



## VNP10N06

### "OMNIFET": FULLY AUTOPROTECTED POWER MOSFET

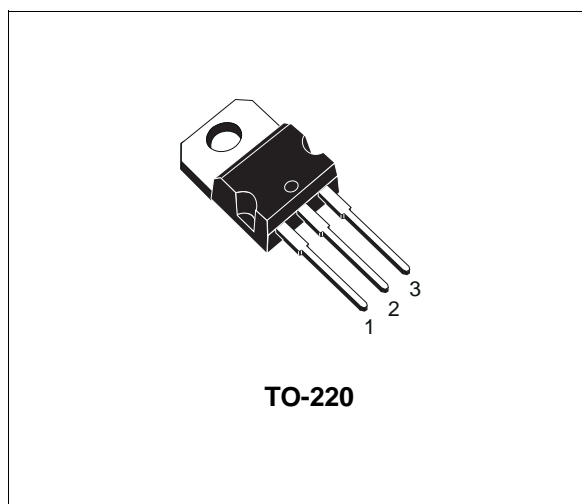
TYPE	V <sub>clamp</sub>	R <sub>DS(on)</sub>	I <sub>lim</sub>
VNP10N06	60 V	0.3 Ω	10 A

- 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

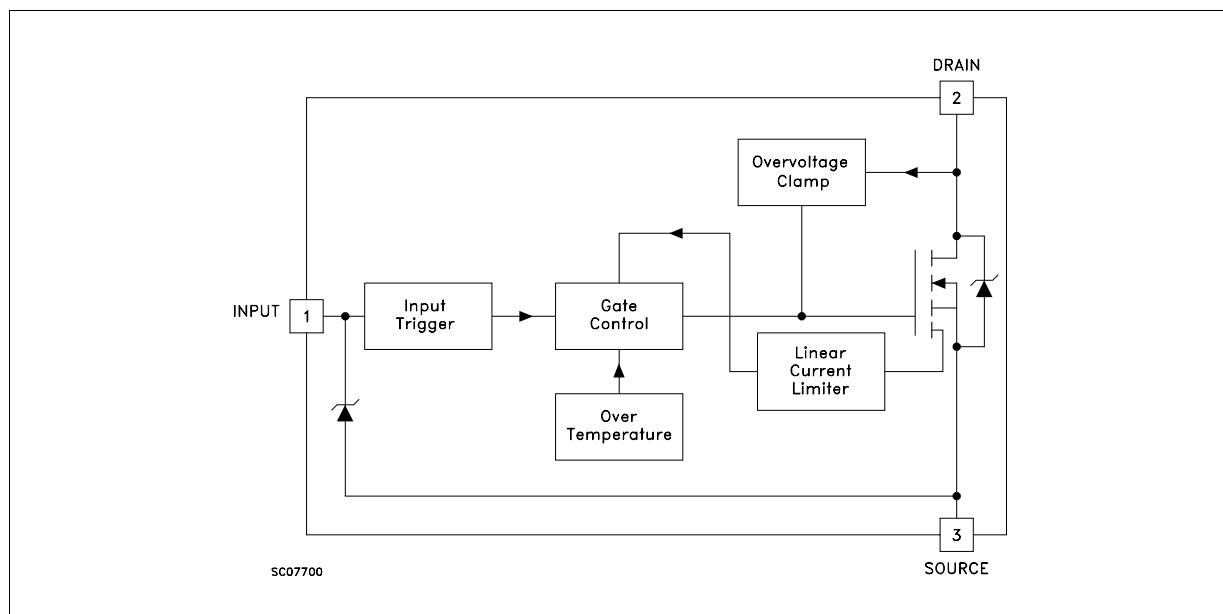
#### DESCRIPTION

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 in harsh environments.



#### 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	$\pm 20$	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 K $\Omega$ )	4000	V
$P_{tot}$	Total Dissipation at $T_c = 25^\circ\text{C}$	42	W
$T_j$	Operating Junction Temperature	Internally Limited	$^\circ\text{C}$
$T_c$	Case Operating Temperature	Internally Limited	$^\circ\text{C}$
$T_{stg}$	Storage Temperature	-55 to 150	$^\circ\text{C}$

### THERMAL DATA

$R_{thj-case}$	Thermal Resistance Junction-case	Max	3	$^\circ\text{C/W}$
$R_{thj-amb}$	Thermal Resistance Junction-ambient	Max	62.5	$^\circ\text{C/W}$

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

#### OFF

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

#### ON (\*)

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

### DYNAMIC

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

**ELECTRICAL CHARACTERISTICS** (continued)**SWITCHING (\*\*)**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on Delay Time	$V_{DD} = 16\text{ V}$ $I_d = 1\text{ A}$		1100	1600	ns
$t_r$	Rise Time	$V_{gen} = 7\text{ V}$ $R_{gen} = 10\ \Omega$		550	900	ns
$t_{d(off)}$	Turn-off Delay Time	(see figure 3)		200	400	ns
$t_f$	Fall Time			100	200	ns
$t_{d(on)}$	Turn-on Delay Time	$V_{DD} = 16\text{ V}$ $I_d = 1\text{ A}$		1.2	1.8	$\mu\text{s}$
$t_r$	Rise Time	$V_{gen} = 7\text{ V}$ $R_{gen} = 1000\ \Omega$		1	1.5	$\mu\text{s}$
$t_{d(off)}$	Turn-off Delay Time	(see figure 3)		1.6	2.3	$\mu\text{s}$
$t_f$	Fall Time			1.2	1.8	$\mu\text{s}$
$(di/dt)_{on}$	Turn-on Current Slope	$V_{DD} = 16\text{ V}$ $I_D = 1\text{ A}$ $V_{in} = 7\text{ V}$ $R_{gen} = 10\ \Omega$		1.5		A/ $\mu\text{s}$
$Q_i$	Total Input Charge	$V_{DD} = 12\text{ V}$ $I_D = 1\text{ A}$ $V_{in} = 7\text{ V}$		13		nC

**SOURCE DRAIN DIODE**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{SD} (*)$	Forward On Voltage	$I_{SD} = 1\text{ A}$ $V_{in} = V_{IL}$		0.8	1.6	V
$t_{rr} (**)$	Reverse Recovery Time	$I_{SD} = 1\text{ A}$ $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 30\text{ V}$ $T_j = 25\text{ }^\circ\text{C}$		125		ns
$Q_{rr} (**)$	Reverse Recovery Charge	(see test circuit, figure 5)		0.22		$\mu\text{C}$
$I_{RRM} (**)$	Reverse Recovery Current			3.5		A

**PROTECTION**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$I_{lim}$	Drain Current Limit	$V_{in} = 7\text{ V}$ $V_{DS} = 13\text{ V}$	6	10	15	A
$t_{dlim} (**)$	Step Response Current Limit	$V_{in} = 7\text{ V}$ $V_{DS}$ step from 0 to 13 V		12	20	$\mu\text{s}$
$T_{jsh} (**)$	Overtemperature Shutdown		150			$^\circ\text{C}$
$T_{jrs} (**)$	Overtemperature Reset		135			$^\circ\text{C}$
$E_{as} (**)$	Single Pulse Avalanche Energy	starting $T_j = 25\text{ }^\circ\text{C}$ $V_{DD} = 24\text{ V}$ $V_{in} = 7\text{ V}$ $R_{gen} = 1\text{ K}\Omega$ $L = 10\text{ mH}$	250			mJ

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

(\*\*) Parameters guaranteed by design/characterization

### 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

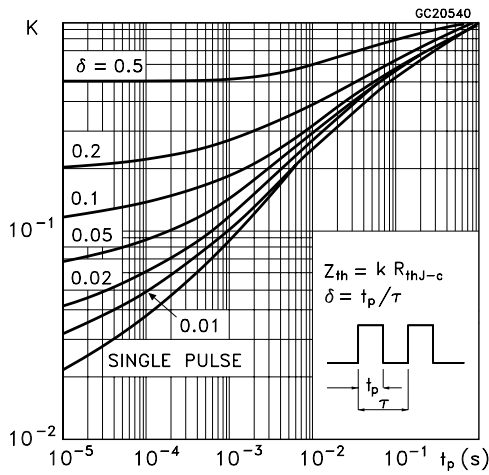
to a voltage high enough to sustain the inductive load current even if the INPUT pin is driven to 0V.

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

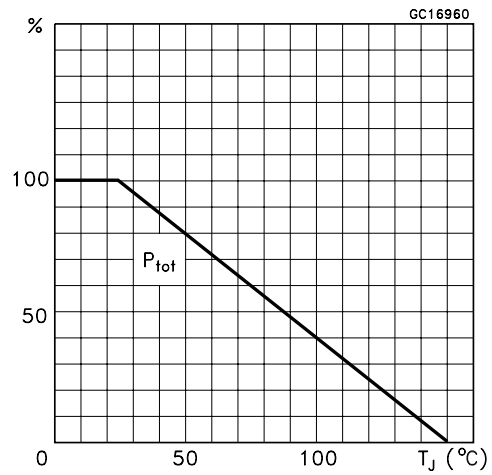
When the current limiter is active, the device operates in the linear region, so power dissipation may exceed the heatsinking capability. Both case and junction temperatures increase, and if this phase lasts long enough, junction temperature may reach the overtemperature threshold  $T_{jsh}$ .

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  $T_{jrs}$

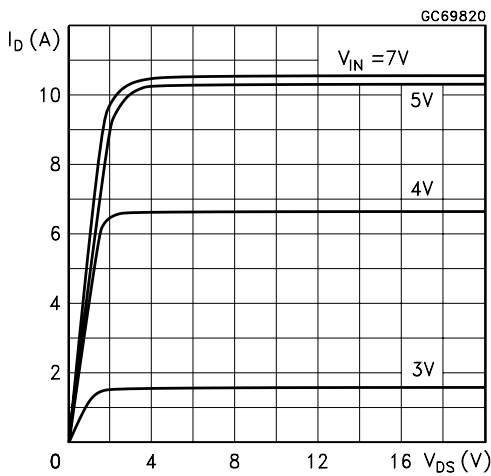
Thermal Impedance



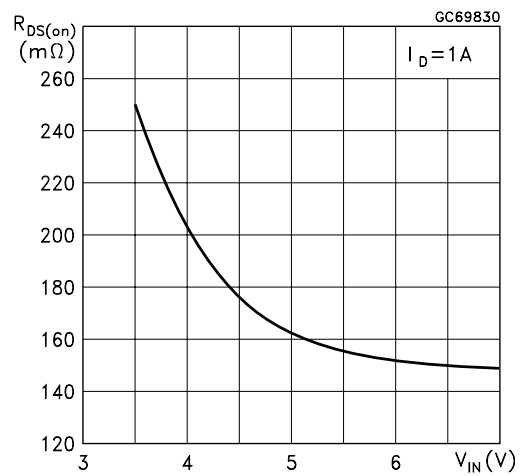
Derating Curve



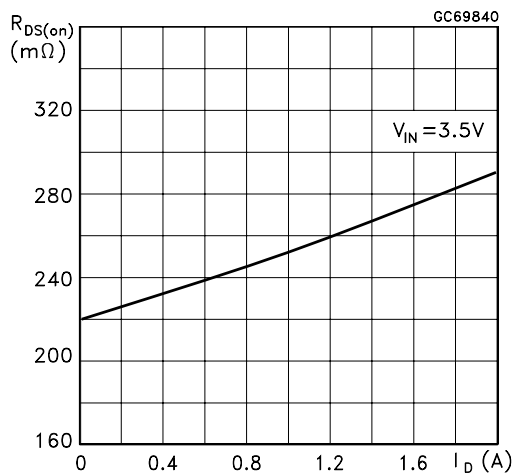
Output Characteristics



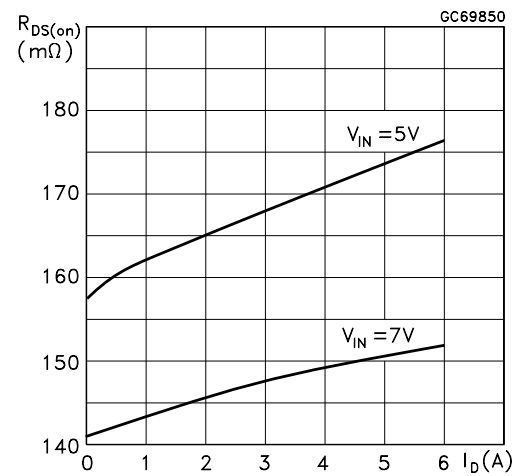
Static Drain-Source On Resistance vs Input Voltage



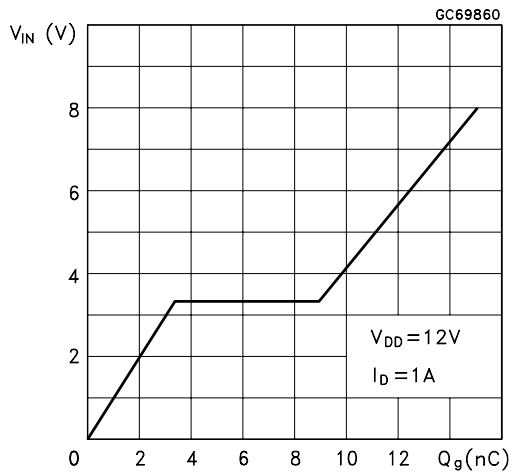
Static Drain-Source On Resistance



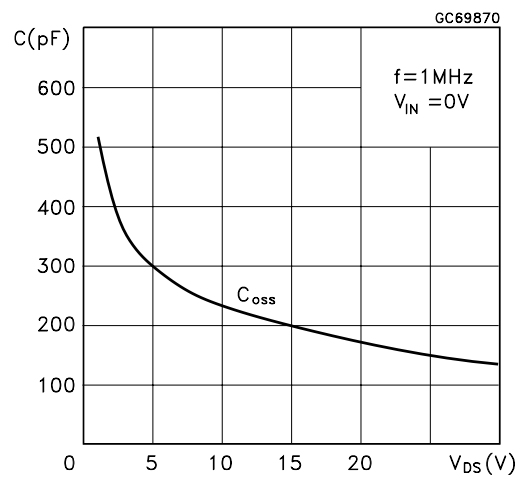
Static Drain-Source On Resistance



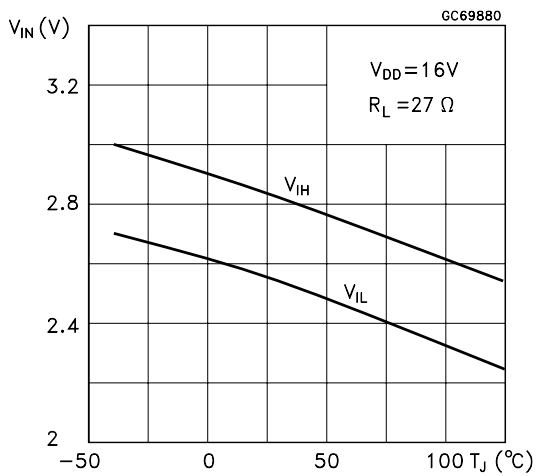
Input Charge vs Input Voltage



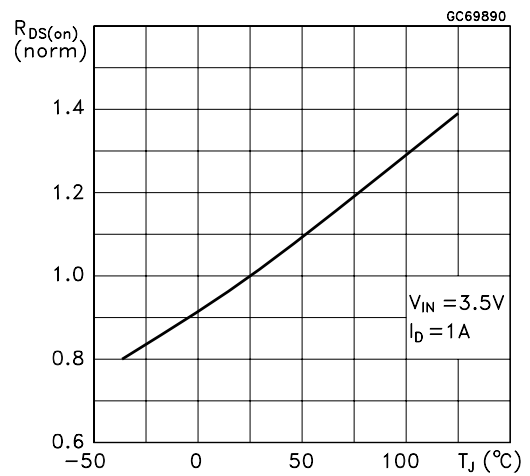
Capacitance Variations



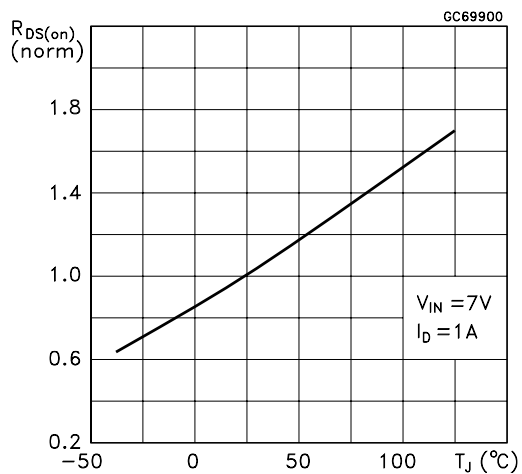
Normalized Input Threshold Voltage vs Temperature



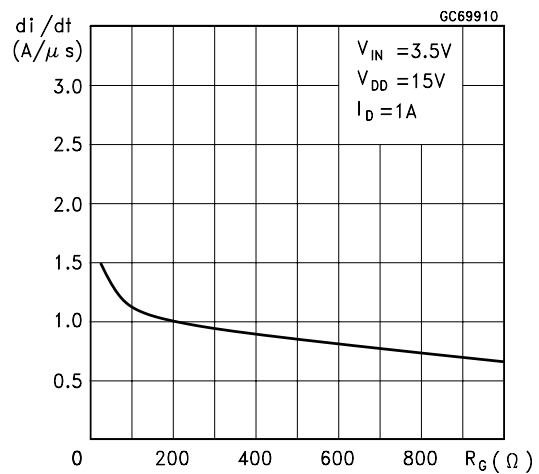
Normalized On Resistance vs Temperature



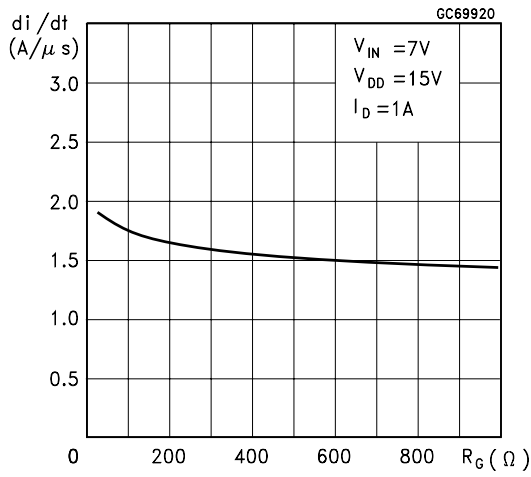
Normalized On Resistance vs Temperature



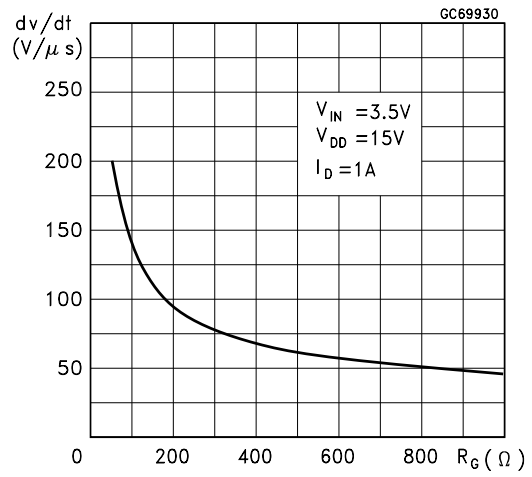
Turn-on Current Slope



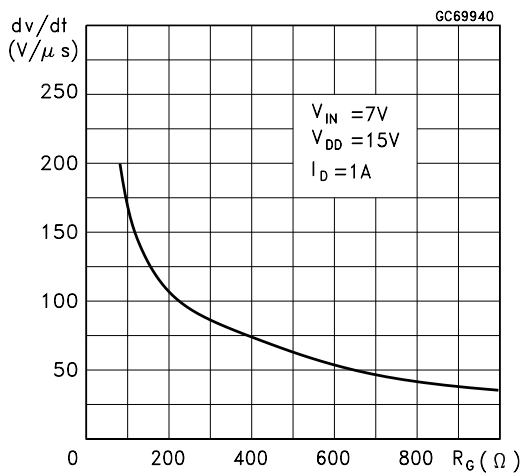
Turn-on Current Slope



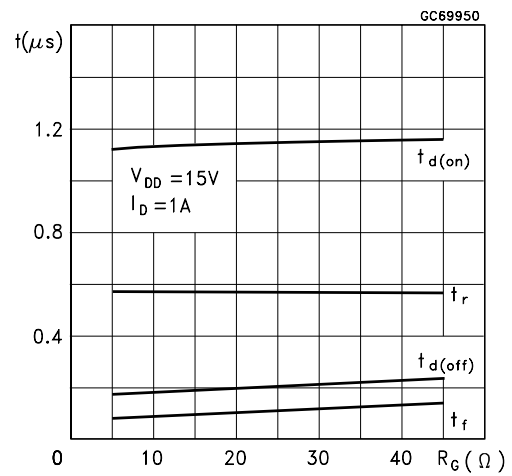
Turn-off Drain-Source Voltage Slope



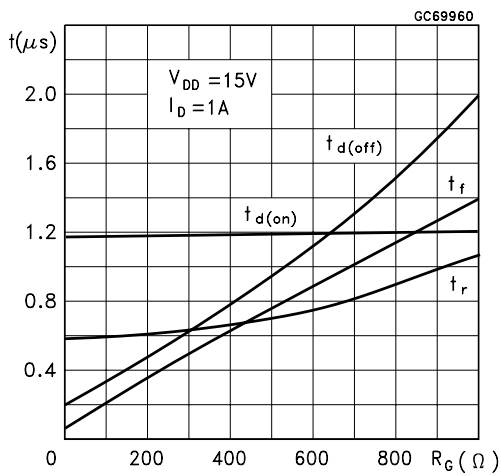
Turn-off Drain-Source Voltage Slope



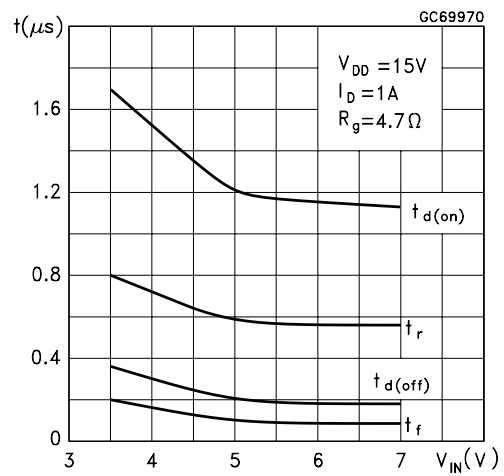
Switching Time Resistive Load



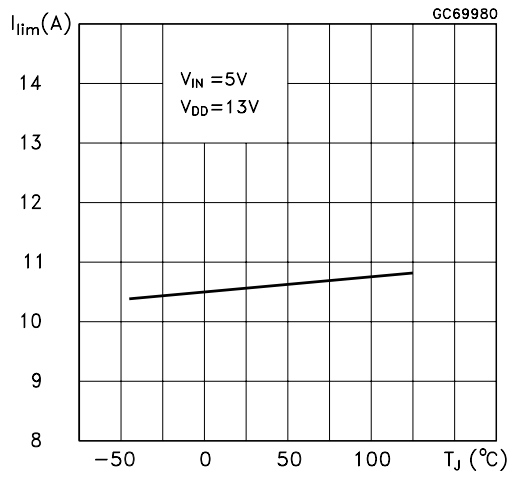
Switching Time Resistive Load



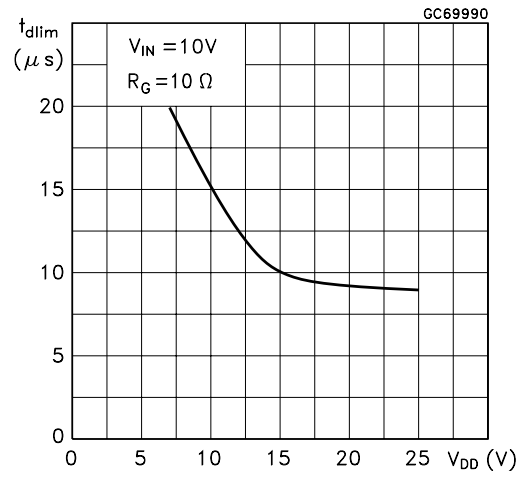
Switching Time Resistive Load



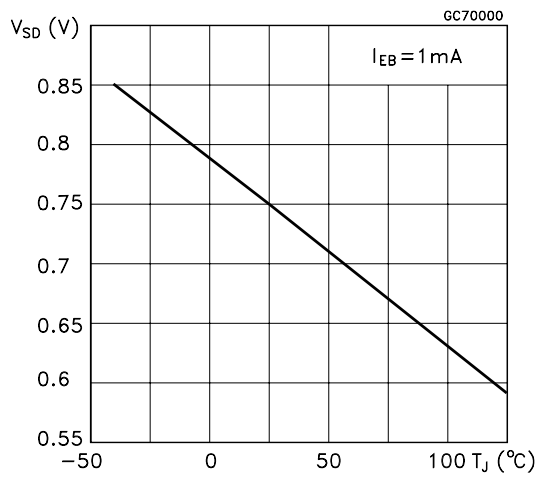
Current Limit vs Junction Temperature



Step Response Current Limit

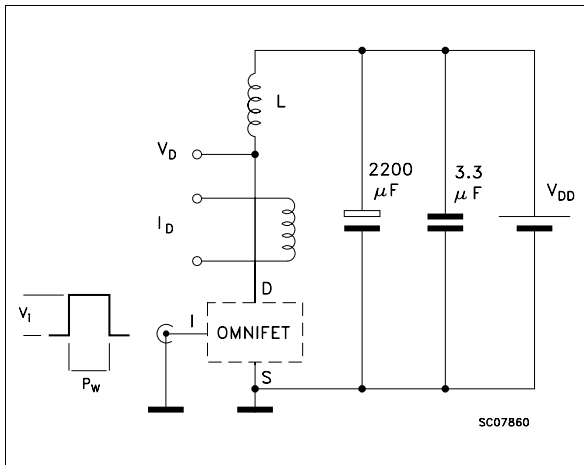


Source Drain Diode Voltage vs Junction Temperature

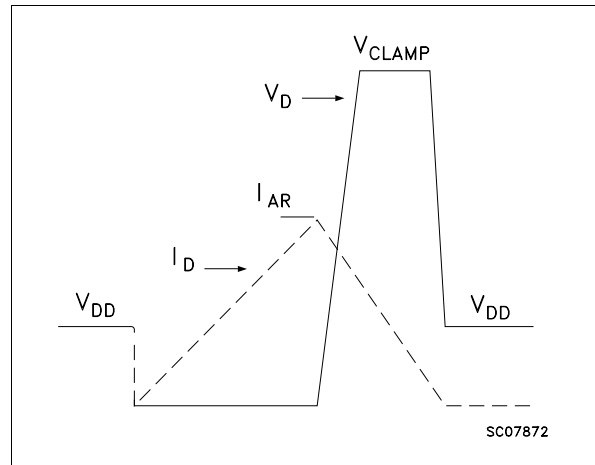




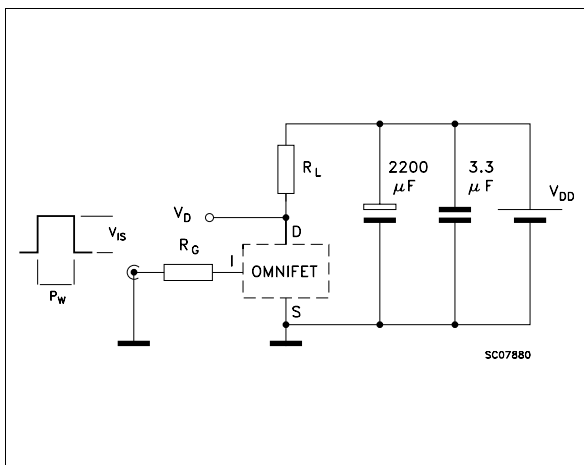
**Fig. 1: Unclamped Inductive Load Test Circuits**



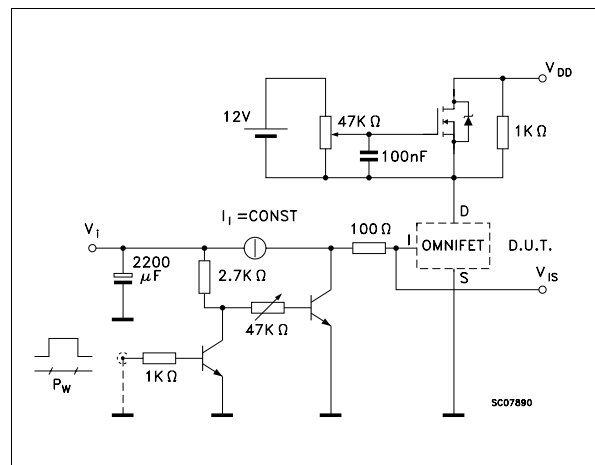
**Fig. 2: Unclamped Inductive Waveforms**



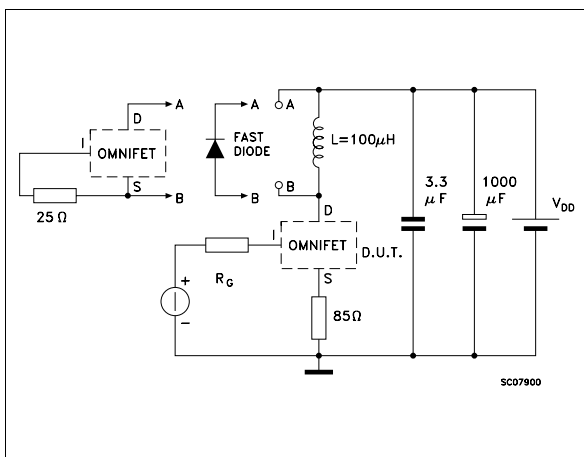
**Fig. 3: Switching Times Test Circuits For Resistive Load**



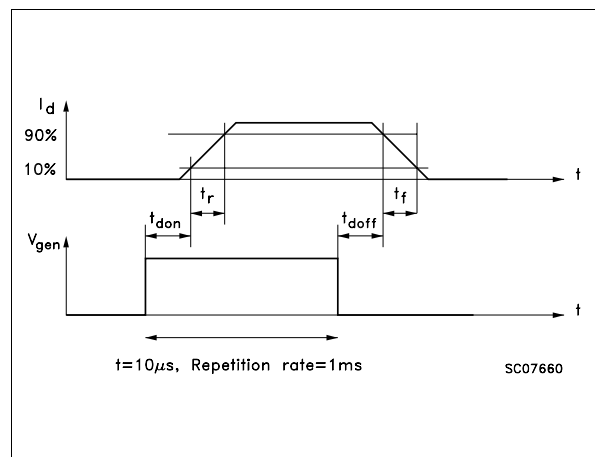
**Fig. 4: Input Charge Test Circuit**



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

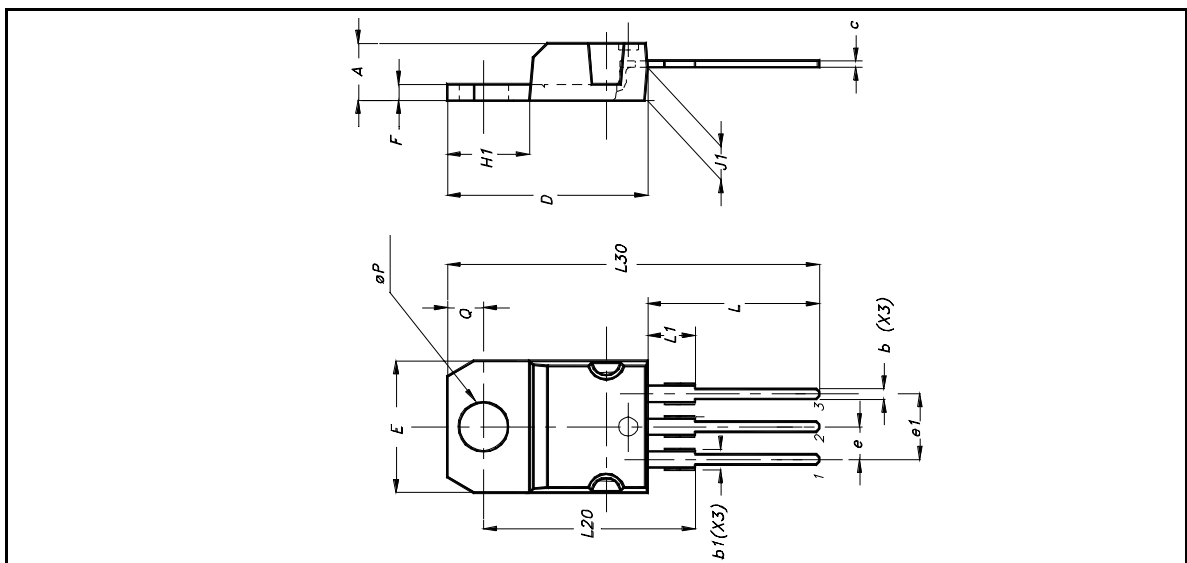


**Fig. 6: Waveforms**



**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	
ØP	3.75		3.85
Q	2.65		2.95
Package Weight	1.9Gr. (Typ.)		



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