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STMicroelectronics
VNP10N06

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# VNP10N06

## "OMNIFET":
## FULLY AUTOPROTECTED POWER MOSFET

| TYPE | $V_{clamp}$ | $R_{DS(on)}$ | $I_{lim}$ |
|---|---|---|---|
| VNP10N06 | 60 V | 0.3 Ω | 10 A |

- LINEAR CURRENT LIMITATION
- THERMAL SHUT DOWN
- SHORT CIRCUIT PROTECTION
- INTEGRATED CLAMP
- LOW CURRENT DRAWN FROM INPUT PIN
- LOGIC LEVEL INPUT THRESHOLD
- ESD PROTECTION
- SCHMITT TRIGGER ON INPUT
- HIGH NOISE IMMUNITY
- STANDARD TO-220 PACKAGE

**TO-220**

### DESCRIPTION
The VNP10N06 is a monolithic device made using STMicroelectronics  VIPower Technology, intended for replacement of standard power MOSFETS in DC to 50 KHz applications.
Built-in thermal shut-down, linear current limitation and overvoltage clamp protect  the  chip n harsh enviroments.
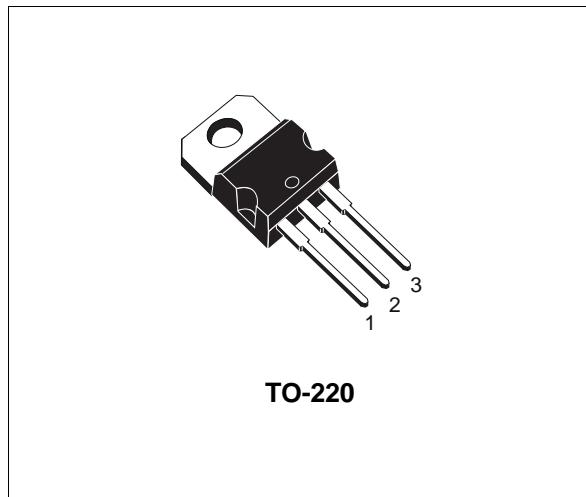
**BLOCK DIAGRAM**
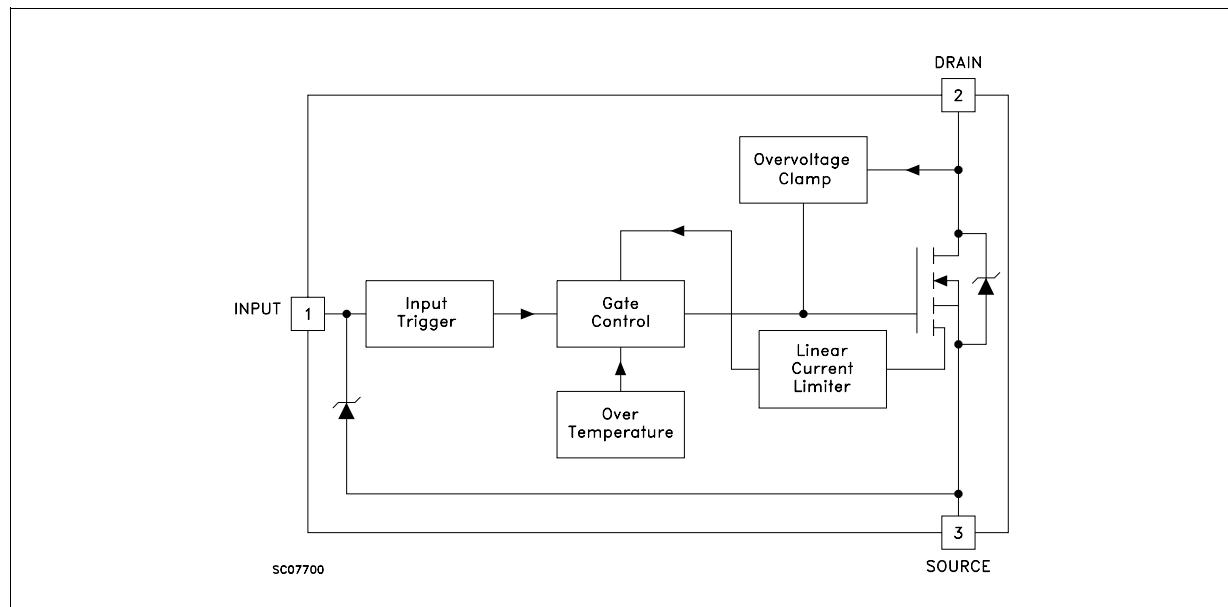
## VNP10N06

### ABSOLUTE MAXIMUM RATING

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{DS}$ | Drain-source Voltage ($V_{in}$ = 0) | Internally Clamped | V |
| $V_{in}$ | Input Voltage | Internally Clamped | V |
| $I_{in}$ | Input Current | ± 20 | mA |
| $I_D$ | Drain Current | Internally Limited | A |
| $I_R$ | Reverse DC Output Current | -15 | A |
| $V_{esd}$ | Electrostatic Discharge (C= 100 pF, R=1.5 KΩ) | 4000 | V |
| $P_{tot}$ | Total Dissipation at $T_c$ = 25 $^o$C | 42 | W |
| $T_j$ | Operating Junction Temperature | Internally Limited | $^o$C |
| $T_c$ | Case Operating Temperature | Internally Limited | $^o$C |
| $T_{stg}$ | Storage Temperature | -55 to 150 | $^o$C |

### THERMAL DATA

| | | | | |
|---|---|---|---|---|
| $R_{thj-case}$ | Thermal Resistance Junction-case | Max | 3 | $^o$C/W |
| $R_{thj-amb}$ | Thermal Resistance Junction-ambient | Max | 62.5 | $^o$C/W |

### ELECTRICAL CHARACTERISTICS ($T_{case}$ = 25 $^o$C unless otherwise specified)

OFF

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{CLAMP}$ | Drain-source Clamp Voltage | $I_D$ = 200 mA    $V_{in}$ = 0 | 50 | 60 | 70 | V |
| $V_{IL}$ | Input Low Level Voltage | $I_D$ = 100 μA    $V_{DS}$ = 16 V | | | 1.5 | V |
| $V_{IH}$ | Input High Level Voltage | $R_L$ = 27 Ω    $V_{DD}$ = 16 V $V_{DS}$ = 0.5 V | 3.2 | | | V |
| $V_{INCL}$ | Input-Source Reverse Clamp Voltage | $I_{in}$ = -1 mA $I_{in}$ =  1 mA | -1 8 | | -0.3 11 | V V |
| $I_{DSS}$ | Zero Input Voltage Drain Current ($V_{in}$ = 0) | $V_{DS}$ = 50 V    $V_{in}$ = $V_{IL}$ $V_{DS}$ < 35 V    $V_{in}$ = $V_{IL}$ | | | 250 100 | μA μA |
| $I_{ISS}$ | Supply Current from Input Pin | $V_{DS}$ = 0 V    $V_{in}$ = 5 V | | 150 | 300 | μA |

ON (∗)

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $R_{DS(on)}$ | Static Drain-source On Resistance | $V_{in}$ = 7 V      $I_D$ = 1 A   $T_J$ < 125 $^o$C | | 0.15 | 0.3 | Ω |

DYNAMIC

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $C_{oss}$ | Output Capacitance | $V_{DS}$ = 13 V    f = 1 MHz    $V_{in}$ = 0 | | 350 | 500 | pF |

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## ELECTRICAL CHARACTERISTICS (continued)

### SWITCHING (∗∗)

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|--------|-----------|-----------------|------|------|------|------|
| $t_{d(on)}$<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 | $V_{DD}$ = 16 V $\quad$ $I_d$ = 1 A<br>$V_{gen}$ = 7 V $\quad$ $R_{gen}$ = 10 Ω<br>(see figure 3) | | 1100<br>550<br>200<br>100 | 1600<br>900<br>400<br>200 | ns<br>ns<br>ns<br>ns |
| $t_{d(on)}$<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 | $V_{DD}$ = 16 V $\quad$ $I_d$ = 1 A<br>$V_{gen}$ = 7 V $\quad$ $R_{gen}$ = 1000 Ω<br>(see figure 3) | | 1.2<br>1<br>1.6<br>1.2 | 1.8<br>1.5<br>2.3<br>1.8 | μs<br>μs<br>μs<br>μs |
| $(di/dt)_{on}$ | Turn-on Current Slope | $V_{DD}$ = 16 V $\quad$ $I_D$ = 1 A<br>$V_{in}$ = 7 V $\quad$ $R_{gen}$ = 10 Ω | | 1.5 | | A/μs |
| $Q_i$ | Total Input Charge | $V_{DD}$ = 12 V $\quad$ $I_D$ = 1 A $\quad$ $V_{in}$ = 7 V | | 13 | | nC |

### SOURCE DRAIN DIODE

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|--------|-----------|-----------------|------|------|------|------|
| $V_{SD}$ (∗) | Forward On Voltage | $I_{SD}$ = 1 A $\quad$ $V_{in}$ = $V_{IL}$ | | 0.8 | 1.6 | V |
| $t_{rr}$ (∗∗) | Reverse Recovery Time | $I_{SD}$ = 1 A $\quad$ di/dt = 100 A/μs<br>$V_{DD}$ = 30 V $\quad$ $T_j$ = 25 °C<br>(see test circuit, figure 5) | | 125 | | ns |
| $Q_{rr}$ (∗∗) | Reverse Recovery Charge | | | 0.22 | | μC |
| $I_{RRM}$ (∗∗) | Reverse Recovery Current | | | 3.5 | | A |

### PROTECTION

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|--------|-----------|-----------------|------|------|------|------|
| $I_{lim}$ | Drain Current Limit | $V_{in}$ = 7 V $\quad$ $V_{DS}$ = 13 V | 6 | 10 | 15 | A |
| $t_{dlim}$ (∗∗) | Step Response Current Limit | $V_{in}$ = 7 V $\quad$ $V_{DS}$ step from 0 to 13 V | | 12 | 20 | μs |
| $T_{jsh}$ (∗∗) | Overtemperature Shutdown | | 150 | | | °C |
| $T_{jrs}$ (∗∗) | Overtemperature Reset | | 135 | | | °C |
| $E_{as}$ (∗∗) | Single Pulse Avalanche Energy | starting $T_j$ = 25 °C $\quad$ $V_{DD}$ = 24 V<br>$V_{in}$ = 7 V $\quad$ $R_{gen}$ = 1 KΩ $\quad$ L = 10 mH | 250 | | | mJ |

(∗) Pulsed: Pulse duration = 300 μs, duty cycle 1.5 %
(∗∗) Parameters guaranteed by design/characterization

## VNP10N06

**PROTECTION FEATURES**

During Normal Operation, the INPUT pin is electrically connected to the gate of the internal power MOSFET through a low impedance path as soon as $V_{IN} > V_{IH}$.

The device then behaves like a standard power MOSFET and can be used as a switch from DC to 50KHz. The only difference from the user's standpoint is that a small DC current (typically 150 $\mu$A) flows into the INPUT pin in order to supply the internal circuitry.

During turn-off of an unclamped inductive load the output voltage is clamped to a safe level by an integrated Zener clamp between DRAIN pin and the gate of the internal Power MOSFET.

In this condition, the Power MOSFET gate is set to a voltage high enough to sustain the inductive load current even if the INPUT pin is driven to 0V.

The device integrates an active current limiter circuit which limits the drain current $I_D$ to $I_{lim}$ whatever the INPUT pin Voltage.

When the current limiter is active, the device operates in the linear region, so power dissipation may exceed the heatsinking capability. Both case and junction temperatures increase, and if this phase lasts long enough, junction temperature may reach the overtemperature threshold $T_{jsh}$.

If $T_j$ reaches $T_{jsh}$, the device shuts down whatever the INPUT pin voltage. The device will restart automatically when $T_j$ has cooled down to $T_{jrs}$

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Thermal Impedance
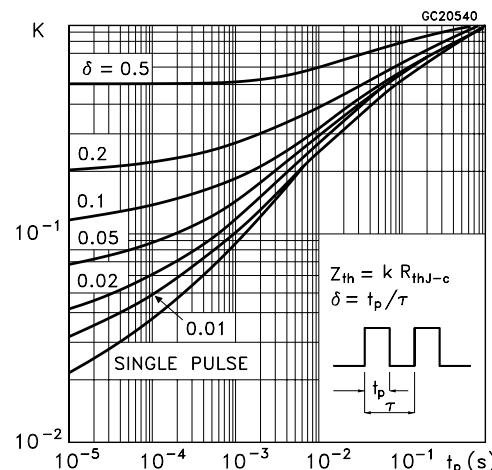


Derating Curve
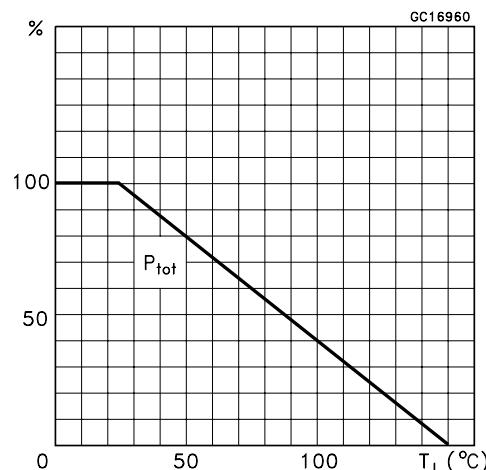


Output Characteristics
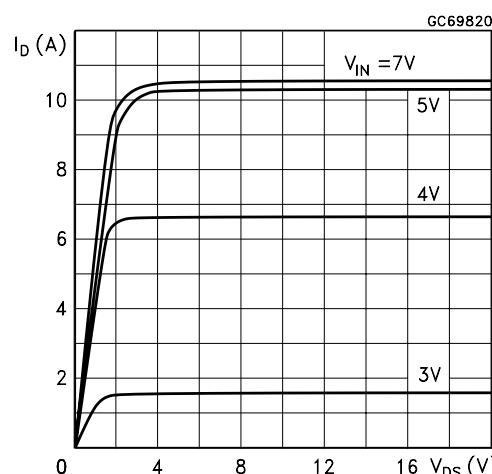


Static Drain-Source On Resistance vs Input Voltage
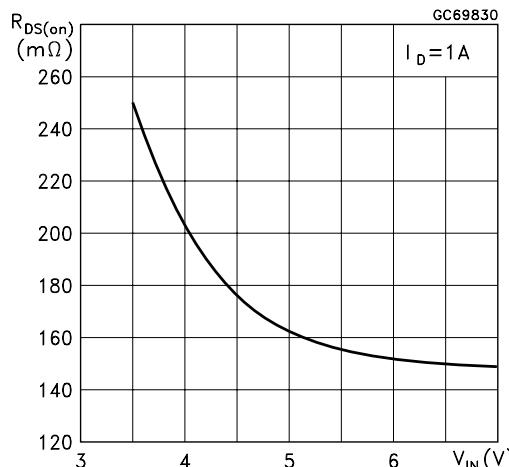


Static Drain-Source On Resistance
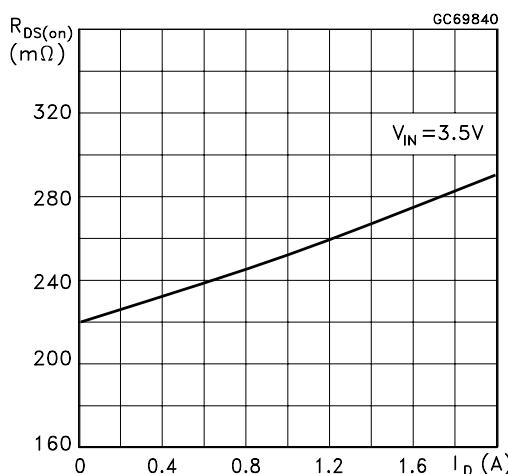


Static Drain-Source On Resistance
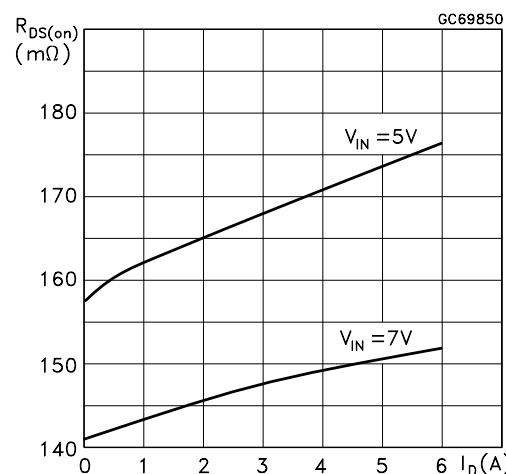
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Input Charge vs Input Voltage
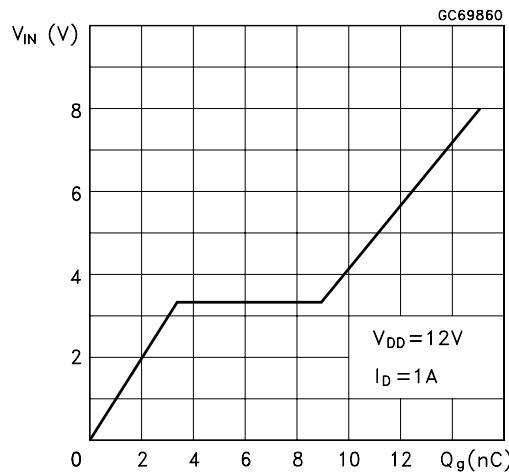


Capacitance Variations
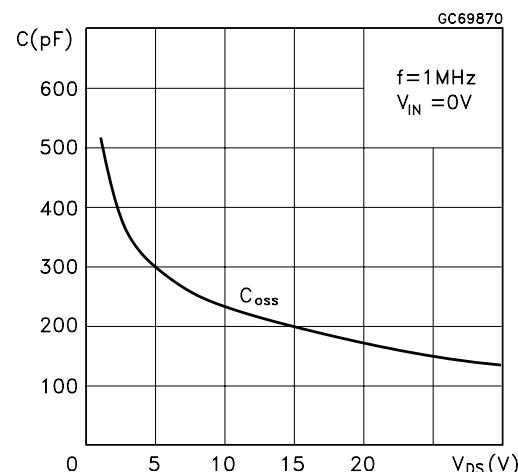


Normalized Input Threshold Voltage vs Temperature
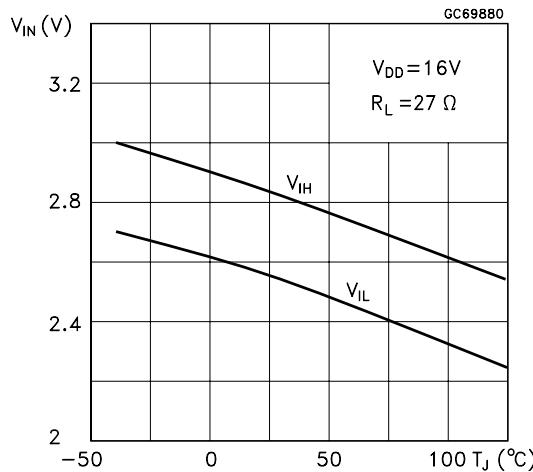


Normalized On Resistance vs Temperature
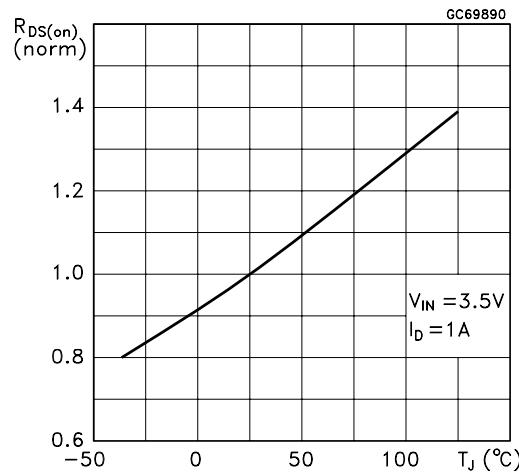


Normalized On Resistance vs Temperature
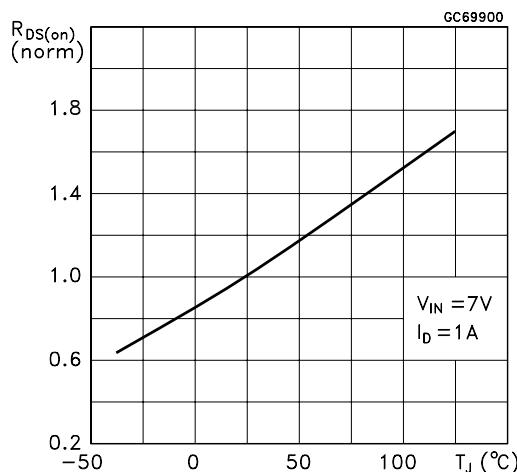


Turn-on Current Slope
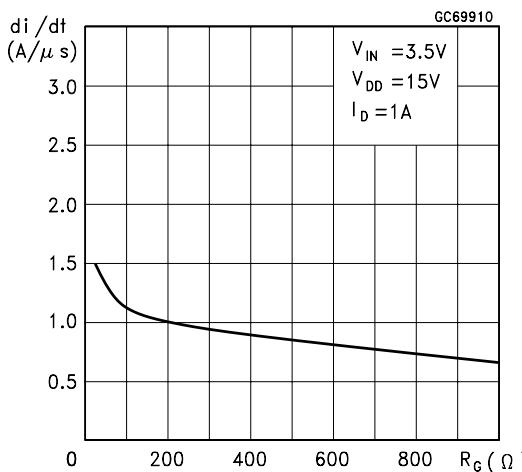
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Turn-on Current Slope
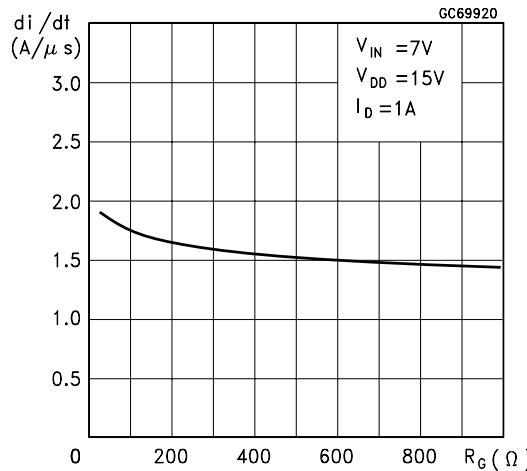


Turn-off Drain-Source Voltage Slope
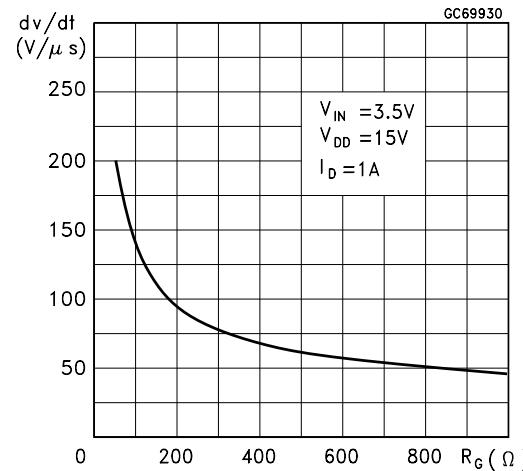


Turn-off Drain-Source Voltage Slope
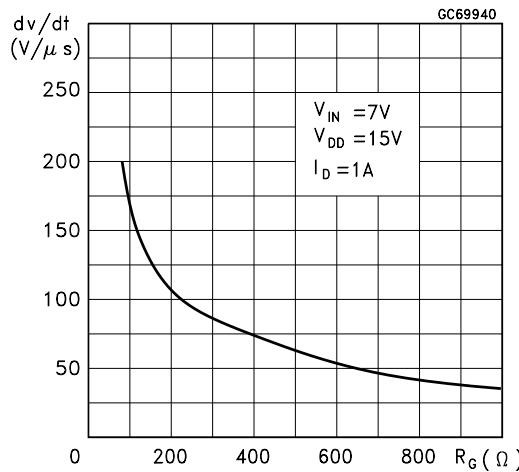


Switching Time Resistive Load
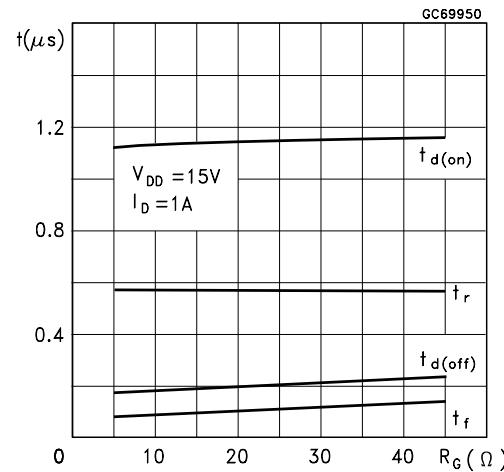


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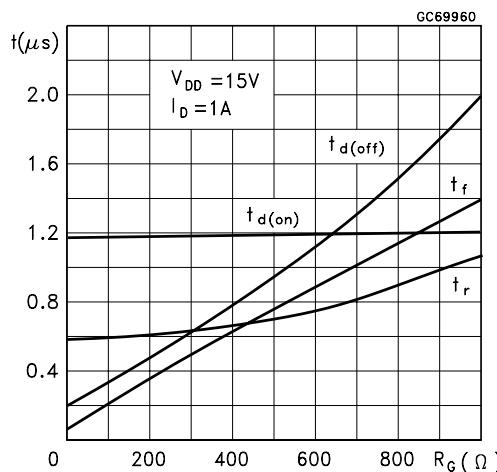


Switching Time Resistive Load
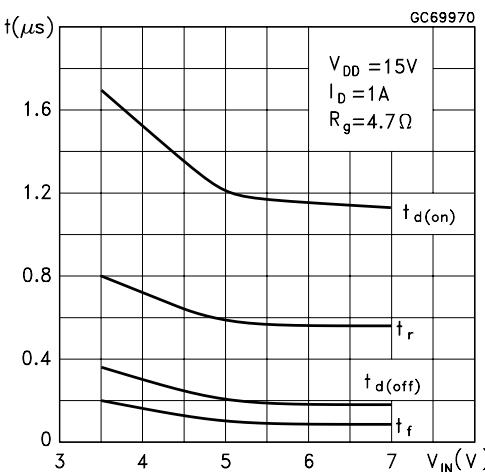
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Current Limit vs Junction Temperature
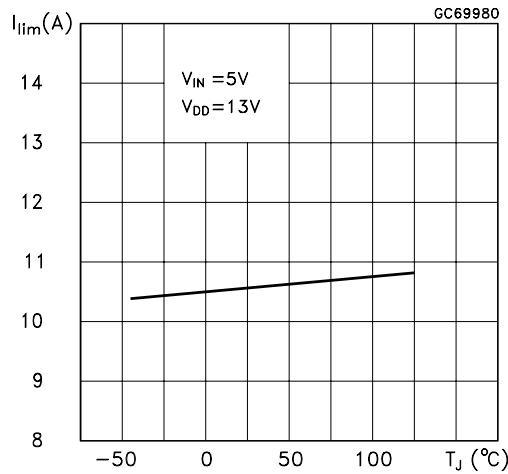


Step Response Current Limit
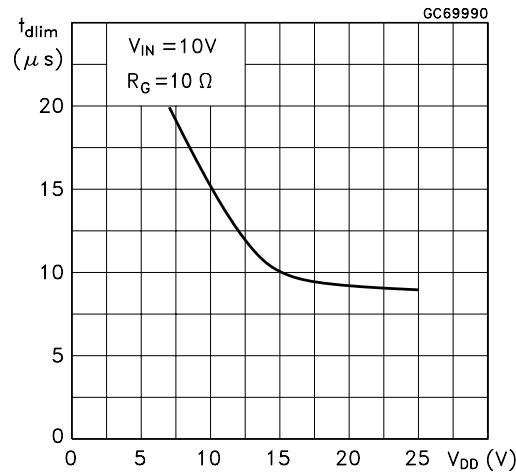


Source Drain Diode Voltage vs Junction Temperature
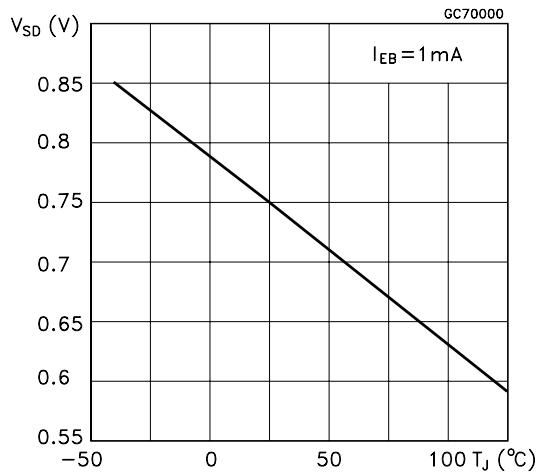
**Fig. 1:** Unclamped Inductive Load Test Circuits
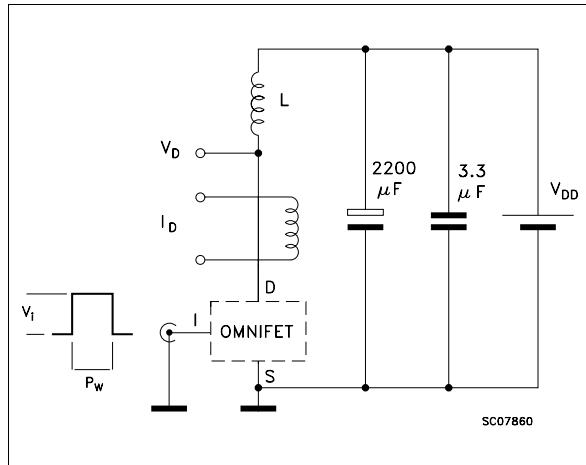


**Fig. 2:** Unclamped Inductive Waveforms
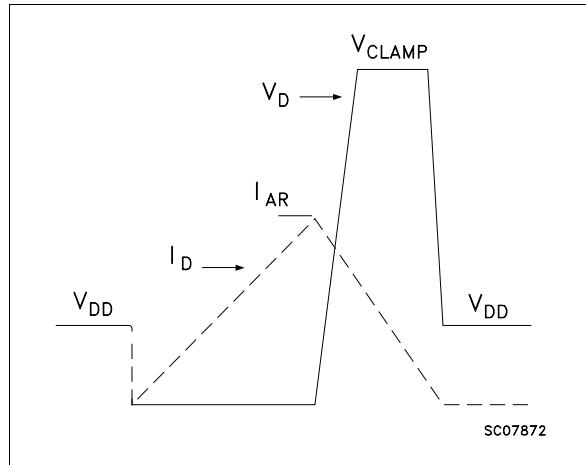


**Fig. 3:** Switching Times Test Circuits For Resistive Load
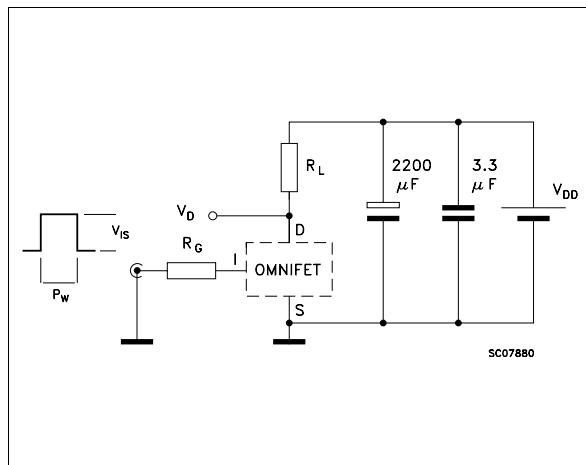


**Fig. 4:** Input Charge Test Circuit
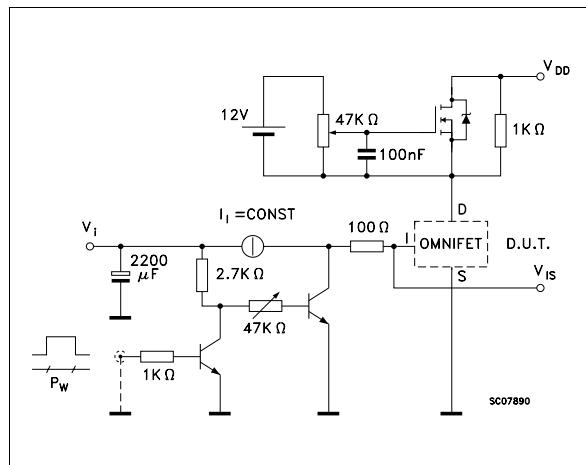


**Fig. 5:** Test Circuit For Inductive Load Switching And Diode Recovery Times
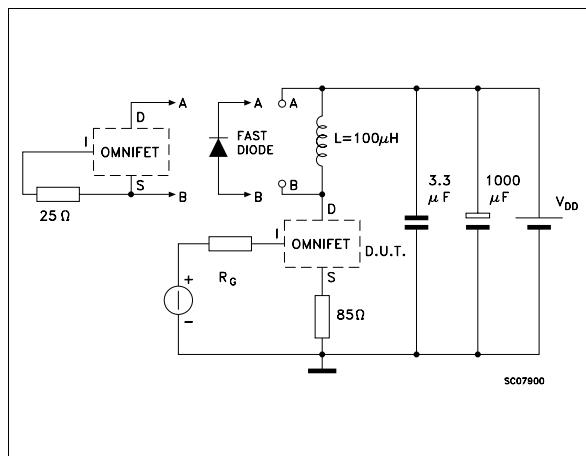


**Fig. 6:** Waveforms
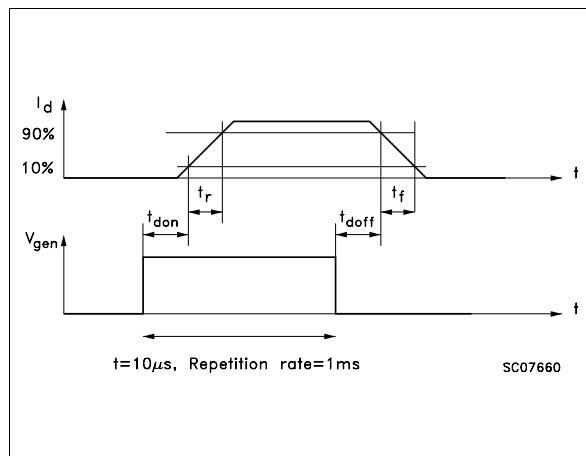
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## TO-220 MECHANICAL DATA

| DIM. | mm. | | |
|---|---|---|---|
| | MIN. | TYP | MAX. |
| A | 4.40 | | 4.60 |
| b | 0.61 | | 0.88 |
| b1 | 1.15 | | 1.70 |
| c | 0.49 | | 0.70 |
| D | 15.25 | | 15.75 |
| E | 10 | | 10.40 |
| e | 2.40 | | 2.70 |
| e1 | 4.95 | | 5.15 |
| F | 1.23 | | 1.32 |
| H1 | 6.20 | | 6.60 |
| J1 | 2.40 | | 2.72 |
| L | 13 | | 14 |
| L1 | 3.50 | | 3.93 |
| L20 | | 16.40 | |
| L30 | | 28.90 | |
| $\varnothing$P | 3.75 | | 3.85 |
| Q | 2.65 | | 2.95 |
| Package Weight | 1.9Gr. (Typ.) | | |
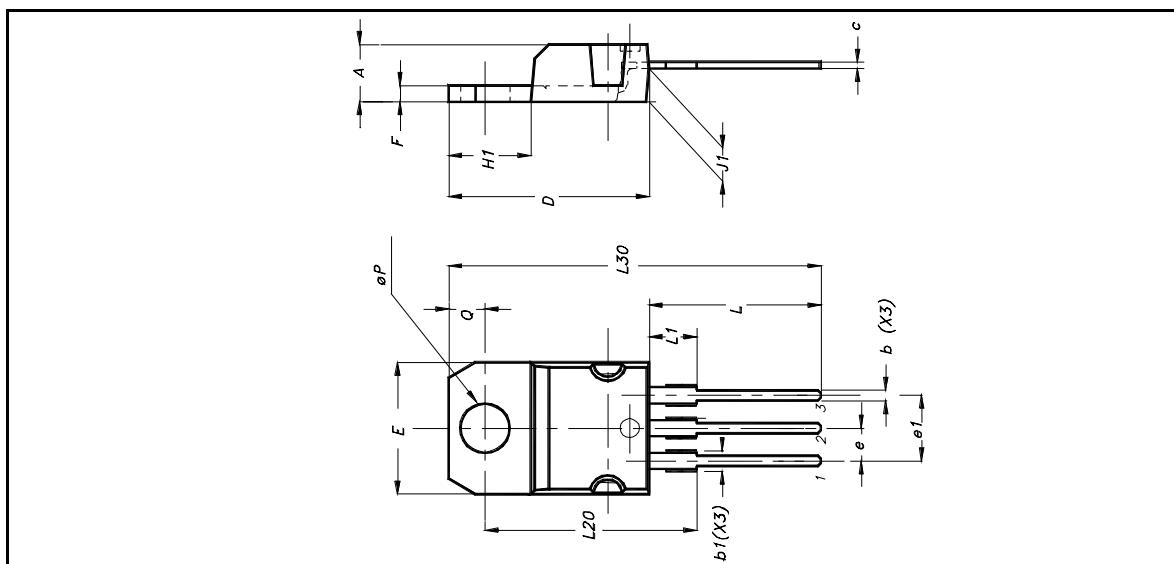
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