

# **VNP49N04**

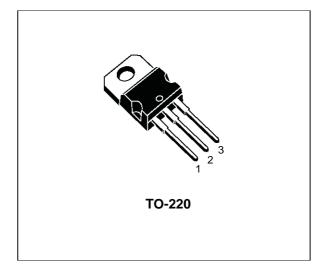
# OMNIFET : FULLY AUTOPROTECTED POWER MOSFET

TYPE	V <sub>clamp</sub>	R <sub>DS(on)</sub>	l <sub>lim</sub>
VNP49N04	42 V	0.02 Ω	49 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

#### DESCRIPTION

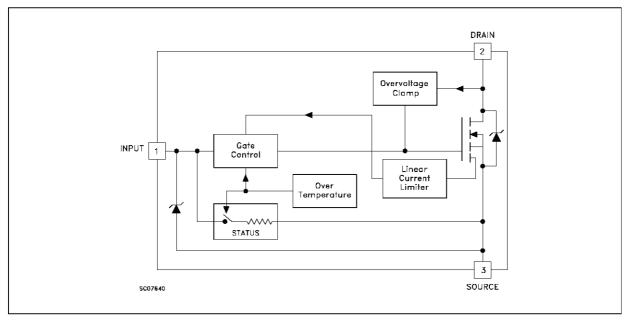
The VNP49N04 is a monolithic device made using STMicroelectronics VIPower Technology, intended for replacement of standard power MOSFETS in DC to 50 KHz applications. Built-in thermal shut-down, linear current limita-



tion and overvoltage clamp protect the chip in harsh enviroments.

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

#### **BLOCK DIAGRAM**



### **ABSOLUTE MAXIMUM RATING**

Symbol	Parameter	Value	Unit
V <sub>DS</sub>	Drain-source Voltage (V <sub>in</sub> = 0)	Internally Clamped	V
Vin	Input Voltage	18	V
ID	Drain Current	Internally Limited	Α
I <sub>R</sub>	Reverse DC Output Current	-50	Α
$V_{\text{esd}}$	Electrostatic Discharge (C= 100 pF, R=1.5 KΩ)	2000	V
P <sub>tot</sub>	Total Dissipation at $T_c = 25 \ ^{\circ}C$	125	W
T <sub>j</sub> Operating Junction Temperature		Internally Limited	°C
Tc	Case Operating Temperature	Internally Limited	°C
T <sub>stg</sub> Storage Temperature		-55 to 150	°C

#### THERMAL DATA

R <sub>thj-case</sub>	Thermal	Resistance	Junction-case	Max	1	°C/W
R <sub>thj-amb</sub>	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
VCLAMP	Drain-source Clamp Voltage	$I_D = 200 \text{ mA}$ $V_{in} = 0$	36	42	48	V
V <sub>CLTH</sub>	Drain-source Clamp Threshold Voltage	$I_D = 2 \text{ mA}  V_{in} = 0$	35			V
VINCL	Input-Source Reverse Clamp Voltage	I <sub>in</sub> = -1 mA	-1		-0.3	V
I <sub>DSS</sub>	Zero Input Voltage Drain Current (V <sub>in</sub> = 0)				50 200	μΑ μΑ
l <sub>ISS</sub>	Supply Current from Input Pin	$V_{DS} = 0 V  V_{in} = 10 V$		250	500	μA

#### ON (\*)

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
V <sub>IN(th)</sub>	Input Threshold Voltage	$V_{DS} = V_{in}$ $I_D + I_{in} = 1 \text{ mA}$	0.8		3	V
R <sub>DS(on)</sub>	Static Drain-source On Resistance				0.02 0.025	Ω Ω

#### DYNAMIC

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
g <sub>fs</sub> (*)	Forward Transconductance	$V_{DS} = 13 V$ $I_{D} = 25 A$	25	30		S
Coss	Output Capacitance	$V_{DS} = 13 V$ f = 1 MHz $V_{in} = 0$		1100	1500	рF

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# ELECTRICAL CHARACTERISTICS (continued)

# SWITCHING (\*\*)

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
t <sub>d(on)</sub> t <sub>r</sub> t <sub>d(off)</sub> t <sub>f</sub>	Turn-on Delay Time Rise Time Turn-off Delay Time Fall Time			200 1300 800 300	300 1800 1200 450	ns ns ns ns
t <sub>d(on)</sub> t <sub>r</sub> t <sub>d(off)</sub> t <sub>f</sub>	Turn-on Delay Time Rise Time Turn-off Delay Time Fall Time			1.3 3.8 12 6.1	1.9 5.2 14 8.5	μs μs μs μs
(di/dt) <sub>on</sub>	Turn-on Current Slope	$V_{DD}$ = 15 V I <sub>D</sub> = 25 A V <sub>in</sub> = 10 V R <sub>gen</sub> = 10 Ω		25		A/µs
Qi	Total Input Charge	$V_{DD} = 15 \text{ V}$ $I_D = 25 \text{ A}$ $V_{in} = 10 \text{ V}$		100		nC

#### SOURCE DRAIN DIODE

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
Vsd (*)	Forward On Voltage	IsD = 25 A Vin = 0			1.6	V
t <sub>rr</sub> (**)	Reverse Recovery Time	$I_{SD} = 25 \text{ A}$ di/dt = 100 A/µs V <sub>DD</sub> = 30 V $T_i = 25 ^{\circ}\text{C}$		250		ns
Qrr (**)	Reverse Recovery Charge	(see test circuit, figure 5)		910		nC
I <sub>RRM</sub> (**)	Reverse Recovery Current			7.5		A

#### PROTECTION

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
l <sub>lim</sub>	Drain Current Limit		30 30	49 49	68 68	A A
t <sub>dlim</sub> (**)	Step Response Current Limit	V <sub>in</sub> = 10 V V <sub>in</sub> = 5 V		35 90	50 150	μs μs
T <sub>jsh</sub> (**)	Overtemperature Shutdown		150			°C
T <sub>jrs</sub> (**)	Overtemperature Reset		135			°C
l <sub>gf</sub> (**)	Fault Sink Current			50 20		mA mA
E <sub>as</sub> (**)	Single Pulse Avalanche Energy	starting T <sub>j</sub> = 25 $^{\circ}$ C V <sub>DD</sub> = 20 V V <sub>in</sub> = 10 V R <sub>gen</sub> = 1 K $\Omega$ L = 6 mH	4			J

(\*) Pulsed: Pulse duration = 300  $\mu s,$  duty cycle 1.5 % (\*\*) Parameters guaranteed by design/characterization

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#### **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.

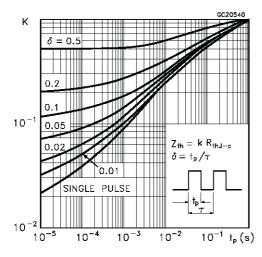
The device integrates:

- OVERVOLTAGE CLAMP PROTECTION: internally set at 42V, 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 Id to Ilim 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<sub>jsh</sub>.
- 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  $\Omega$ . The failure can be detected by monitoring the voltage at the Input pin, which will be close to ground potential.

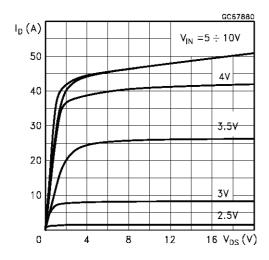
Additional features of this device are ESD protection according to the Human Body model and the ability to be driven from a TTL Logic circuit (with a small increase in R<sub>DS(on)</sub>).

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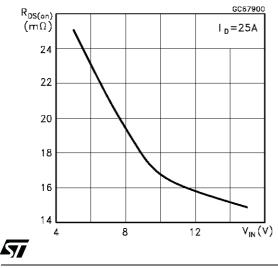
#### **Thermal Impedance**



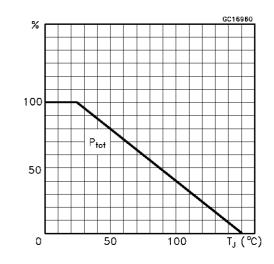
#### **Output Characteristics**



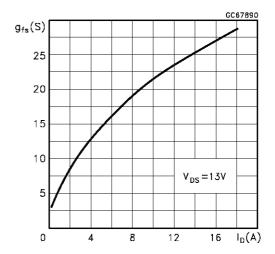
Static Drain-Source On Resistance vs Input Voltage



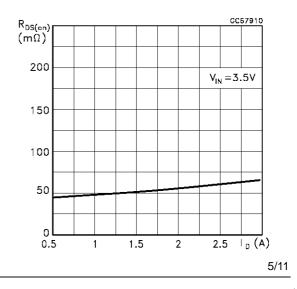
#### **Derating Curve**

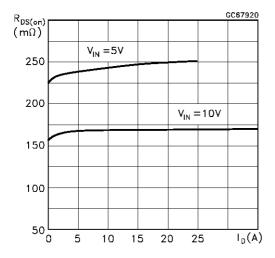


#### Transconductance



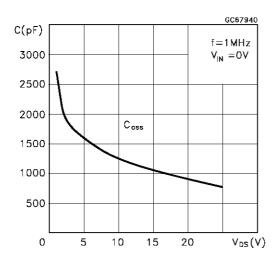
#### Static Drain-Source On Resistance



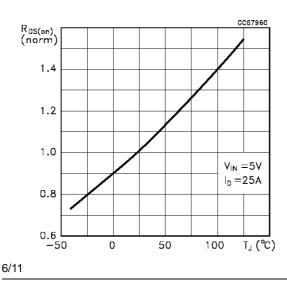


Static Drain-Source On Resistance

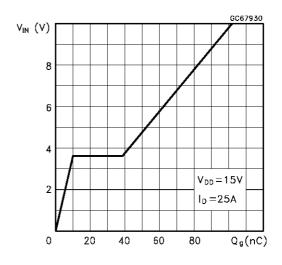
#### **Capacitance Variations**



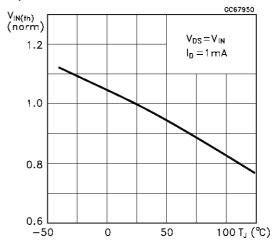
#### Normalized On Resistance vs Temperature



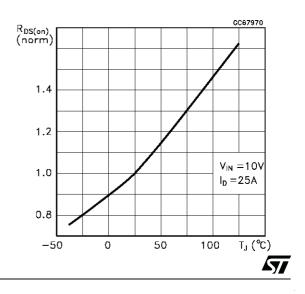
Input Charge vs Input Voltage



#### Normalized Input Threshold Voltage vs Temperature

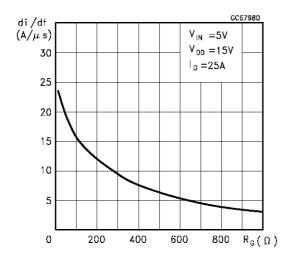


#### Normalized On Resistance vs Temperature

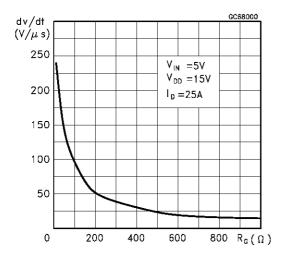


# ce Input Cha

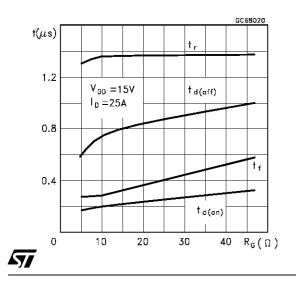
#### Turn-on Current Slope



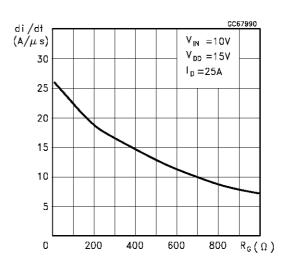
Turn-off Drain-Source Voltage Slope

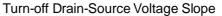


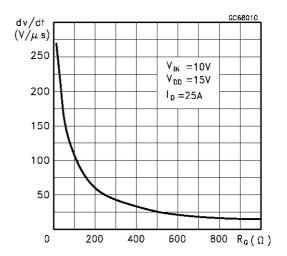




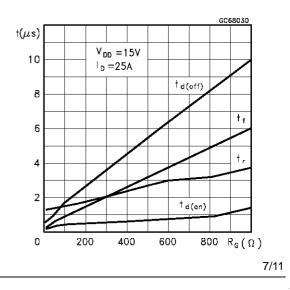
Turn-on Current Slope



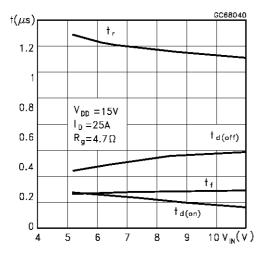




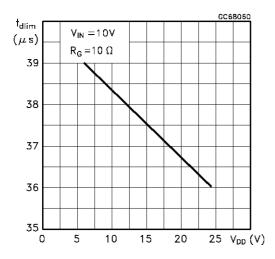




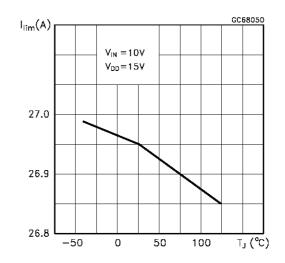
Switching Time Resistive Load



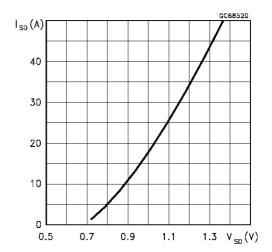
Step Response Current Limit



Current Limit vs Junction Temperature

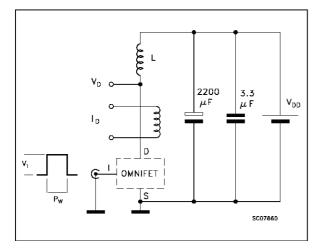


Source Drain Diode Forward Characteristics

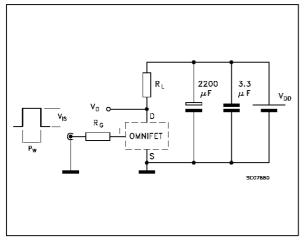




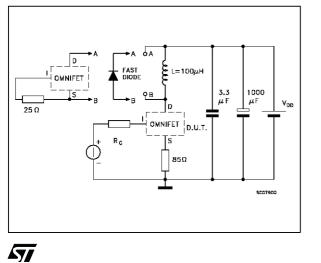
#### Fig. 1: Unclamped Inductive Load Test Circuits



**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

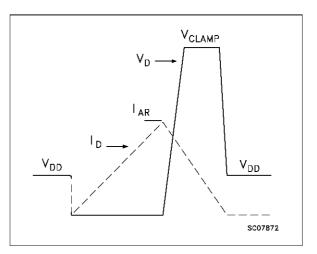


Fig. 4: Input Charge Test Circuit

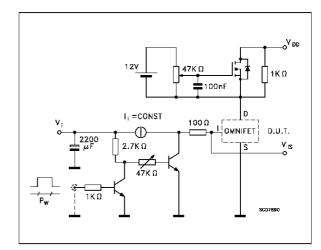
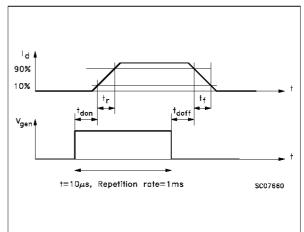


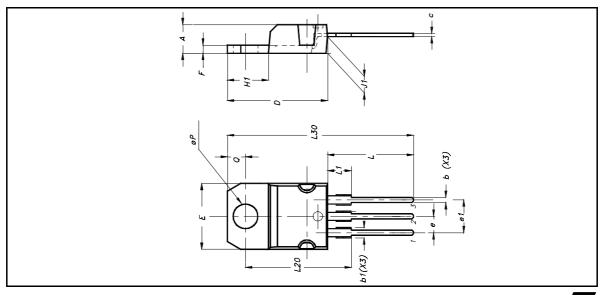
Fig. 6: Waveforms



# VNP49N04

# **TO-220 MECHANICAL DATA**

DIM	mm.				
DIM.	MIN.	ТҮР	MAX.		
A	4.40		4.60		
b	0.61		0.88		
b1	1.15		1.70		
с	0.49		0.70		
D	15.25		15.75		
E	10		10.40		
е	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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