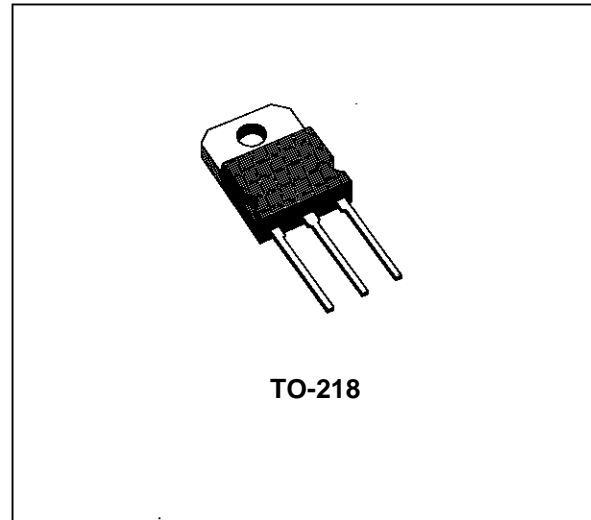


## "OMNIFET": FULLY AUTOPROTECTED POWER MOSFET

TARGET DATA

TYPE	V <sub>clamp</sub>	R <sub>DS(on)</sub>	I <sub>lim</sub>
VNH50N04	40 V	0.012 Ω	50 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-218 PACKAGE



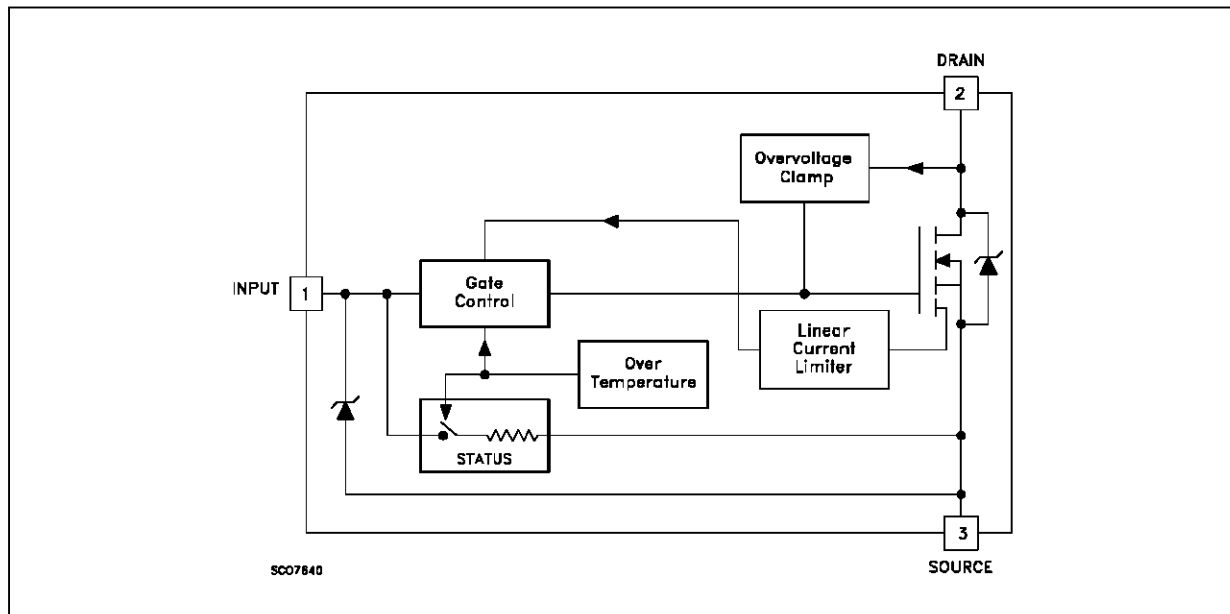
### DESCRIPTION

The VNH50N04 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



**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	A
$I_R$	Reverse DC Output Current	-50	A
$V_{esd}$	Electrostatic Discharge (C= 100 pF, R=1.5 K $\Omega$ )	2000	V
$P_{tot}$	Total Dissipation at $T_c = 25$ °C	208	W
$T_j$	Operating Junction Temperature	Internally Limited	°C
$T_c$	Case Operating Temperature	Internally Limited	°C
$T_{stg}$	Storage Temperature	-55 to 150	°C

**THERMAL DATA**

$R_{thj-case}$	Thermal Resistance Junction-case	Max	0.6	°C/W
$R_{thj-amb}$	Thermal Resistance Junction-ambient	Max	30	°C/W

**ELECTRICAL CHARACTERISTICS** ( $T_{case} = 25$  °C unless otherwise specified)

OFF

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{CLAMP}$	Drain-source Clamp Voltage	$I_D = 18$ A $V_{in} = 0$	31		45	V
$V_{CLTH}$	Drain-source Clamp Threshold Voltage	$I_D = 2$ mA $V_{in} = 0$	30			V
$V_{INCL}$	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 $V_{DS} = 25$ V			50 200	$\mu$ A $\mu$ A
$I_{ISS}$	Supply Current from Input Pin	$V_{DS} = 0$ V $V_{in} = 8$ V		250	500	$\mu$ A

ON (\*)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{IS(th)}$	Input Threshold Voltage	$V_{DS} = V_{in}$ $I_D = 1$ mA	1		3	V
$R_{DS(on)}$	Static Drain-source On Resistance	$V_{in} = 10$ V $I_D = 30$ A $V_{in} = 5$ V $I_D = 30$ A			0.012 TBD	$\Omega$ $\Omega$

DYNAMIC

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$g_{fs}$ (*)	Forward Transconductance	$V_{DS} = 13$ V $I_D = 30$ A		40		S
$C_{oss}$	Output Capacitance	$V_{DS} = 13$ V $f = 1$ MHz $V_{in} = 0$		1800	3000	pF

**ELECTRICAL CHARACTERISTICS** (continued)  
SWITCHING

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ $t_r$ $t_{d(off)}$ $t_f$	Turn-on Delay Time Rise Time Turn-off Delay Time Fall Time	$V_{DD} = 15\text{ V}$ $I_d = 30\text{ A}$ $V_{gen} = 10\text{ V}$ $R_{gen} = 10\ \Omega$ (see figure 3)		100 200 700 350	TBD TBD TBD TBD	ns ns ns ns
$t_{d(on)}$ $t_r$ $t_{d(off)}$ $t_f$	Turn-on Delay Time Rise Time Turn-off Delay Time Fall Time	$V_{DD} = 15\text{ V}$ $I_d = 30\text{ A}$ $V_{gen} = 10\text{ V}$ $R_{gen} = 10\ \Omega$ $T_j = 125\text{ }^\circ\text{C}$ (see figure 3)		100 350 1000 650	TBD TBD TBD TBD	ns ns ns ns
$t_{d(on)}$ $t_r$ $t_{d(off)}$ $t_f$	Turn-on Delay Time Rise Time Turn-off Delay Time Fall Time	$V_{DD} = 15\text{ V}$ $I_d = 30\text{ A}$ $V_{gen} = 10\text{ V}$ $R_{gen} = 1000\ \Omega$ (see figure 3)		1.9 5.7 20 12	TBD TBD TBD TBD	$\mu\text{s}$ $\mu\text{s}$ $\mu\text{s}$ $\mu\text{s}$
$(di/dt)_{on}$	Turn-on Current Slope	$V_{DD} = 15\text{ V}$ $I_D = 30\text{ A}$ $V_{in} = 10\text{ V}$		TBD		$\text{A}/\mu\text{s}$
$Q_g$	Total Gate Charge	$V_{DD} = 12\text{ V}$ $I_D = 30\text{ A}$ $V_{in} = 10\text{ V}$		TBD		nC

SOURCE DRAIN DIODE

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{SD} (*)$	Forward On Voltage	$I_{SD} = 30\text{ A}$ $V_{in} = 0$		0.86	TBD	V
$t_{rr}$	Reverse Recovery Time	$I_{SD} = 30\text{ A}$ $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = \text{V}$ $T_j = 150\text{ }^\circ\text{C}$ (see test circuit, figure 5)		TBD		ns
$Q_{rr}$	Reverse Recovery Charge			TBD		$\mu\text{C}$
$I_{RRM}$	Reverse Recovery Current			TBD		A

PROTECTION

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$I_{lim}$	Drain Current Limit	$V_{in} = 10\text{ V}$ $V_{DS} = 13\text{ V}$	35	50	65	A
$t_{dlim}$	Step Response Current Limit	$V_{in} = 10\text{ V}$ $V_{DS} = 13\text{ V}$		40	80	$\mu\text{s}$
$T_{jsh}$	Overtemperature Shutdown		150	170	190	$^\circ\text{C}$
$T_{jrs}$	Overtemperature Reset		135			$^\circ\text{C}$
$I_{gf}$	Fault Sink Current	$V_{in} = 10\text{ V}$ $V_{DS} = 13\text{ V}$		50		mA
$E_{as}$	Single Pulse Avalanche Energy	starting $T_j = 25\text{ }^\circ\text{C}$ $V_{DD} = 20\text{ V}$ $V_{in} = 10\text{ V}$ $R_{gen} = 1\text{ K}\Omega$ $L = 1.6\text{ mH}$	5			J

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

### 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.

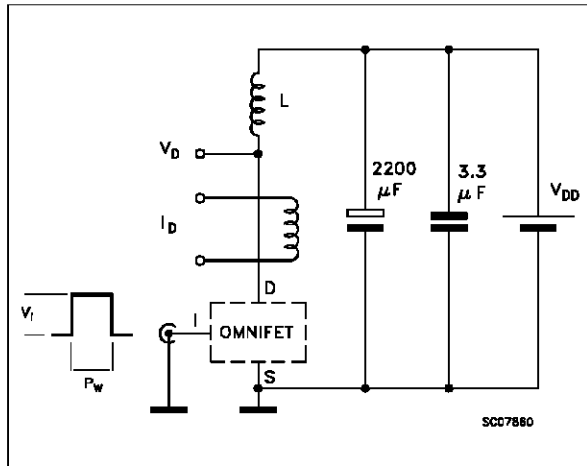
The device integrates:

- **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  $I_d$  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 capability of the heatsink. Both case and junction temperatures increase, and if this phase lasts long enough, junction temperature may reach the overtemperature threshold  $T_{jsh}$ .

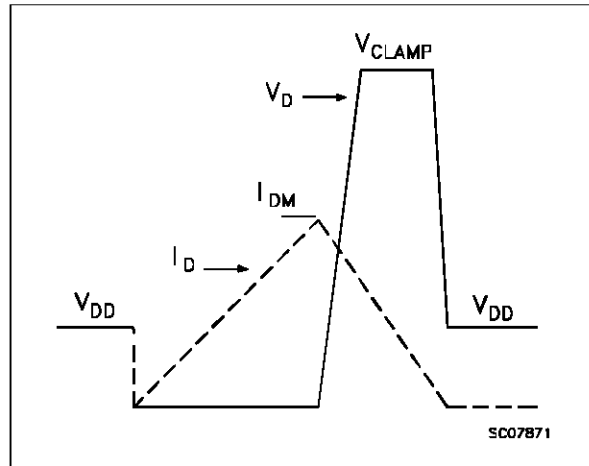
- **OVERTEMPERATURE AND SHORT CIRCUIT PROTECTION:** these are based on sensing the chip temperature and are not dependent on the input voltage. The location of the sensing element on the chip in the power stage area ensures fast, accurate detection of the junction temperature. Overtemperature cutout occurs in the range 150 to 190°C, a typical value being 170°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 200  $\Omega$ . 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  $R_{DS(on)}$ ).

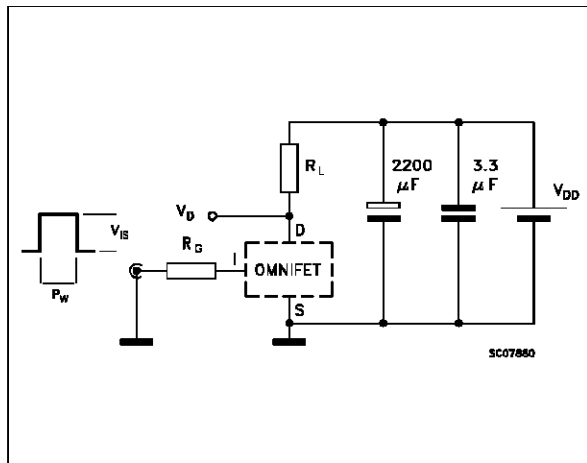
**Fig. 1: Unclamped Inductive Load Test Circuits**



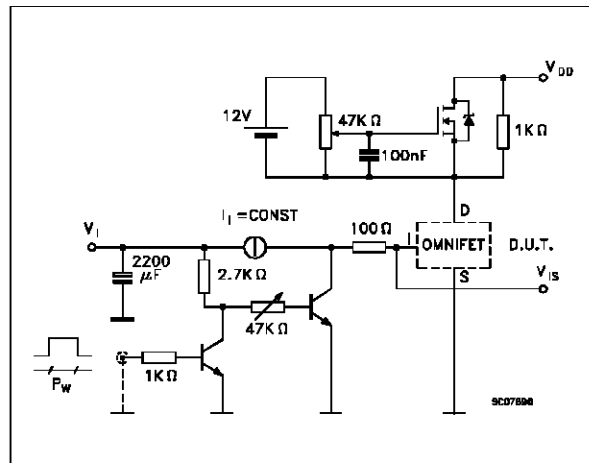
**Fig. 2: Unclamped Inductive Waveforms**



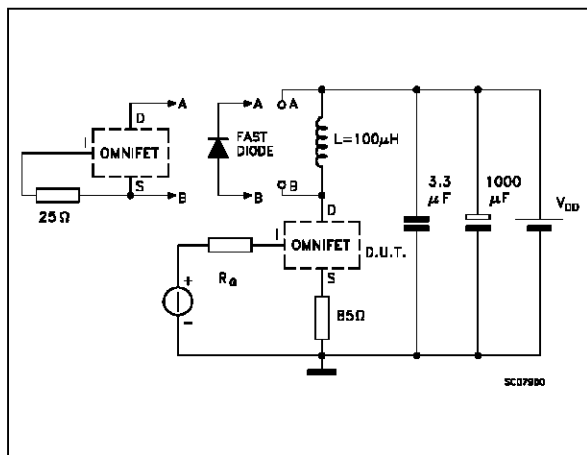
**Fig. 3: Switching Times Test Circuits For Resistive Load**



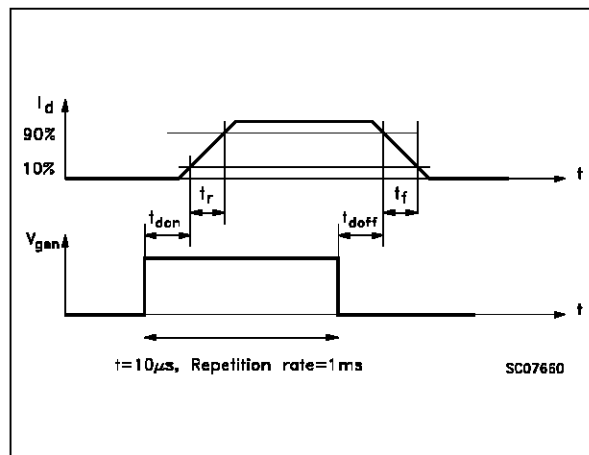
**Fig. 4: Input Charge Test Circuit**



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

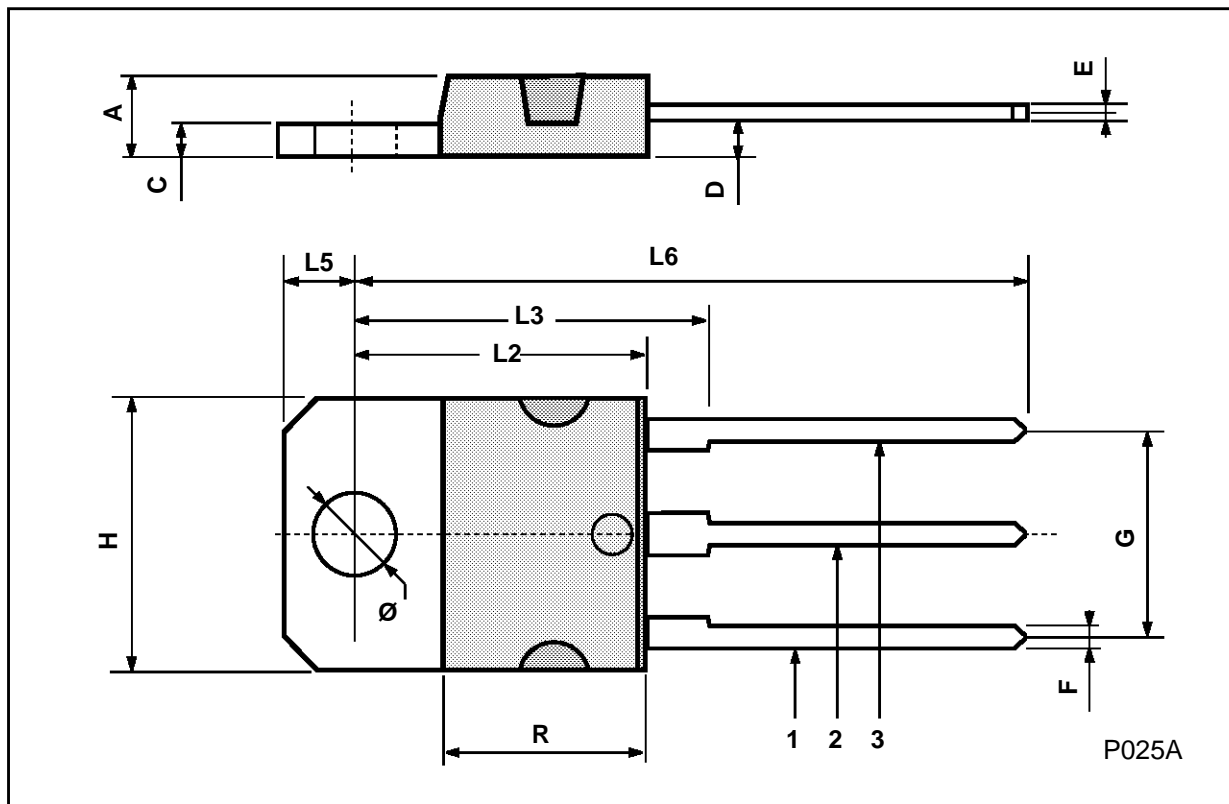


**Fig. 6: Waveforms**



**TO-218 (SOT-93) MECHANICAL DATA**

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.7		4.9	0.185		0.193
C	1.17		1.37	0.046		0.054
D		2.5			0.098	
E	0.5		0.78	0.019		0.030
F	1.1		1.3	0.043		0.051
G	10.8		11.1	0.425		0.437
H	14.7		15.2	0.578		0.598
L2	-		16.2	-		0.637
L3		18			0.708	
L5	3.95		4.15	0.155		0.163
L6		31			1.220	
R	-		12.2	-		0.480
Ø	4		4.1	0.157		0.161



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