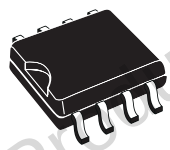
VNS3NV04D

"OMNIFET II": FULLY AUTOPROTECTED POWER MOSFET

TYPE	$R_{DS(on)}$	I_{lim}	V_{clamp}
VNS3NV04D	120 mΩ (*)	3.5 A (*)	40 V (*)

(*)Per each device

- 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



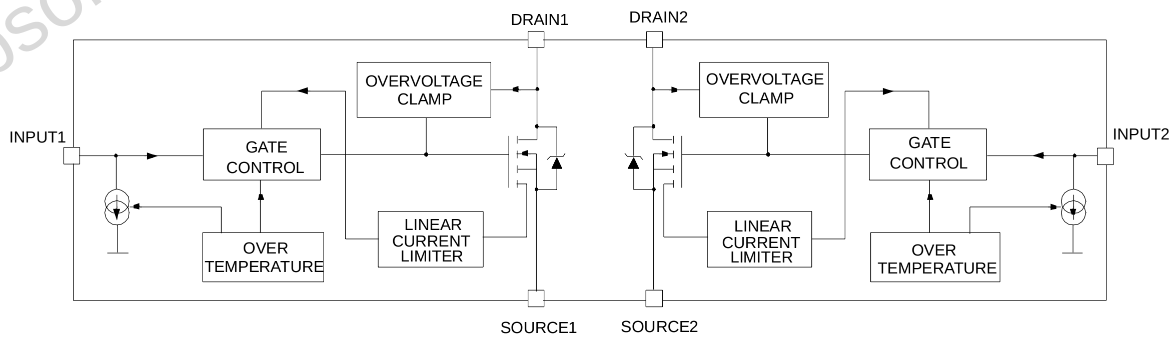
SO-8

DESCRIPTION

The VNS3NV04D is a device formed by two monolithic OMNIFET II chips housed in a standard SO-8 package. The OMNIFET II are designed in STMicroelectronics VIPower M0-3 Technology: they are intended for replacement of standard Power MOSFETS from DC up to 50KHz applications. Built in thermal shutdown, linear current limitation and overvoltage clamp protects the chip in harsh environments.

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

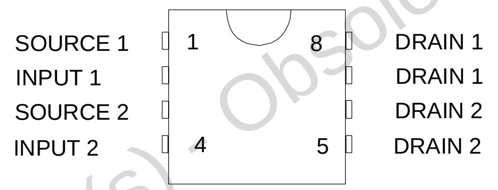
BLOCK DIAGRAM



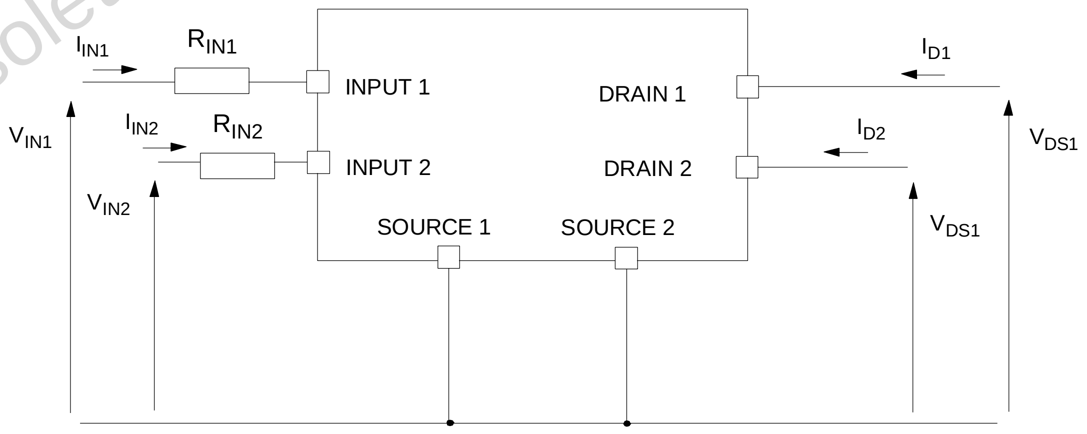
ABSOLUTE MAXIMUM RATING

Symbol	Parameter	Value	Unit
V_{DSn}	Drain-source Voltage (V_{INn}=0V)	Internally Clamped	V
V_{INn}	Input Voltage	Internally Clamped	V
I_{INn}	Input Current	+/-20	mA
$R_{IN\ MINn}$	Minimum Input Series Impedance	220	Ω
I_{Dn}	Drain Current	Internally Limited	A
I_{Rn}	Reverse DC Output Current	-5.5	A
V_{ESD1}	Electrostatic Discharge (R=1.5KΩ, C=100pF)	4000	V
V_{ESD2}	Electrostatic Discharge on output pins only (R=330Ω, C=150pF)	16500	V
P_{tot}	Total Dissipation at T_c=25°C	4	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

CONNECTION DIAGRAM (TOP VIEW)



CURRENT AND VOLTAGE CONVENTIONS



THERMAL DATA

Symbol	Parameter		Value	Unit
$R_{thj-lead}$	Thermal Resistance Junction-lead (per channel)	MAX	30	°C/W
$R_{thj-amb}$	Thermal Resistance Junction-ambient	MAX	80(*)	°C/W

(*) When mounted on a standard single-sided FR4 board with 50mm^2 of Cu (at least 35 µm thick) connected to all DRAIN pins of the relative channel.

ELECTRICAL CHARACTERISTICS (-40°C < T_j < 150°C, unless otherwise specified)
(Per each device)

OFF

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{CLAMP}	Drain-source Clamp Voltage	V_{IN}=0V; I_D=1.5A	40	45	55	V
V_{CLTH}	Drain-source Clamp Threshold Voltage	V_{IN}=0V; I_D=2mA	36			V
V_{INTH}	Input Threshold Voltage	V_{DS}=V_{IN}; I_D=1mA	0.5		2.5	V
I_{ISS}	Supply Current from Input Pin	V_{DS}=0V; V_{IN}=5V		100	150	µA
V_{INCL}	Input-Source Clamp Voltage	I_{IN}=1mA I_{IN}=-1mA	6 -1.0	6.8	8 -0.3	V
I_{DSS}	Zero Input Voltage Drain Current (V_{IN}=0V)	V_{DS}=13V; V_{IN}=0V; T_j=25°C V_{DS}=25V; V_{IN}=0V			30 75	µA

ON

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$R_{DS(on)}$	Static Drain-source On Resistance	V_{IN}=5V; I_D=1.5A; T_j=25°C V_{IN}=5V; I_D=1.5A			120 240	mΩ

ELECTRICAL CHARACTERISTICS (continued) (T_j=25°C, unless otherwise specified)

DYNAMIC

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
g_{fs} (*)	Forward Transconductance	V_{DD}=13V; I_D=1.5A		5.0		S
C_{OSS}	Output Capacitance	V_{DS}=13V; f=1MHz; V_{IN}=0V		150		pF

SWITCHING

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$t_{d(on)}$	Turn-on Delay Time	V_{DD}=15V; I_D=1.5A V_{gen}=5V; R_{gen}=$R_{IN\ MINn}$=220Ω (see figure 1)		90	300	ns
t_r	Rise Time			250	750	ns
$t_{d(off)}$	Turn-off Delay Time			450	1350	ns
t_f	Fall Time			250	750	ns
$t_{d(on)}$	Turn-on Delay Time	V_{DD}=15V; I_D=1.5A V_{gen}=5V; R_{gen}=2.2KΩ (see figure 1)		0.45	1.35	µs
t_r	Rise Time			2.5	7.5	µs
$t_{d(off)}$	Turn-off Delay Time			3.3	10.0	µs
t_f	Fall Time			2.0	6.0	µs
$(dI/dt)_{on}$	Turn-on Current Slope	V_{DD}=15V; I_D=1.5A V_{gen}=5V; R_{gen}=$R_{IN\ MINn}$=220Ω		4.7		A/µs
Q_i	Total Input Charge	V_{DD}=12V; I_D=1.5A; V_{IN}=5V I_{gen} =2.13mA (see figure 5)		8.5		nC

SOURCE DRAIN DIODE

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{SD} (*)	Forward On Voltage	I_{SD}=1.5A; V_{IN}=0V		0.8		V
t_{rr}	Reverse Recovery Time	I_{SD}=1.5A; dI/dt=12A/µs V_{DD}=30V; L=200µH (see test circuit, figure 2)		107		ns
Q_{rr}	Reverse Recovery Charge			37		µC
I_{RRM}	Reverse Recovery Current			0.7		A

PROTECTIONS (-40°C < T_j < 150°C, unless otherwise specified)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
I_{lim}	Drain Current Limit	V_{IN}=5V; V_{DS}=13V	3.5	5	7	A
t_{dlim}	Step Response Current Limit	V_{IN}=5V; V_{DS}=13V		10		µs
T_{jsh}	Overtemperature Shutdown		150	175	200	°C
T_{jrs}	Overtemperature Reset		135			°C
I_{gf}	Fault Sink Current	V_{IN}=5V; V_{DS}=13V; T_j=T_{jsh}	10	15	20	mA
E_{as}	Single Pulse Avalanche Energy	starting T_j=25°C; V_{DD}=24V V_{IN}=5V; R_{gen}=$R_{IN\ MINn}$=220Ω; L=24mH (see figures 3 & 4)	100			mJ

(*) Pulsed: Pulse duration = 300µs, duty cycle 1.5%

PROTECTION FEATURES

During normal operation, the INPUT pin is electrically connected to the gate of the internal power MOSFET through a low impedance path.

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 I_{ISS} (typ. 100μA) flows into the INPUT pin in order to supply the internal circuitry.

The device integrates:

- OVERVOLTAGE CLAMP PROTECTION: internally set at 45V, 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 of about 15°C below shut-down temperature.

- STATUS FEEDBACK: in the case of an overtemperature fault condition ($T_j > T_{jsh}$), the device tries to sink a diagnostic current I_{gf} through the INPUT pin in order to indicate fault condition. If driven from a low impedance source, this current may be used in order to warn the control circuit of a device shutdown. If the drive impedance is high enough so that the INPUT pin driver is not able to supply the current I_{gf}, the INPUT pin will fall to 0V. **This will not however affect the device operation: no requirement is put on the current capability of the INPUT pin driver except to be able to supply the normal operation drive current I_{ISS}.**

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.

Fig.1: Switching Time Test Circuit for Resistive Load

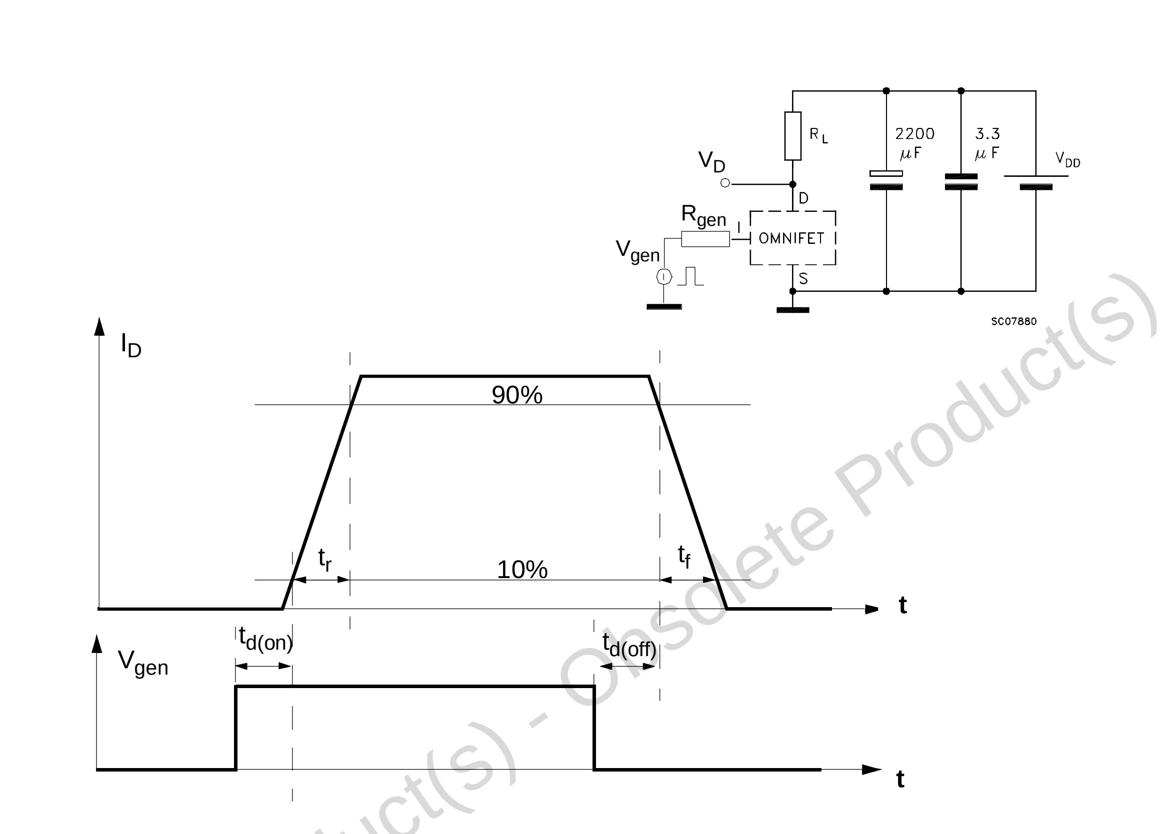


Fig.2: Test Circuit for Diode Recovery Times

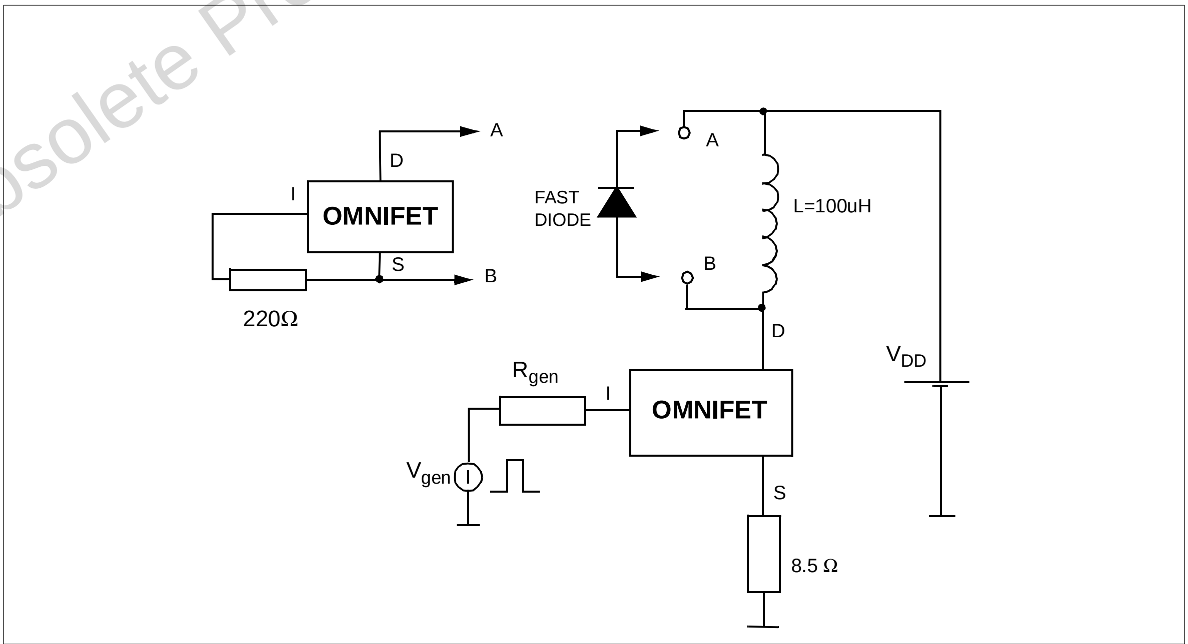


Fig. 3: Unclamped Inductive Load Test Circuits

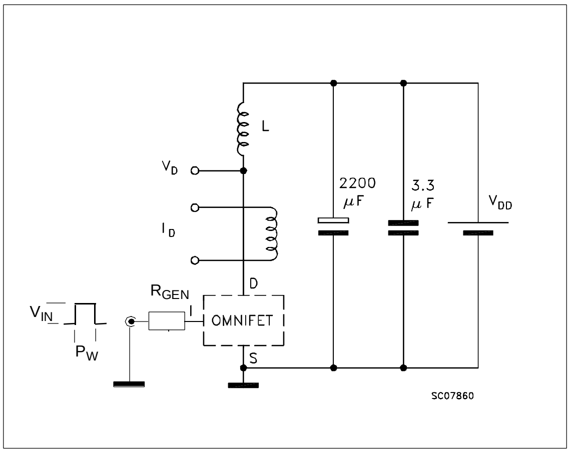


Fig. 4: Unclamped Inductive Waveforms

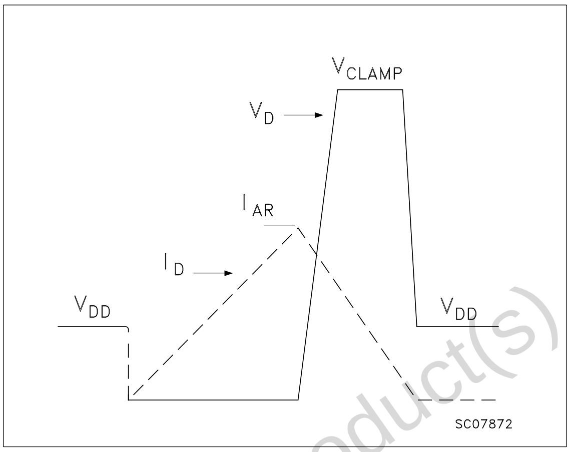
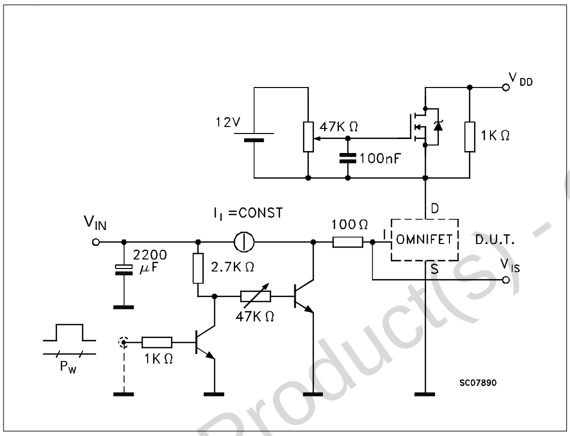
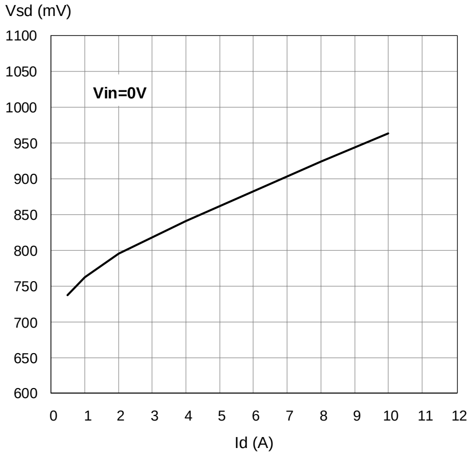


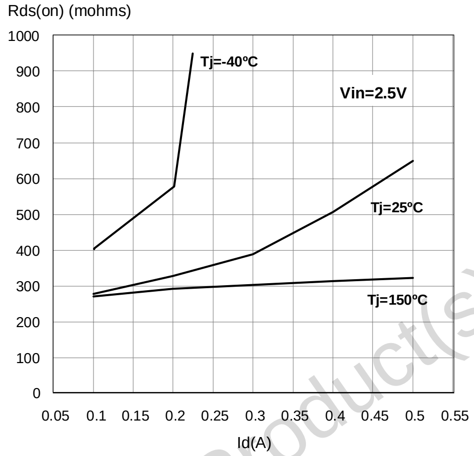
Fig. 5: Input Charge Test Circuit



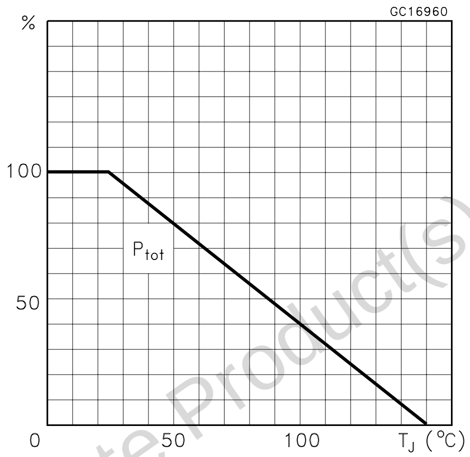
Source-Drain Diode Forward Characteristics



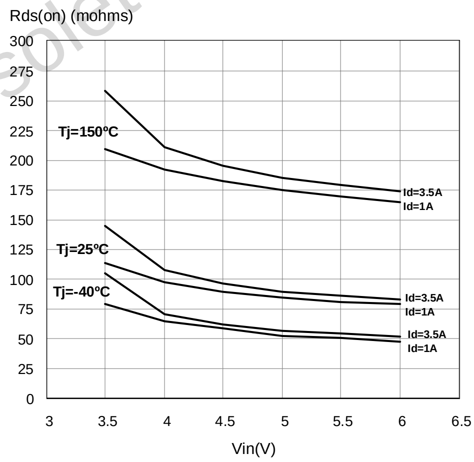
Static Drain Source On Resistance



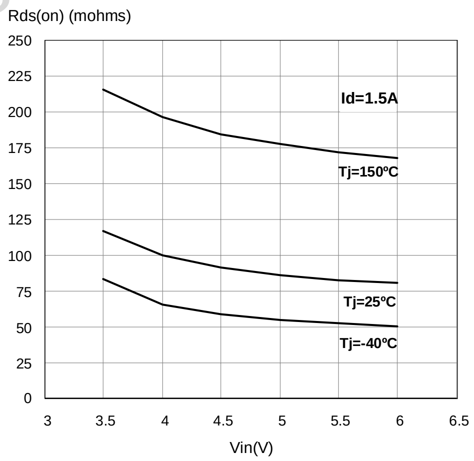
Derating Curve



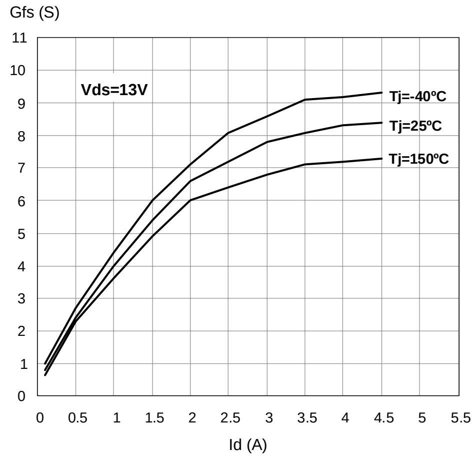
Static Drain-Source On resistance Vs. Input Voltage



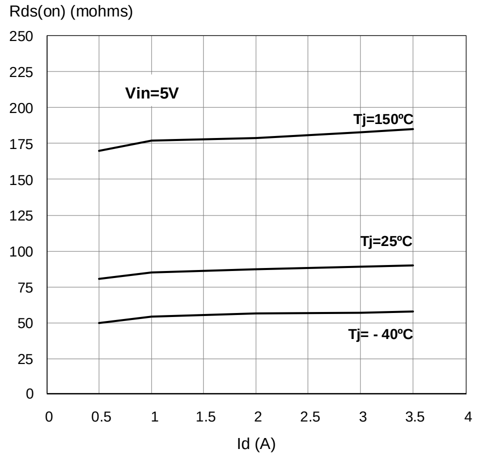
Static Drain-Source On resistance Vs. Input Voltage



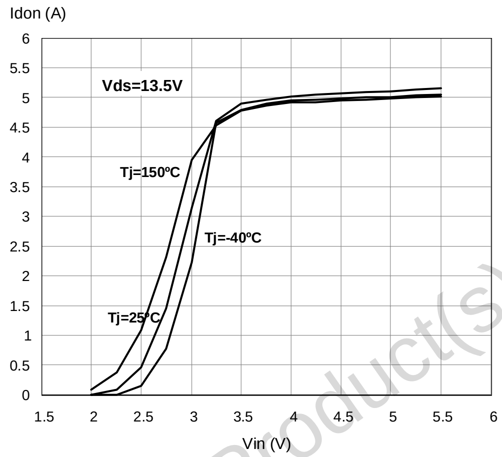
Transconductance



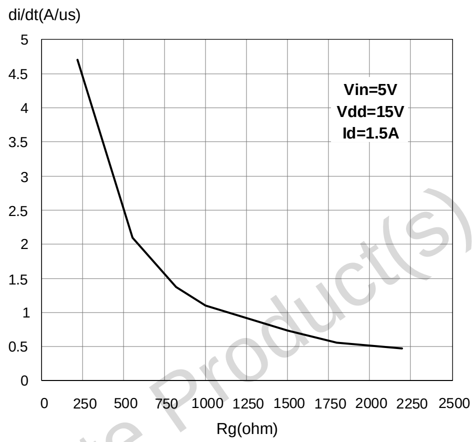
Static Drain-Source On Resistance Vs. Id



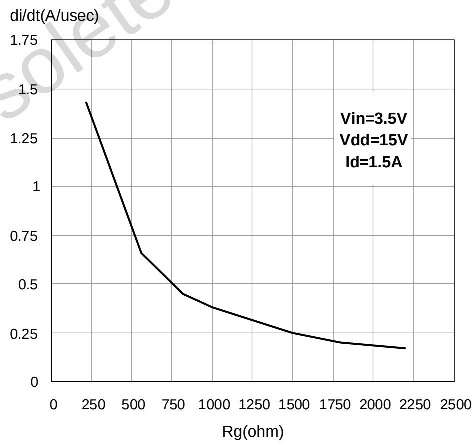
Transfer Characteristics



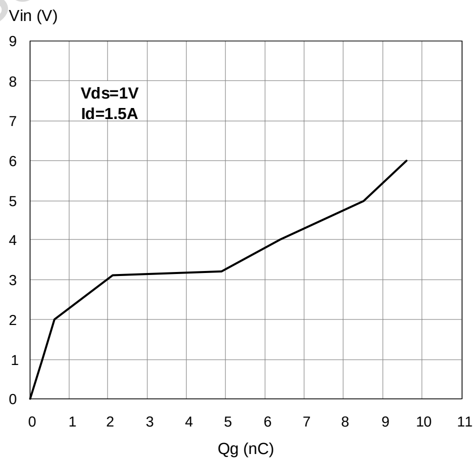
Turn On Current Slope



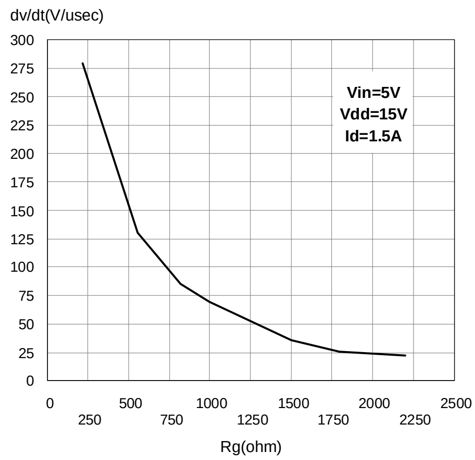
Turn On Current Slope



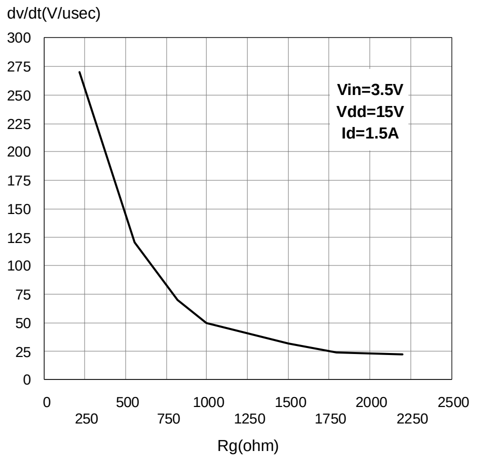
Input Voltage Vs. Input Charge



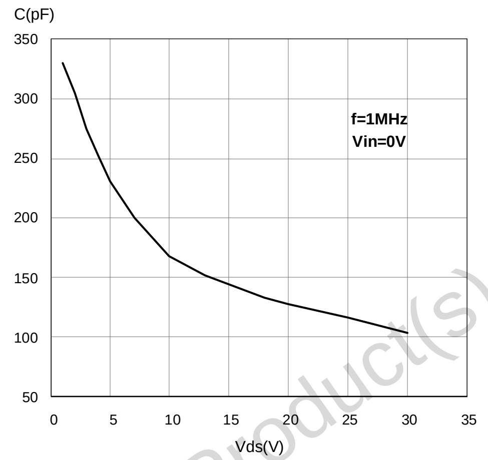
Turn off drain source voltage slope



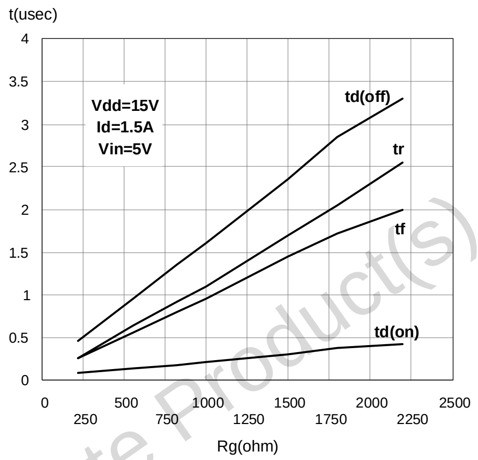
Turn Off Drain-Source Voltage Slope



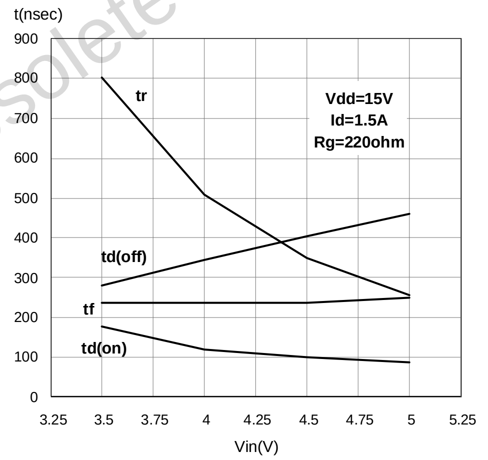
Capacitance Variations



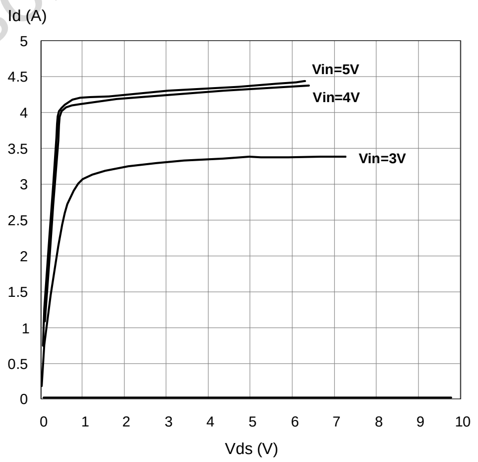
Switching Time Resistive Load



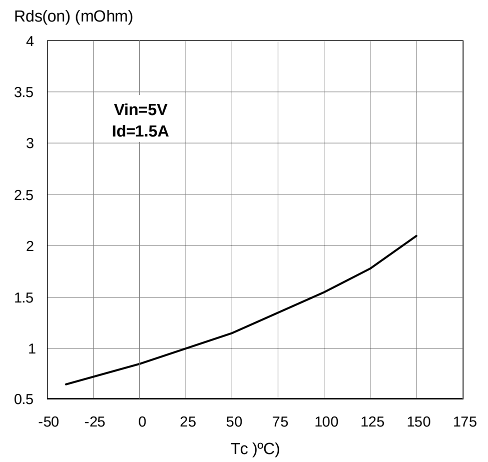
Switching Time Resistive Load



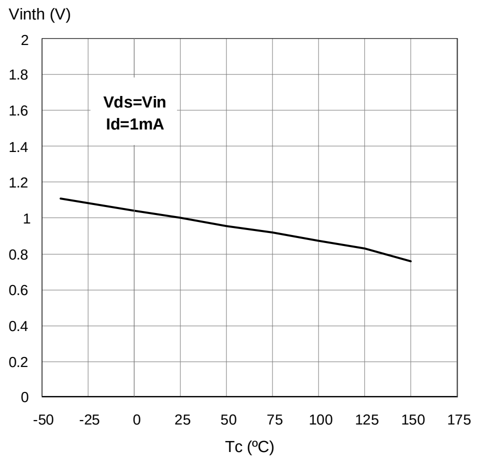
Output Characteristics



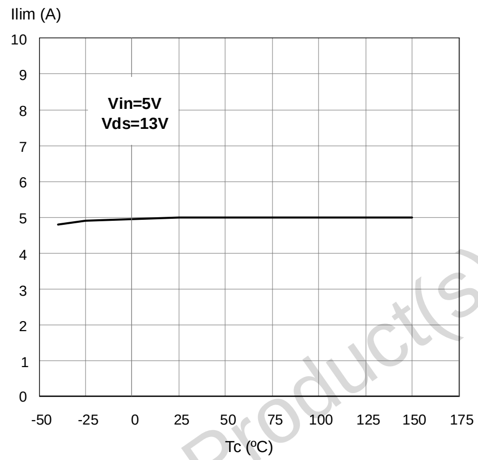
Normalized On Resistance Vs. Temperature



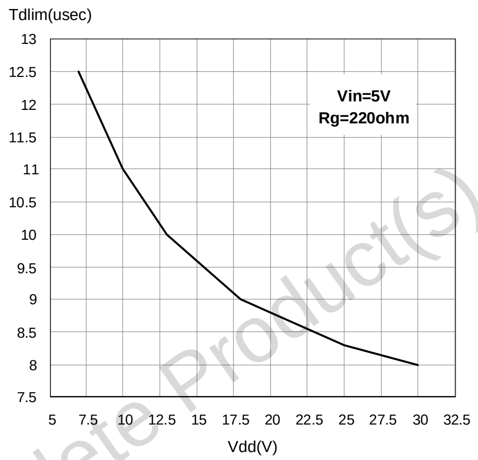
Normalized Input Threshold Voltage Vs. Temperature



Normalized Current Limit Vs. Junction Temperature

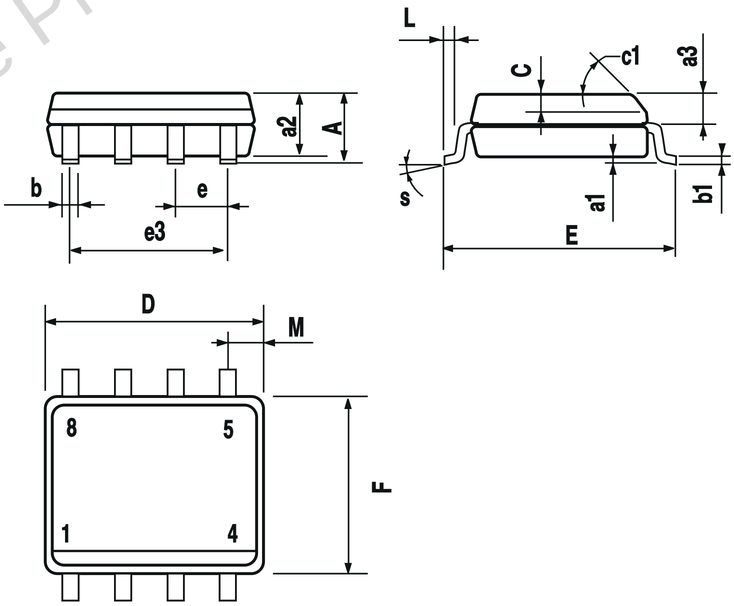


Step Response Current Limit

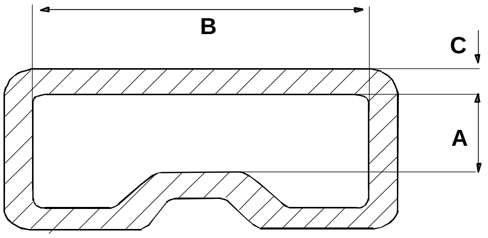


SO-8 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.75			0.068
a1	0.1		0.25	0.003		0.009
a2			1.65			0.064
a3	0.65		0.85	0.025		0.033
b	0.35		0.48	0.013		0.018
b1	0.19		0.25	0.007		0.010
C	0.25		0.5	0.010		0.019
c1	45 (typ.)					
D	4.8		5.0	0.188		0.196
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		3.81			0.150	
F	3.8		4.0	0.14		0.157
L	0.4		1.27	0.015		0.050
M			0.6			0.023
F	8 (max.)					



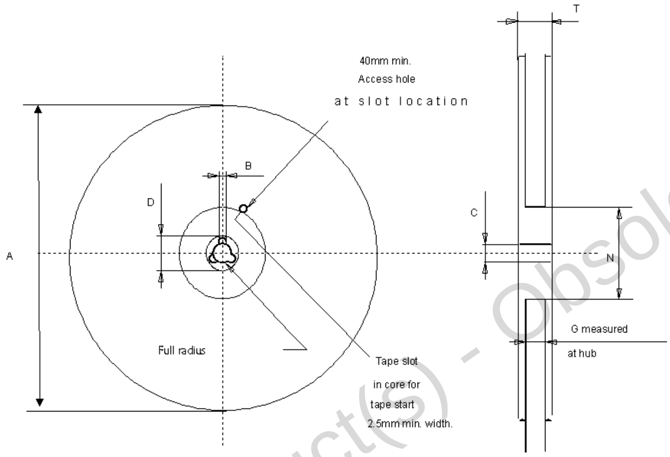
SO-8 TUBE SHIPMENT (no suffix)



Base Q.ty	100
Bulk Q.ty	2000
Tube length (± 0.5)	532
A	3.2
B	6
C (± 0.1)	0.6

All dimensions are in mm.

TAPE AND REEL SHIPMENT (suffix “13TR”)



REEL DIMENSIONS

Base Q.ty	2500
Bulk Q.ty	2500
A (max)	330
B (min)	1.5
C (± 0.2)	13
F	20.2
G (+ 2 / -0)	12.4
N (min)	60
T (max)	18.4

All dimensions are in mm.

TAPE DIMENSIONS

According to Electronic Industries Association (EIA) Standard 481 rev. A, Feb 1986

Tape width	**W**	12
Tape Hole Spacing	**P0 (± 0.1)**	4
Component Spacing	**P**	8
Hole Diameter	**D (± 0.1/-0)**	1.5
Hole Diameter	**D1 (min)**	1.5
Hole Position	**F (± 0.05)**	5.5
Compartment Depth	**K (max)**	4.5
Hole Spacing	**P1 (± 0.1)**	2

All dimensions are in mm.