

VNP5N07

"OMNIFET": FULLY AUTOPROTECTED POWER MOSFET

TYPE	V _{clamp}	R _{DS(on)}	l _{lim}
VNP5N07	70 V	0.2 Ω	5 A

- LINEAR CURRENT LIMITATION
- THERMAL SHUT DOWN
- SHORT CIRCUIT PROTECTION
- INTEGRATED CLAMP
- LOW CURRENT DRAWN FROM INPUT PIN
- DIAGNOSTIC FEEDBACK THROUGH INPUT PIN
- ESD PROTECTION
- DIRECT ACCESS TO THE GATE OF THE POWER MOSFET (ANALOG DRIVING)
- COMPATIBLE WITH STANDARD POWER MOSFET
- STANDARD TO-220 PACKAGE

TO-220

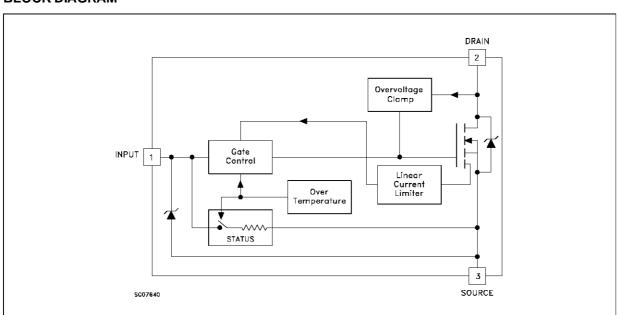
DESCRIPTION

The VNP5N07 is a monolithic device made using SGS-THOMSON Vertical Intelligent Power M0 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.

Fault feedback can be detected by monitoring the voltage at the input pin.

BLOCK DIAGRAM



April 1996 1/11

ABSOLUTE MAXIMUM RATING

Symbol	Parameter	Value	Unit
V _{DS}	Drain-source Voltage (V _{in} = 0)	Internally Clamped	V
V _{in}	Input Voltage	18	V
I _D	Drain Current	Internally Limited	Α
I _R	Reverse DC Output Current	-7	Α
V _{esd}	Electrostatic Discharge (C= 100 pF, R=1.5 KΩ)	2000	V
P _{tot}	Total Dissipation at T _c = 25 °C	31	W
Tj	Operating Junction Temperature	Internally Limited	°C
Tc	Case Operating Temperature	Internally Limited	°C
T _{stg}	Storage Temperature	-55 to 150	°C

THERMAL DATA

R _{thj-case}	Thermal	Resistance	Junction-case	Max	4	°C/W
R _{thj-amb}	Thermal	Resistance	Junction-ambient	Max	62.5	°C/W

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

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
V _{CLAMP}	Drain-source Clamp Voltage	I _D = 200 mA V _{in} = 0	60	70	80	V
V_{CLTH}	Drain-source Clamp Threshold Voltage	$I_D = 2 \text{ mA}$ $V_{in} = 0$	55			V
VINCL	Input-Source Reverse Clamp Voltage	I _{in} = -1 mA	-1		-0.3	V
I _{DSS}	Zero Input Voltage Drain Current (V _{in} = 0)	$V_{DS} = 13 \ V \qquad V_{in} = 0 \ V_{DS} = 25 \ V \qquad V_{in} = 0$			50 200	μA μA
l _{ISS}	Supply Current from Input Pin	V _{DS} = 0 V V _{in} = 10 V		250	500	μΑ

ON (*)

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
V _{IS(th)}	Input Threshold Voltage	$V_{DS} = V_{in}$ $I_D + I_{in} = 1 \text{ mA}$	0.8		3	V
R _{DS(on)}	Static Drain-source On Resistance	$V_{in} = 10 \text{ V}$ $I_D = 2.5 \text{ A}$ $V_{in} = 5 \text{ V}$ $I_D = 2.5 \text{ A}$			0.200 0.280	Ω

DYNAMIC

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
gfs (*)	Forward Transconductance	$V_{DS} = 13 \text{ V}$ $I_{D} = 2.5 \text{ A}$	3	4		Ø
Coss	Output Capacitance	$V_{DS} = 13 \text{ V}$ f = 1 MHz $V_{in} = 0$		200	300	pF



ELECTRICAL CHARACTERISTICS (continued)

SWITCHING (**)

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
t _{d(on)}	Turn-on Delay Time	$V_{DD} = 15 \text{ V}$ $I_{d} = 2.5 \text{ A}$		50	100	ns
tr	Rise Time	$V_{gen} = 10 \text{ V}$ $R_{gen} = 10 \Omega$		60	100	ns
t _{d(off)}	Turn-off Delay Time	(see figure 3)		150	300	ns
t _f	Fall Time			40	80	ns
t _{d(on)}	Turn-on Delay Time	V _{DD} = 15 V I _d = 2.5 A		150	250	ns
t _r	Rise Time	$V_{gen} = 10 \text{ V}$ $R_{gen} = 1000 \Omega$		400	600	ns
t _{d(off)}	Turn-off Delay Time	(see figure 3)		3900	5000	ns
t _f	Fall Time			1100	1600	ns
(di/dt) _{on}	Turn-on Current Slope	$V_{DD} = 15 \text{ V}$ $I_D = 2.5 \text{ A}$		35		A/μs
		$V_{in} = 10 \text{ V}$ $R_{gen} = 10 \Omega$				·
Qi	Total Input Charge	$V_{DD} = 12 \text{ V}$ $I_{D} = 2.5 \text{ A}$ $V_{in} = 10 \text{ V}$		18		nC

SOURCE DRAIN DIODE

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
VsD (*)	Forward On Voltage	I _{SD} = 2.5 A V _{IN} =0			1.6	V
t _{rr} (**)	Reverse Recovery Time	$I_{SD} = 2.5 \text{ A}$		150		ns
Qrr (**)	Reverse Recovery Charge	(see test circuit, figure 5)		0.3		μC
I _{RRM} (**)	Reverse Recovery Current			5.7		А

PROTECTION

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
I _{lim}	Drain Current Limit	$V_{in} = 10 \text{ V}$ $V_{DS} = 13 \text{ V}$ $V_{in} = 5 \text{ V}$ $V_{DS} = 13 \text{ V}$	3.5 3.5	5 5	7 7	A A
t _{dlim} (**)	Step Response Current Limit	V _{in} = 10 V V _{in} = 5 V		15 40	20 60	μs
T _{jsh} (**)	Overtemperature Shutdown		150			°C
T _{jrs} (**)	Overtemperature Reset		135			°C
I _{gf} (**)	Fault Sink Current	$V_{in} = 10 \text{ V}$ $V_{DS} = 13 \text{ V}$ $V_{in} = 5 \text{ V}$ $V_{DS} = 13 \text{ V}$		50 20		mA
Eas (**)	Single Pulse Avalanche Energy	starting $T_j = 25$ °C $V_{DD} = 20$ V $V_{in} = 10$ V $R_{gen} = 1$ K Ω L = 30 mH	0.2			J



^(*) Pulsed: Pulse duration = 300 µs, duty cycle 1.5 % (**) Parametes guaranteed by design/characterization

PROTECTION FEATURES

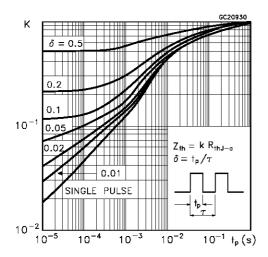
During normal operation, the Input pin is electrically connected to the gate of the internal power MOSFET. The device then behaves like a standard power MOSFET and can be used as a switch from DC to 50 KHz. The only difference from the user's standpoint is that a small DC current (I_{iss}) flows into the Input pin in order to supply the internal circuitry.

The device integrates:

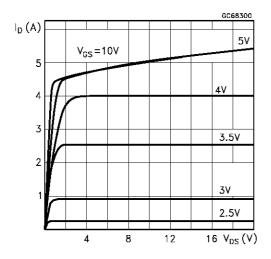
- OVERVOLTAGE CLAMP PROTECTION: internally set at 70V, along with the rugged avalanche characteristics of the Power MOSFET stage give this device unrivalled ruggedness and energy handling capability. This feature is mainly important when driving inductive loads.
- LINEAR CURRENT LIMITER CIRCUIT: limits the drain current ld to llim whatever the Input pin voltage. When the current limiter is active, the device operates in the linear region, so power dissipation may exceed the capability of the heatsink. Both case and junction temperatures increase, and if this phase lasts long enough, junction temperature may reach the overtemperature threshold T_{ish}.
- OVERTEMPERATURE AND SHORT CIRCUIT PROTECTION: these are based on sensing the chip temperature and are not dependent on the input voltage. The location of the sensing element on the chip in the power stage area ensures fast, accurate detection of the junction temperature. Overtemperature cutout occurs at minimum 150°C. The device is automatically restarted when the chip temperature falls below 135°C.
- STATUS FEEDBACK: In the case of an overtemperature fault condition, a Status Feedback is provided through the Input pin. The internal protection circuit disconnects the input from the gate and connects it instead to ground via an equivalent resistance of 100 Ω . The failure can be detected by monitoring the voltage at the Input pin, which will be close to ground potential.

Additional features of this device are ESD protection according to the Human Body model and the ability to be driven from a TTL Logic circuit (with a small increase in R_{DS(on)}).

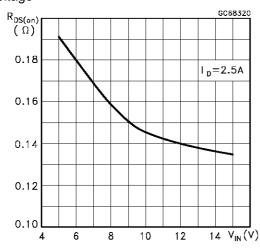
Thermal Impedance



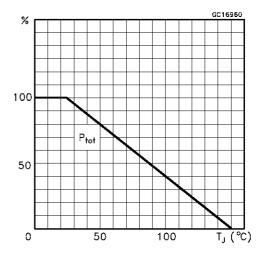
Output Characteristics



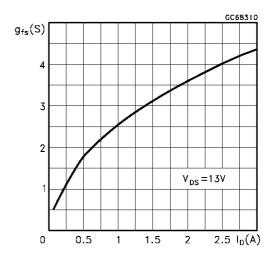
Static Drain-Source On Resistance vs Input Voltage



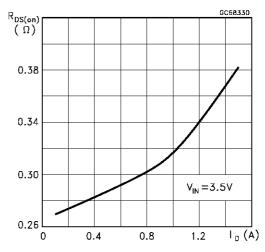
Derating Curve



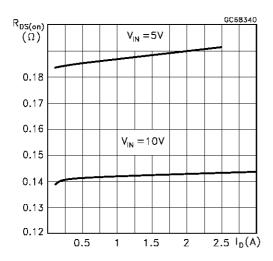
Transconductance



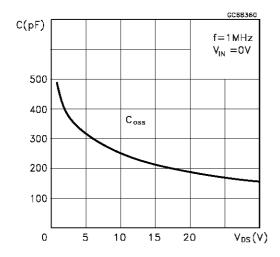
Static Drain-Source On Resistance



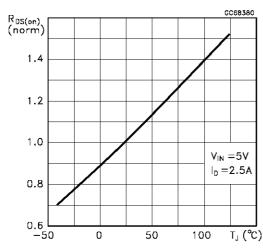
Static Drain-Source On Resistance



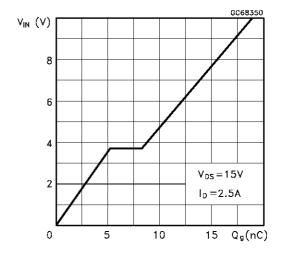
Capacitance Variations



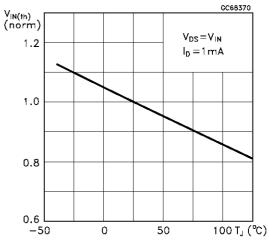
Normalized On Resistance vs Temperature



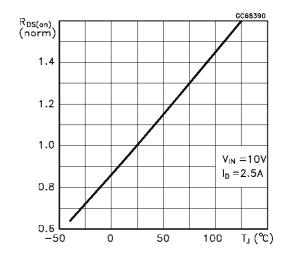
Input Charge vs Input Voltage



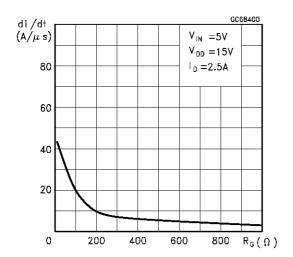
Normalized Input Threshold Voltage vs Temperature



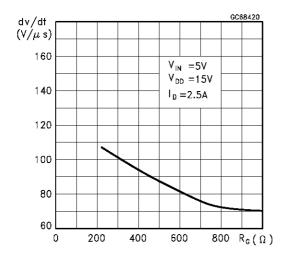
Normalized On Resistance vs Temperature



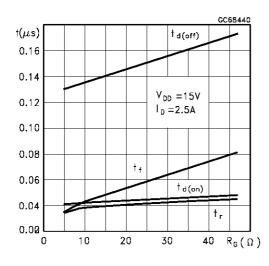
Turn-on Current Slope



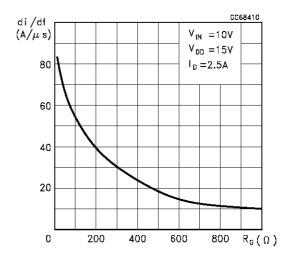
Turn-off Drain-Source Voltage Slope



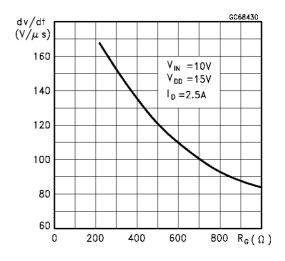
Switching Time Resistive Load



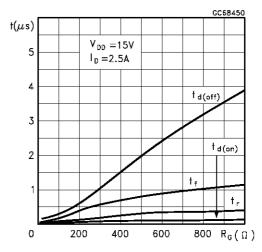
Turn-on Current Slope



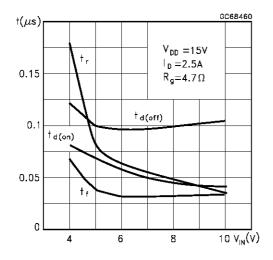
Turn-off Drain-Source Voltage Slope



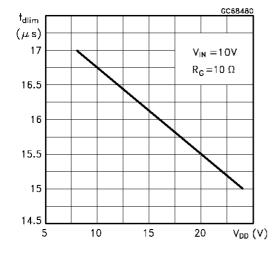
Switching Time Resistive Load



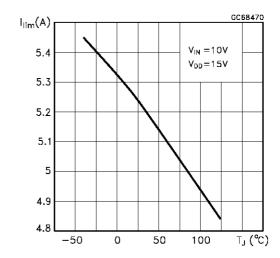
Switching Time Resistive Load



Step Response Current Limit



Current Limit vs Junction Temperature



Source Drain Diode Forward Characteristics

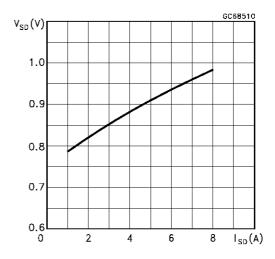


Fig. 1: Unclamped Inductive Load Test Circuits

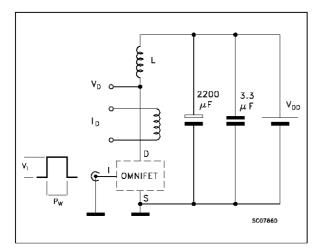


Fig. 3: Switching Times Test Circuits For Resistive Load

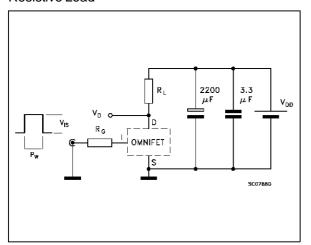


Fig. 5: Test Circuit For Inductive Load Switching And Diode Recovery Times

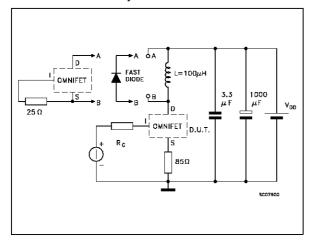


Fig. 2: Unclamped Inductive Waveforms

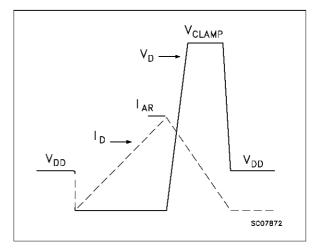


Fig. 4: Input Charge Test Circuit

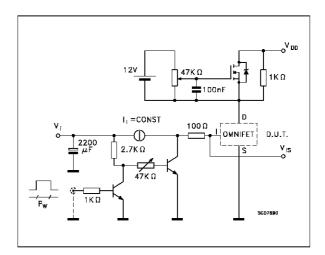
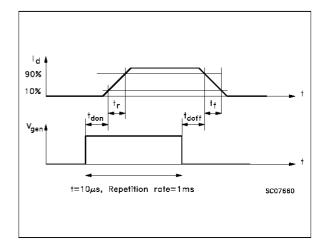
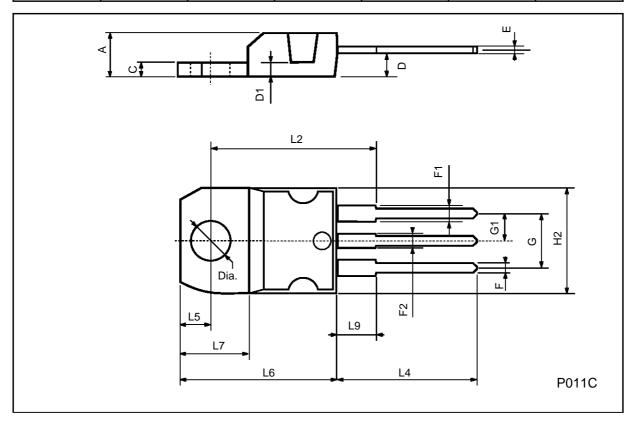


Fig. 6: Waveforms



TO-220 MECHANICAL DATA

DIM		mm		inch			
DIM.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
А	4.40		4.60	0.173		0.181	
С	1.23		1.32	0.048		0.051	
D	2.40		2.72	0.094		0.107	
D1		1.27			0.050		
Е	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	



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