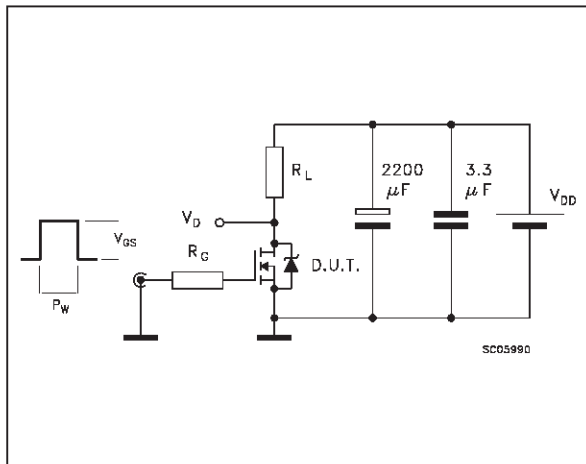


Fig. 4: Gate Charge test Circuit

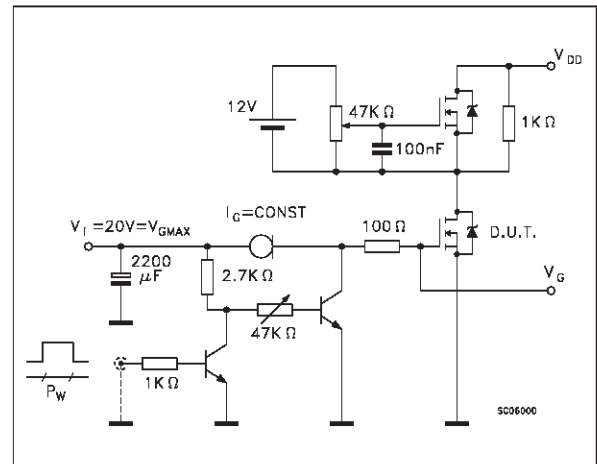
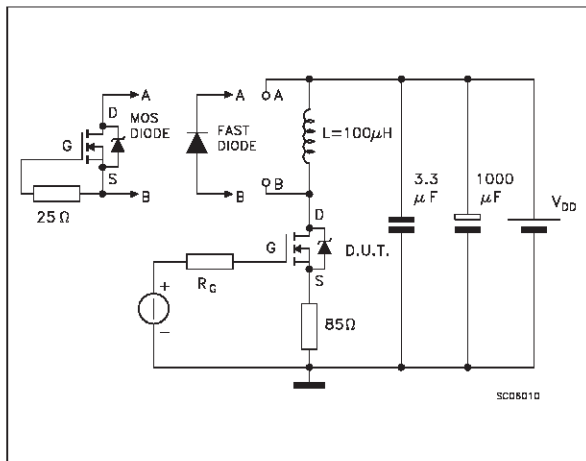
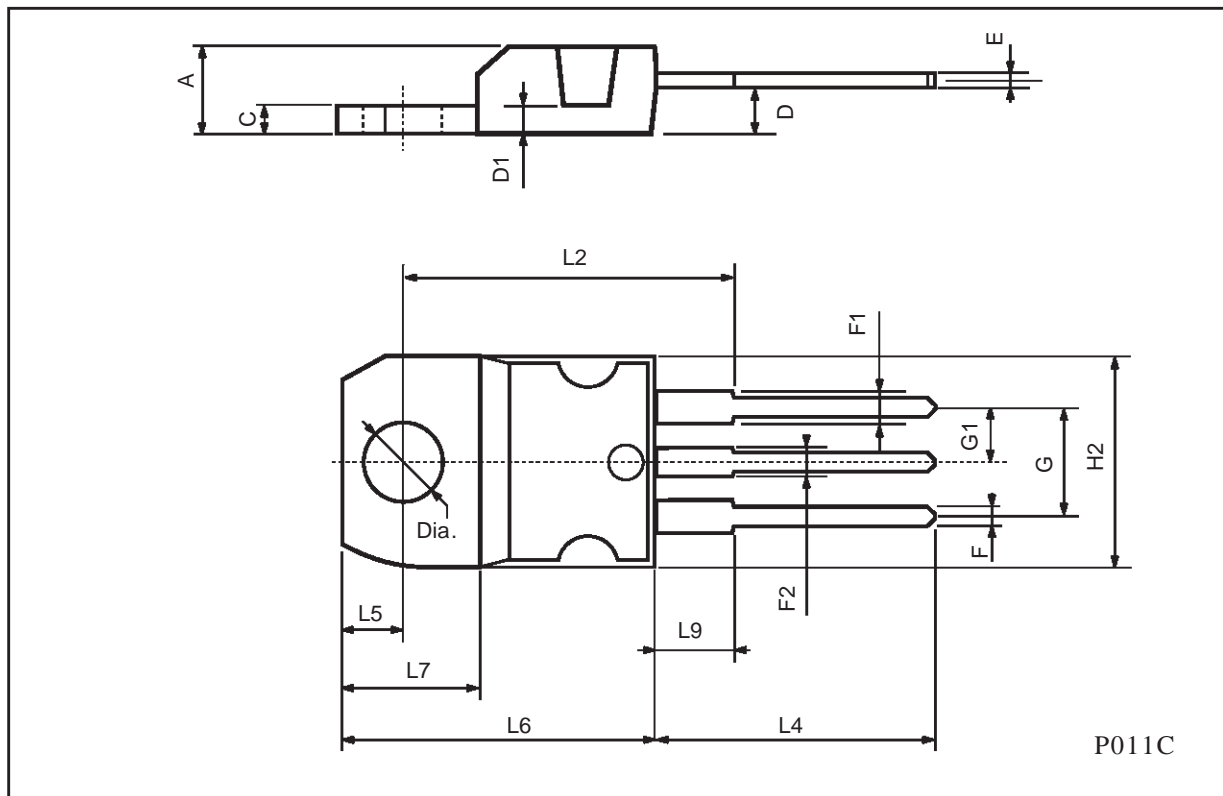


Fig. 5: Test Circuit For Inductive Load Switching And Diode Recovery Times



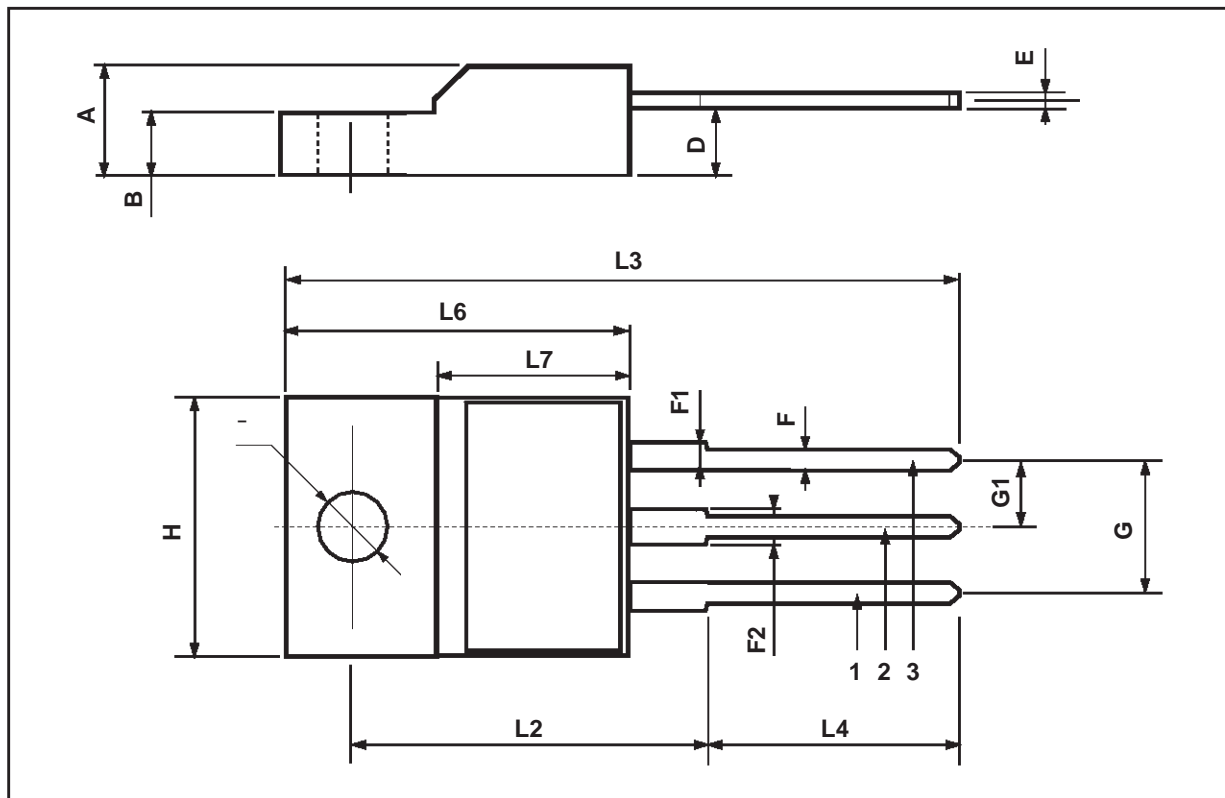
TO-220 MECHANICAL DATA

| 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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