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

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.

TO-220

BLOCK DIAGRAM

SC07700
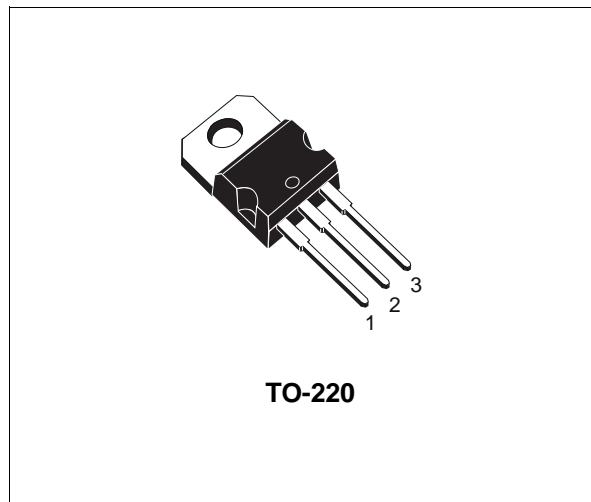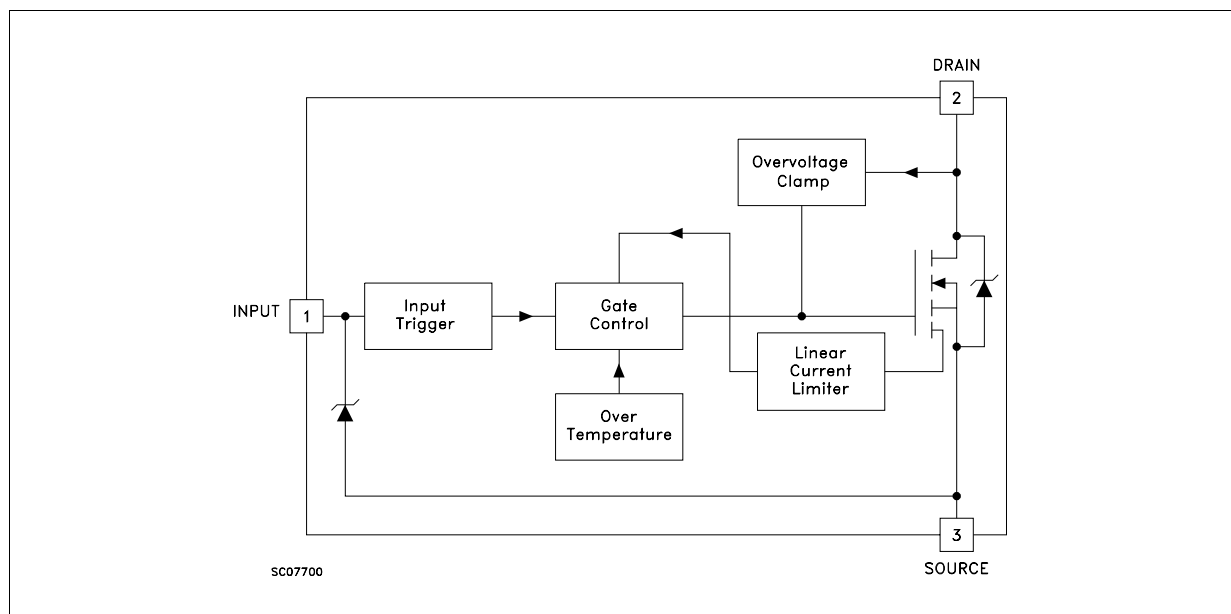
ABSOLUTE MAXIMUM RATING

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

ELECTRICAL CHARACTERISTICS (continued)

SWITCHING (∗∗)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on Delay Time	$V_{DD} = 16$ V $\quad I_d = 1$ A		1100	1600	ns
t_r	Rise Time	$V_{gen} = 7$ V $\quad R_{gen} = 10$ Ω		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	$V_{DD} = 16$ V $\quad I_d = 1$ A		1.2	1.8	μs
t_r	Rise Time	$V_{gen} = 7$ V $\quad R_{gen} = 1000$ Ω		1	1.5	μs
$t_{d(off)}$	Turn-off Delay Time	(see figure 3)		1.6	2.3	μs
t_f	Fall Time			1.2	1.8	μs
$(di/dt)_{on}$	Turn-on Current Slope	$V_{DD} = 16$ V $\quad I_D = 1$ A $V_{in} = 7$ 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 $V_{DD} = 30$ V $\quad T_j = 25$ ^{o}C (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			^{o}C
T_{jrs} (∗∗)	Overtemperature Reset		135			^{o}C
E_{as} (∗∗)	Single Pulse Avalanche Energy	starting $T_j = 25$ ^{o}C $\quad V_{DD} = 24$ V $V_{in} = 7$ 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

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 μA) 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
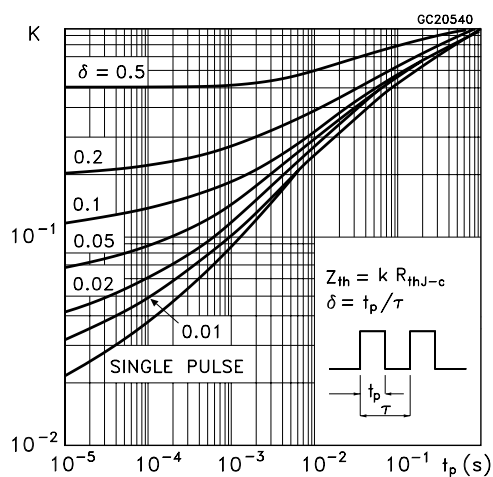
Derating Curve
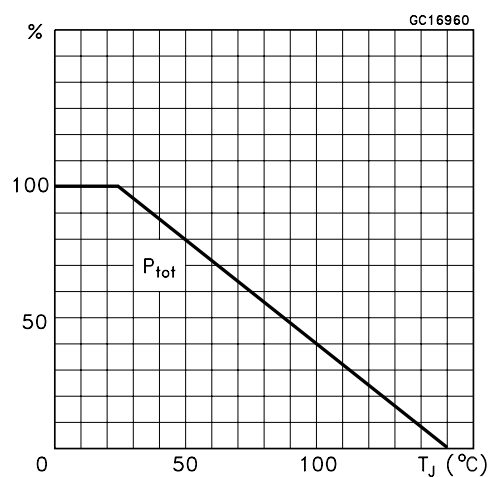
Output Characteristics
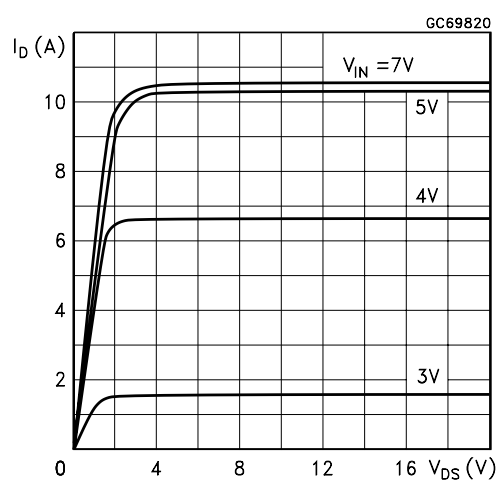
Static Drain-Source On Resistance vs Input Voltage
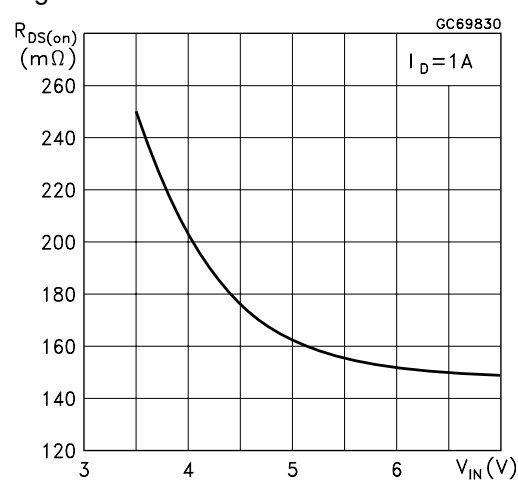
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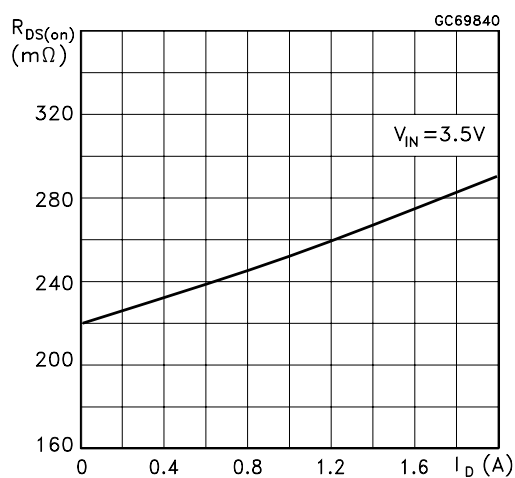
Static Drain-Source On Resistance
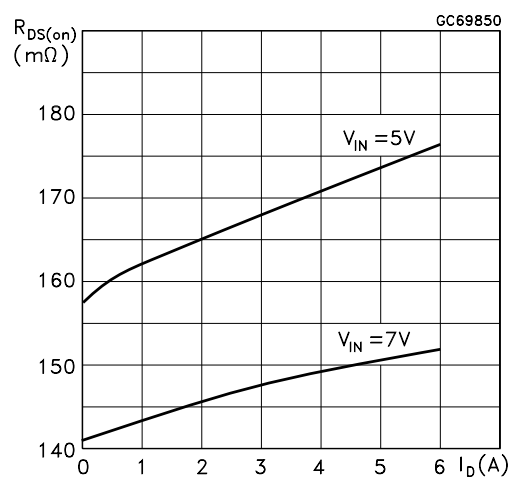
Input Charge vs Input Voltage
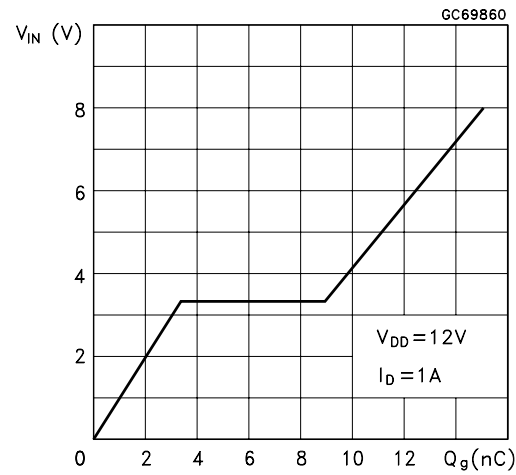
Capacitance Variations
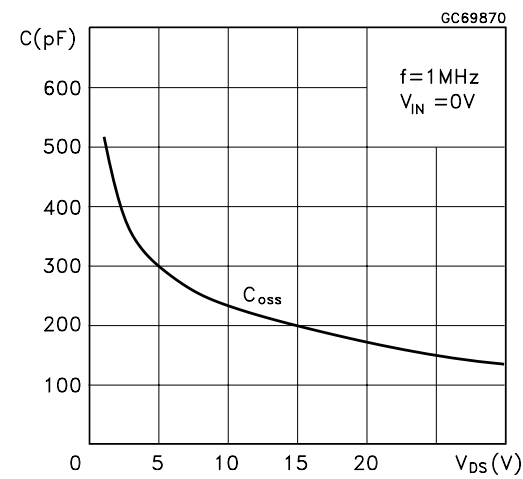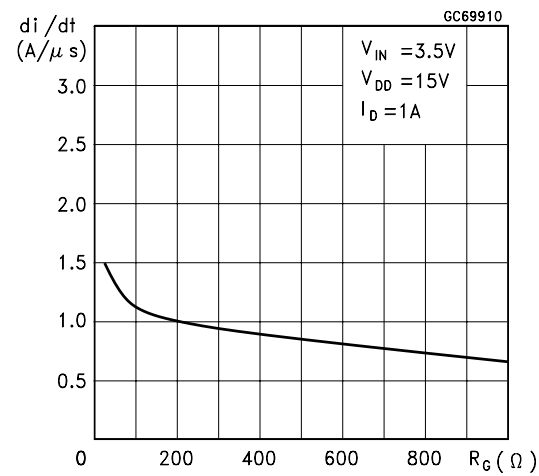

Normalized Input Threshold Voltage vs Temperature
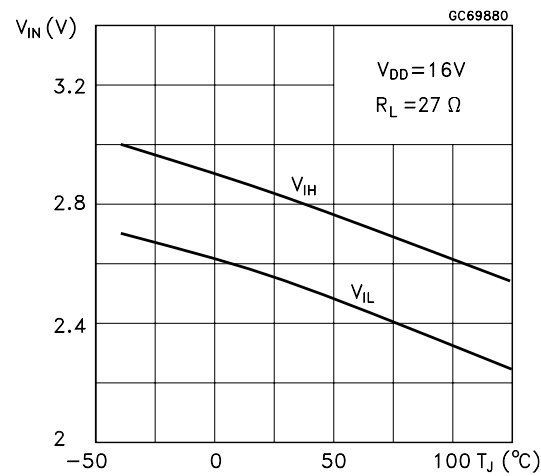
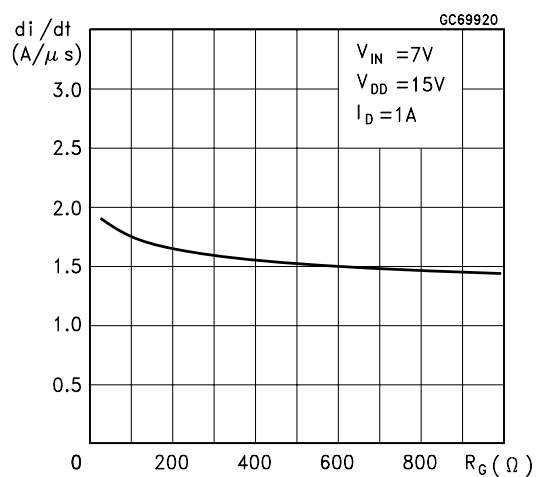
Normalized On Resistance vs Temperature
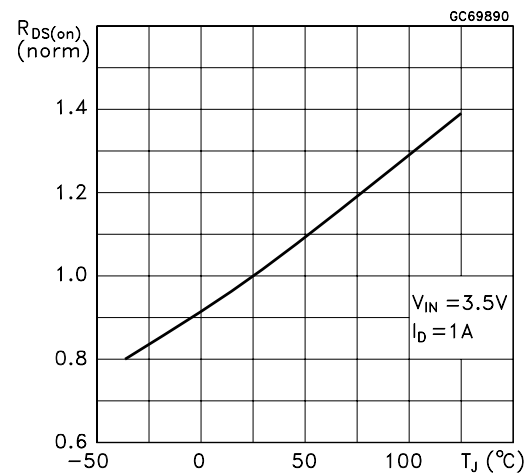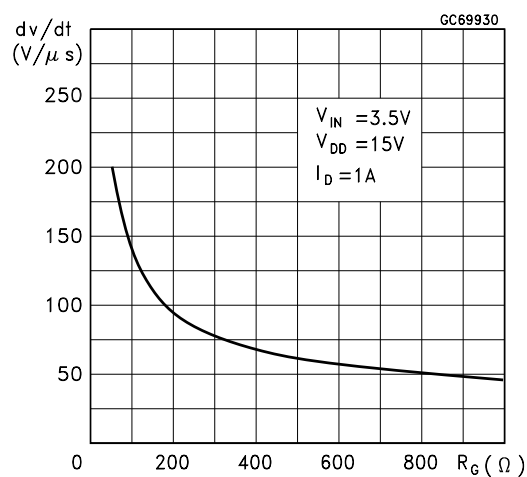

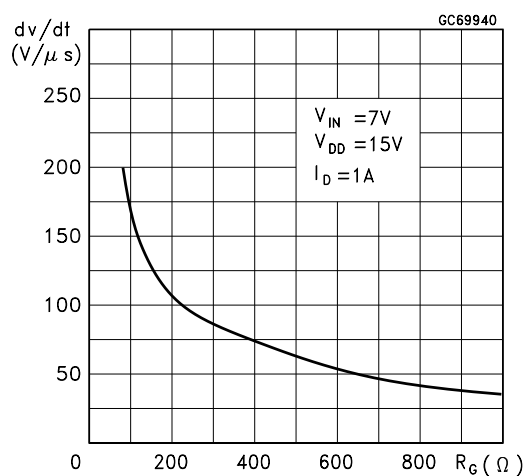### Normalized On Resistance vs Temperature
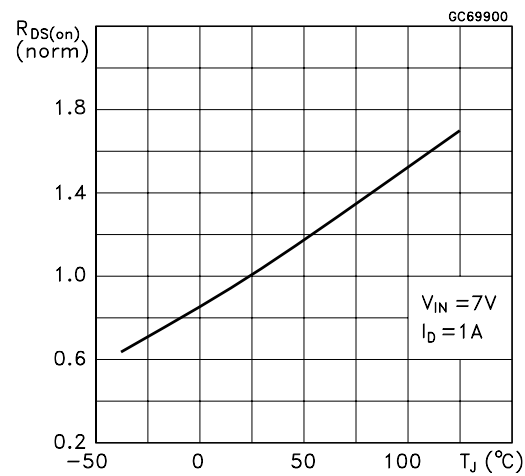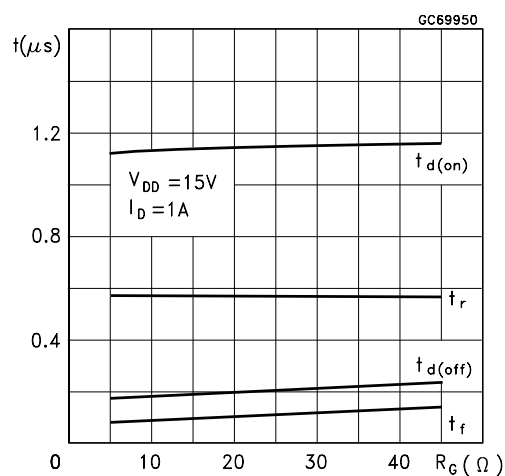

Turn-on Current Slope

Turn-on Current Slope

Turn-off Drain-Source Voltage Slope

Turn-off Drain-Source Voltage Slope

Switching Time Resistive Load

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Switching Time Resistive Load

VNP10N06
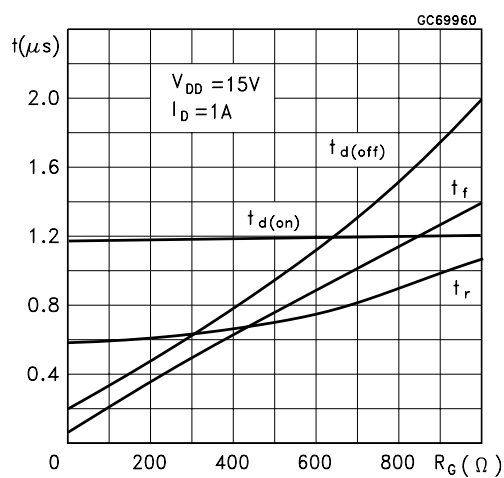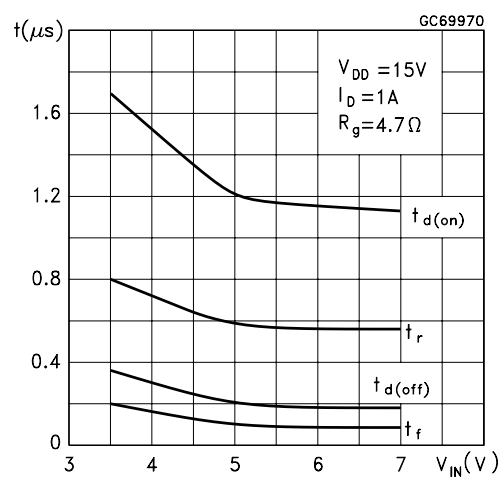
Current Limit vs Junction Temperature
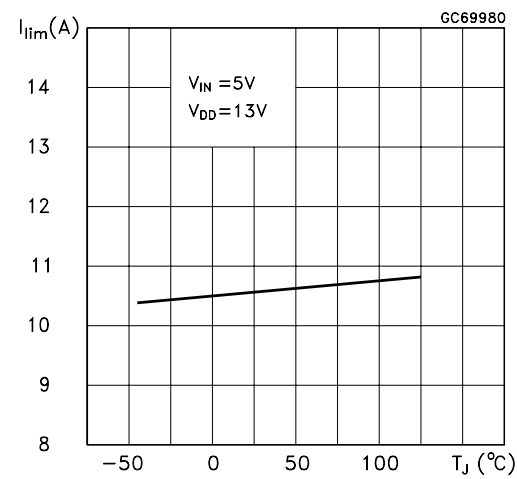
Step Response Current Limit
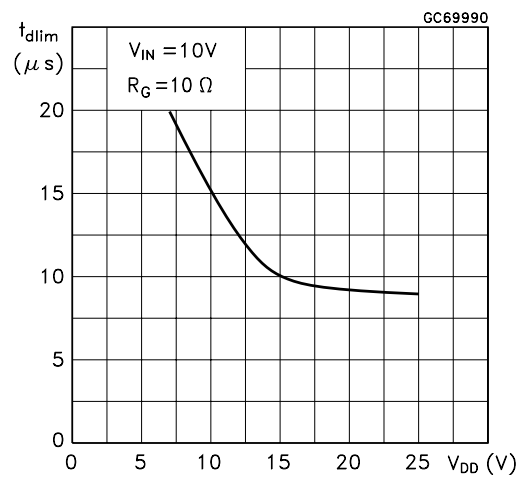
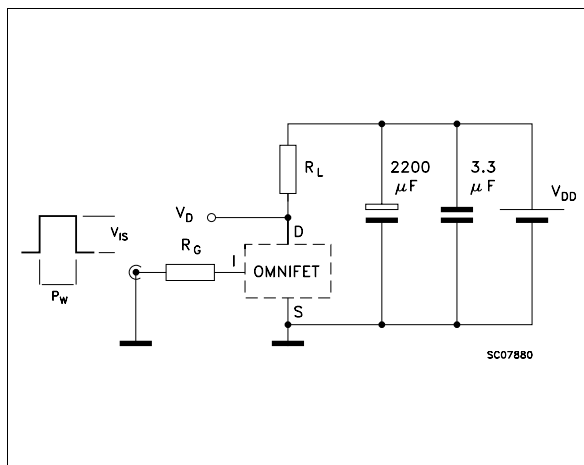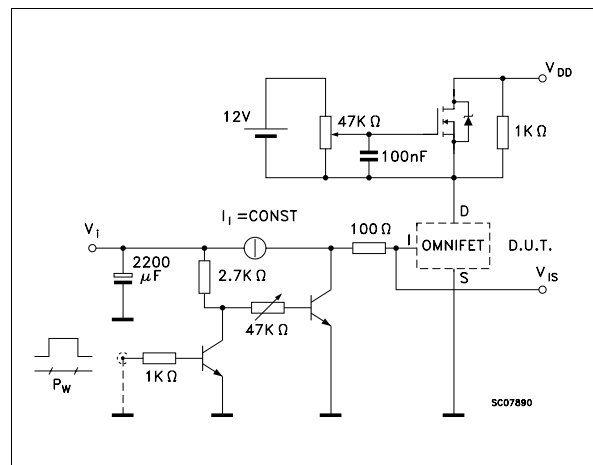## Source Drain Diode Voltage vs Junction Temperature
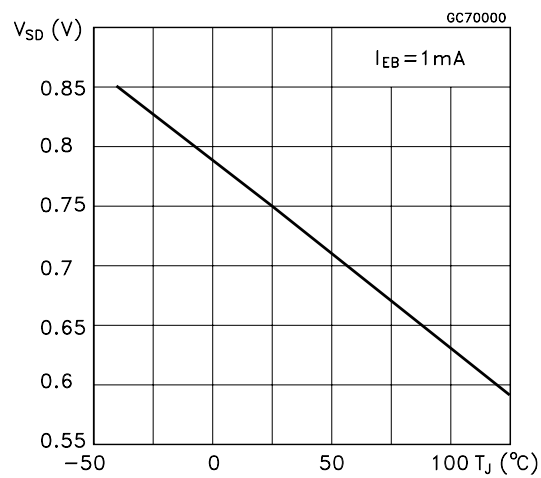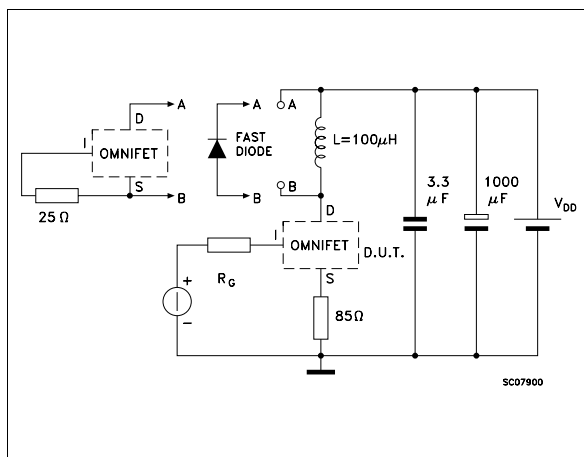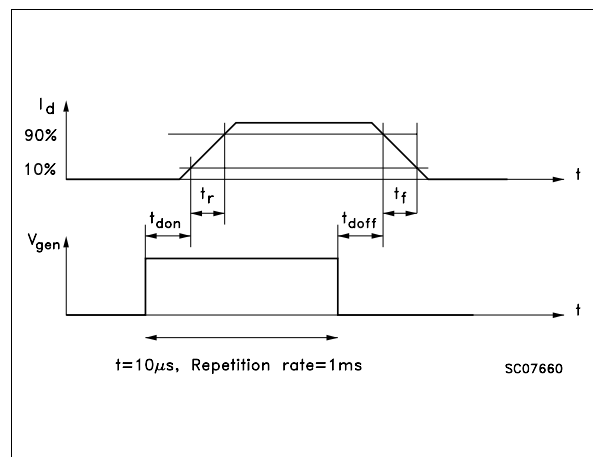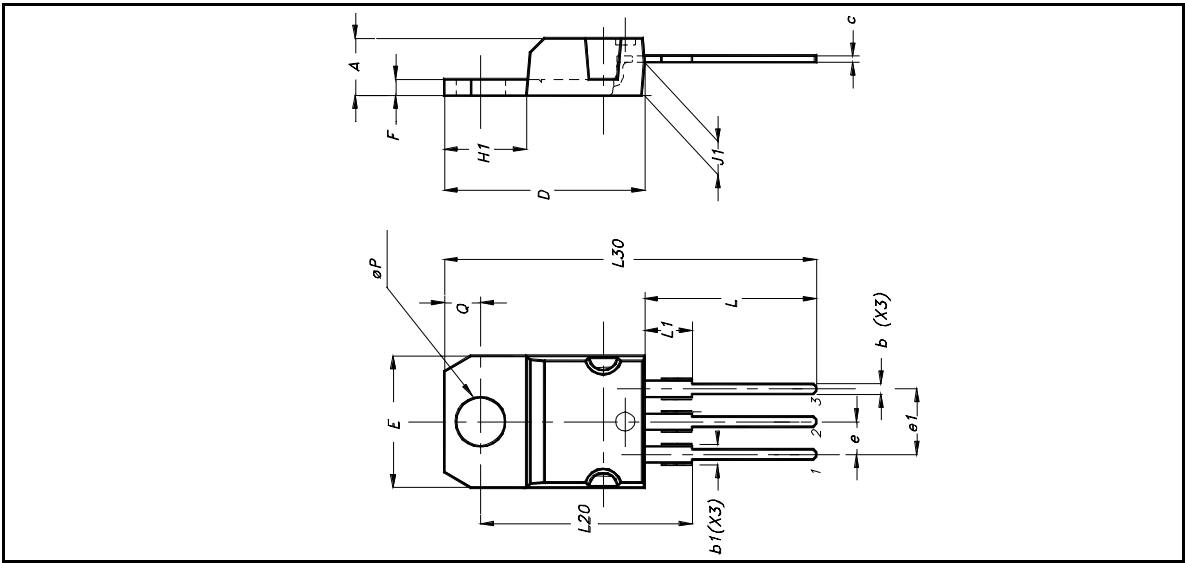
Fig. 1: Unclamped Inductive Load Test Circuits
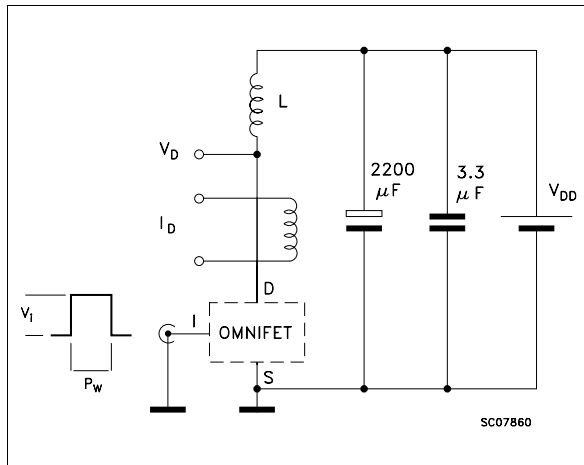
Fig. 2: Unclamped Inductive Waveforms
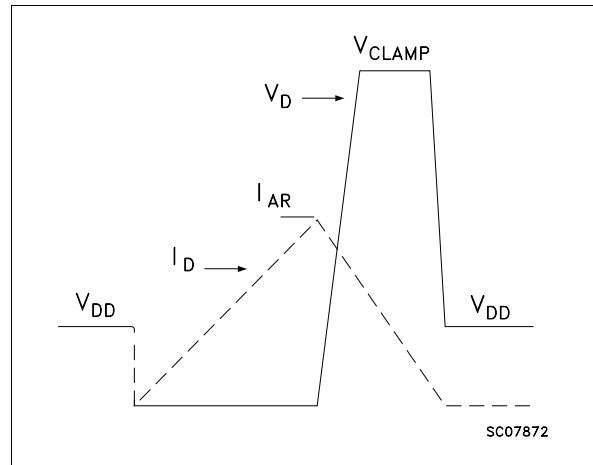
Fig. 3: Switching Times Test Circuits For Resistive Load

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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