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# VNB35NV04 / VNP35NV04 VNV35NV04 / VNW35NV04

## “OMNIFET II”: FULLY AUTOPROTECTED POWER MOSFET

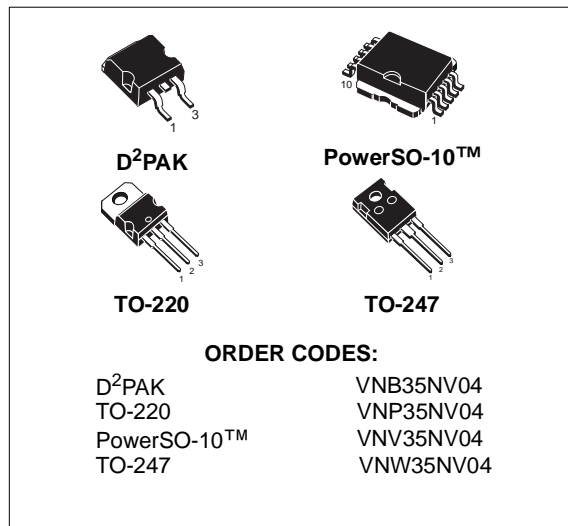
TYPE	$R_{DS(on)}$	$I_{lim}$	$V_{clamp}$
VNB35NV04	10 m $\Omega$ (*)	30 A	40 V
VNP35NV04			
VNV35NV04			
VNW35NV04			

(\*) For PowerSO-10 only

- 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

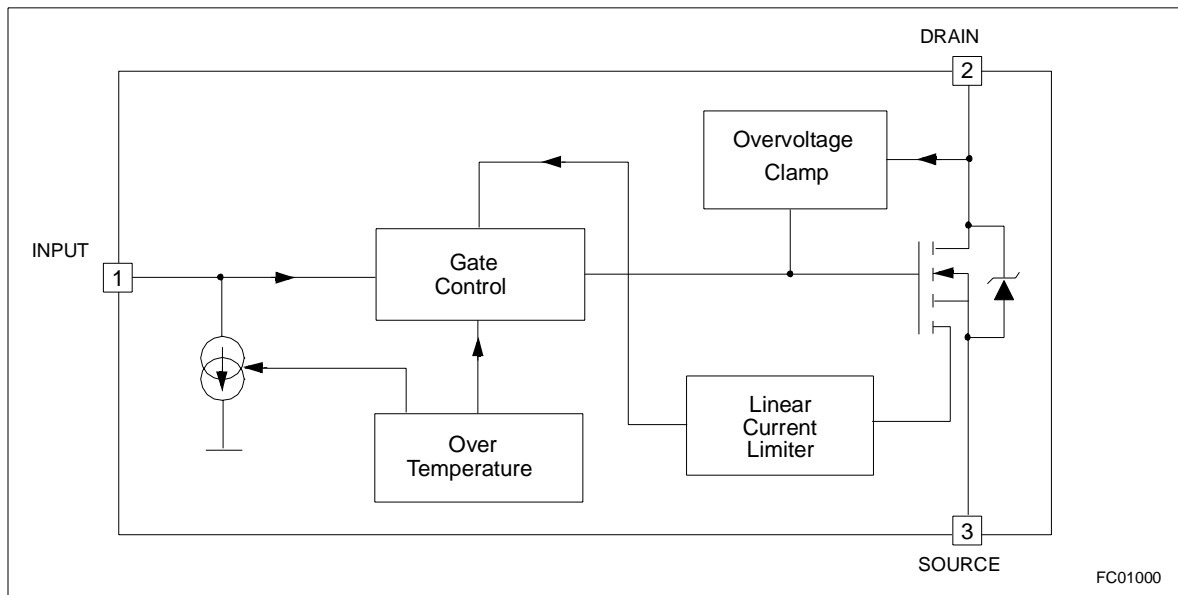
### DESCRIPTION

The VNB35NV04, VNP35NV04, VNV35NV04, VNW35NV04 are monolithic devices designed in STMicroelectronics VIPower M0-3 Technology,



intended for replacement of standard Power MOSFETS from DC up to 25KHz applications. Built in thermal shutdown, 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

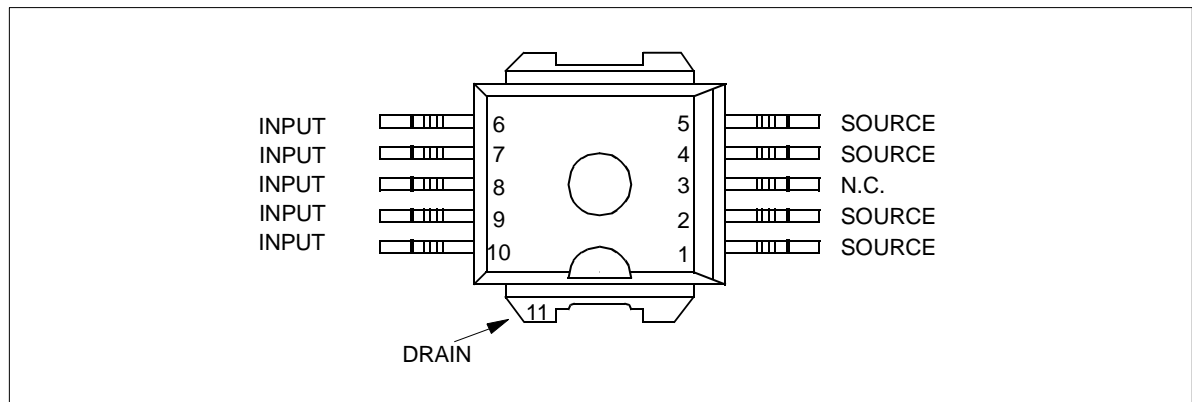


## VNB35NV04 / VNP35NV04 / VNV35NV04 / VNW35NV04

### ABSOLUTE MAXIMUM RATING

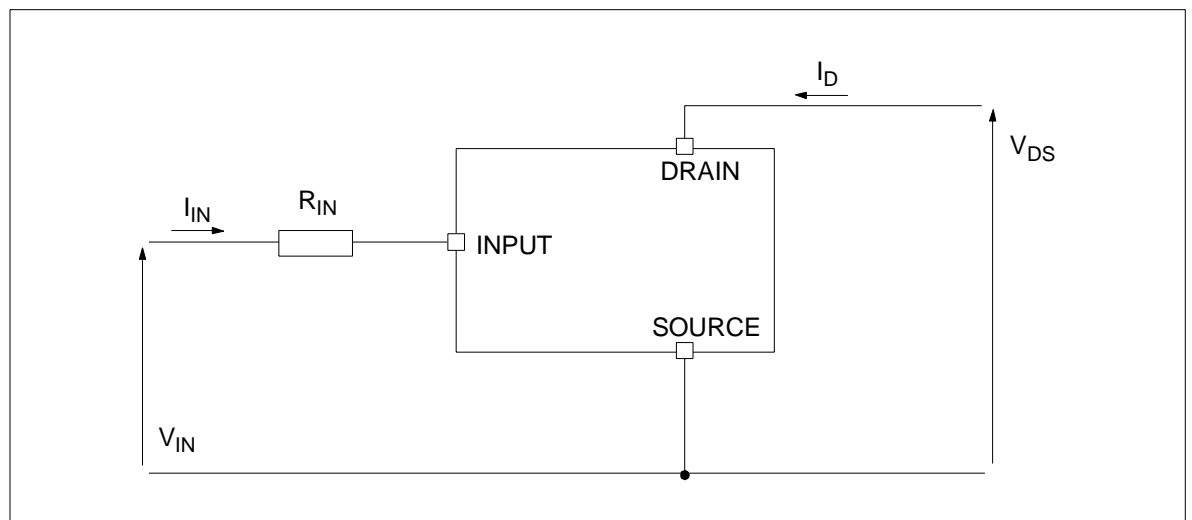
Symbol	Parameter	Value				Unit
		PowerSO-10™	D <sup>2</sup> PAK	TO-220	TO-247	
$V_{DS}$	Drain-source Voltage ( $V_{IN}=0V$ )	Internally Clamped				V
$V_{IN}$	Input Voltage	Internally Clamped				V
$I_{IN}$	Input Current	+/-20				mA
$R_{IN\ MIN}$	Minimum Input Series Impedance	4.7				$\Omega$
$I_D$	Drain Current	Internally Limited				A
$I_R$	Reverse DC Output Current	-30				A
$V_{ESD1}$	Electrostatic Discharge ( $R=1.5K\Omega$ , $C=100pF$ )	4000				V
$V_{ESD2}$	Electrostatic Discharge on output pin only ( $R=330\Omega$ , $C=150pF$ )	16500				V
$P_{tot}$	Total Dissipation at $T_c=25^\circ C$	125	125	125	208	W
$T_j$	Operating Junction Temperature	Internally limited				$^\circ C$
$T_c$	Case Operating Temperature	Internally limited				$^\circ C$
$T_{stg}$	Storage Temperature	-55 to 150				$^\circ C$

### CONNECTION DIAGRAM (TOP VIEW)



(\*) For the pins configuration related to TO-220, TO-247, D<sup>2</sup>PAK, see outlines at page 1.

### CURRENT AND VOLTAGE CONVENTIONS



**THERMAL DATA**

Symbol	Parameter	MAX	Value				Unit
			PowerSO-10™	D2PAK	TO-220	TO-247	
R <sub>thj-case</sub>	Thermal Resistance Junction-case		1	1	1	0.6	°C/W
R <sub>thj-amb</sub>	Thermal Resistance Junction-ambient		50(*)	50(*)	50	30	°C/W

(\*) When mounted on a standard single-sided FR4 board with 50mm<sup>2</sup> of Cu (at least 35 μm thick) connected to all DRAIN pins.

**ELECTRICAL CHARACTERISTICS** (-40°C < T<sub>j</sub> < 150°C, unless otherwise specified)

OFF

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V <sub>CLAMP</sub>	Drain-source Clamp Voltage	V <sub>IN</sub> =0V; I <sub>D</sub> =15A	40	45	55	V
V <sub>CLTH</sub>	Drain-source Clamp Threshold Voltage	V <sub>IN</sub> =0V; I <sub>D</sub> =2mA	36			V
V <sub>INTH</sub>	Input Threshold Voltage	V <sub>DS</sub> =V <sub>IN</sub> ; I <sub>D</sub> =1mA	0.5		2.5	V
I <sub>ISS</sub>	Supply Current from Input Pin	V <sub>DS</sub> =0V; V <sub>IN</sub> =5V		100	150	μA
V <sub>INCL</sub>	Input-Source Clamp Voltage	I <sub>IN</sub> =1mA I <sub>IN</sub> =-1mA	6 -1.0	6.8	8 -0.3	V
I <sub>DSS</sub>	Zero Input Voltage Drain Current (V <sub>IN</sub> =0V)	V <sub>DS</sub> =13V; V <sub>IN</sub> =0V; T <sub>j</sub> =25°C V <sub>DS</sub> =25V; V <sub>IN</sub> =0V			30 75	μA

ON

Symbol	Parameter	Test Conditions	Max		Unit
			PowerSO-10	D <sup>2</sup> PAK TO-220 / TO-247	
R <sub>DS(on)</sub>	Static Drain-source On Resistance	V <sub>IN</sub> =5V; I <sub>D</sub> =15A; T <sub>j</sub> =25°C V <sub>IN</sub> =5V; I <sub>D</sub> =15A; T <sub>j</sub> =150°C	10 20	13 24	mΩ

## VNB35NV04 / VNP35NV04 / VNV35NV04 / VNW35NV04

### ELECTRICAL CHARACTERISTICS (continued) ( $T_j=25^\circ\text{C}$ , unless otherwise specified)

#### DYNAMIC

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$g_{fs}^*$	Forward Transconductance	$V_{DD}=13\text{V}; I_D=15\text{A}$		35		S
$C_{OSS}$	Output Capacitance	$V_{DS}=13\text{V}; f=1\text{MHz}; V_{IN}=0\text{V}$		1300		pF

#### SWITCHING

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$t_{d(on)}$	Turn-on Delay Time	$V_{DD}=15\text{V}; I_D=15\text{A}$		150	500	ns
$t_r$	Rise Time			840	2500	ns
$t_{d(off)}$	Turn-off Delay Time	$V_{gen}=5\text{V}; R_{gen}=R_{IN\ MIN}=4.7\Omega$ (see figure 1)		980	3000	ns
$t_f$	Fall Time			600	1500	ns
$t_{d(on)}$	Turn-on Delay Time	$V_{DD}=15\text{V}; I_D=15\text{A}$		4	12	$\mu\text{s}$
$t_r$	Rise Time			27	100	$\mu\text{s}$
$t_{d(off)}$	Turn-off Delay Time	$V_{gen}=5\text{V}; R_{gen}=2.2\text{K}\Omega$ (see figure 1)		34	120	$\mu\text{s}$
$t_f$	Fall Time			31	110	$\mu\text{s}$
$(di/dt)_{on}$	Turn-on Current Slope	$V_{DD}=15\text{V}; I_D=15\text{A}$ $V_{gen}=5\text{V}; R_{gen}=R_{IN\ MIN}=4.7\Omega$		18		$\text{A}/\mu\text{s}$
$Q_i$	Total Input Charge	$V_{DD}=12\text{V}; I_D=15\text{A}; V_{IN}=5\text{V}$ $I_{gen}=2.13\text{mA}$ (see figure 5)		118		nC

#### SOURCE DRAIN DIODE

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$V_{SD}^*$	Forward On Voltage	$I_{SD}=15\text{A}; V_{IN}=0\text{V}$		0.8		V
$t_{rr}$	Reverse Recovery Time	$I_{SD}=15\text{A}; di/dt=100\text{A}/\mu\text{s}$		400		ns
$Q_{rr}$	Reverse Recovery Charge	$V_{DD}=30\text{V}; L=200\mu\text{H}$		1.4		$\mu\text{C}$
$I_{RRM}$	Reverse Recovery Current	(see test circuit, figure 2)		7		A

#### PROTECTIONS ( $-40^\circ\text{C} < T_j < 150^\circ\text{C}$ , unless otherwise specified)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$I_{lim}$	Drain Current Limit	$V_{IN}=6\text{V}; V_{DS}=13\text{V}$	30	45	60	A
$t_{dlim}$	Step Response Current Limit	$V_{IN}=6\text{V}; V_{DS}=13\text{V}$		50		$\mu\text{s}$
$T_{jsh}$	Overtemperature Shutdown		150	175	200	$^\circ\text{C}$
$T_{jrs}$	Overtemperature Reset		135			$^\circ\text{C}$
$I_{gf}$	Fault Sink Current	$V_{IN}=5\text{V}; V_{DS}=13\text{V}; T_j=T_{jsh}$	10	15	20	mA
$E_{as}$	Single Pulse Avalanche Energy	starting $T_j=25^\circ\text{C}; V_{DD}=24\text{V}$ $V_{IN}=5\text{V}; R_{gen}=R_{IN\ MIN}=4.7\Omega; L=24\text{mH}$ (see figures 3 & 4)	1.7			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 through a low impedance path.

The device then behaves like a standard power MOSFET and can be used as a switch from DC up to 25KHz. The only difference from the user's standpoint is that a small DC current  $I_{SS}$  (typ. 100 $\mu$ A) 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 voltages is. 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  $I_{SS}$ .**

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

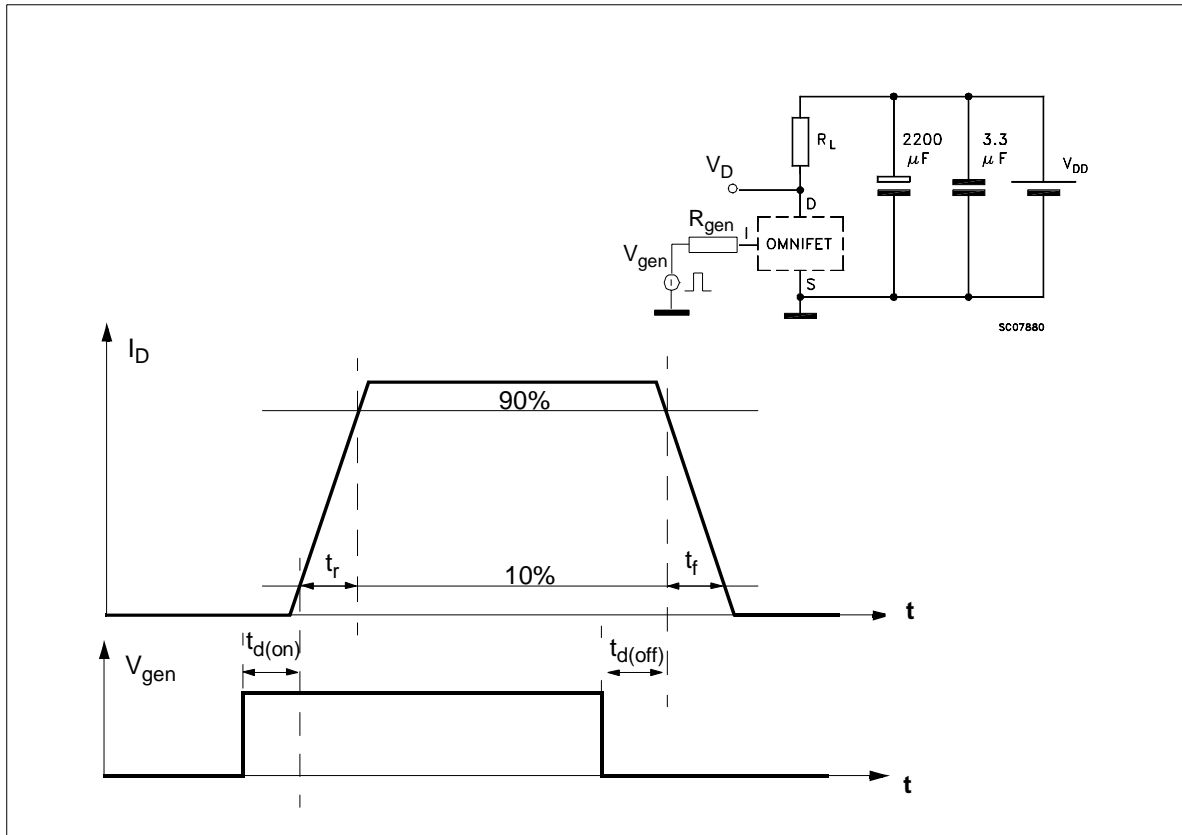


Fig.2: Test Circuit for Diode Recovery Times

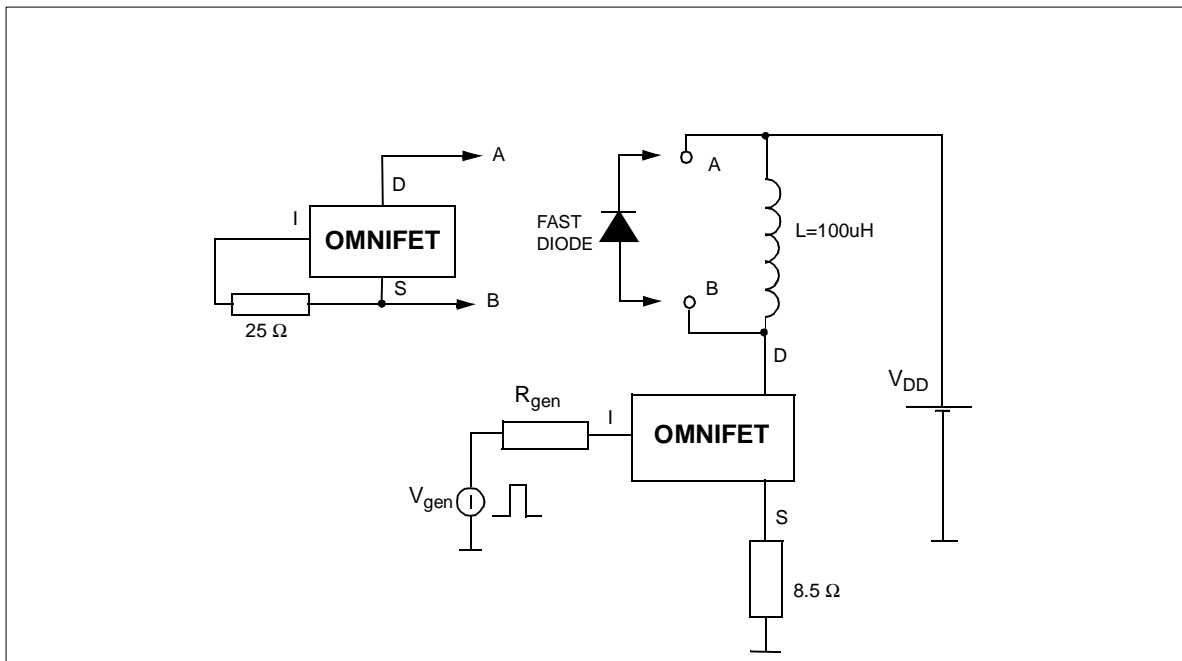


Fig. 3: Unclamped Inductive Load Test Circuits

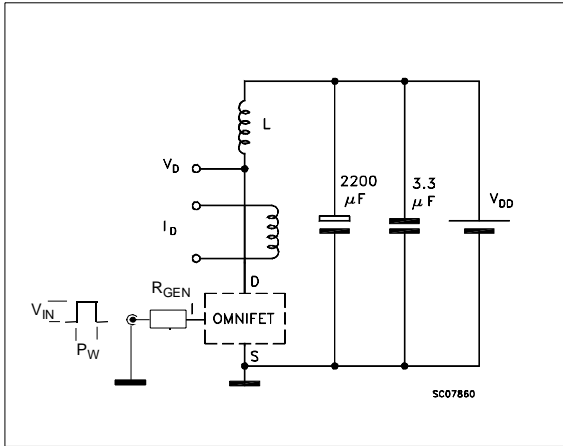


Fig. 4: Unclamped Inductive Waveforms

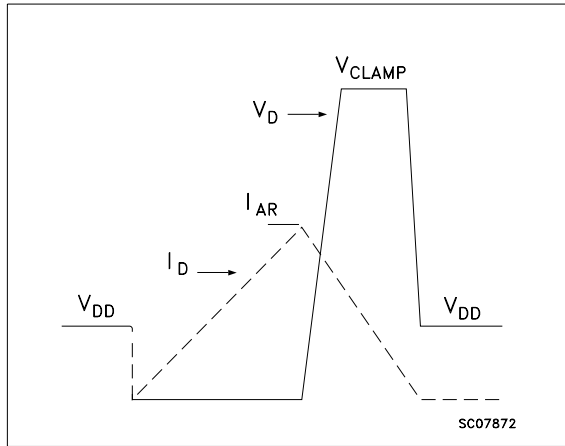


Fig. 5: Input Charge Test Circuit

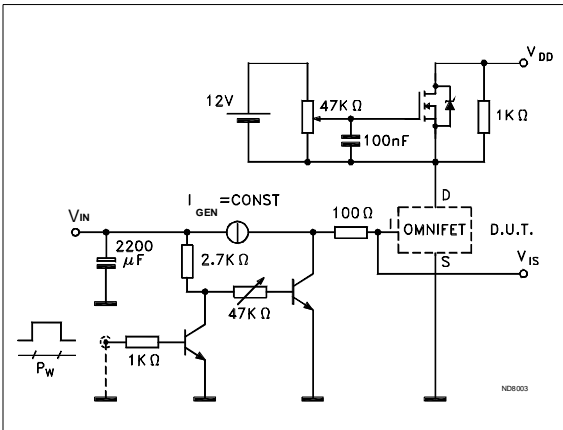


Fig 6 : Thermal Impedance for TO-220

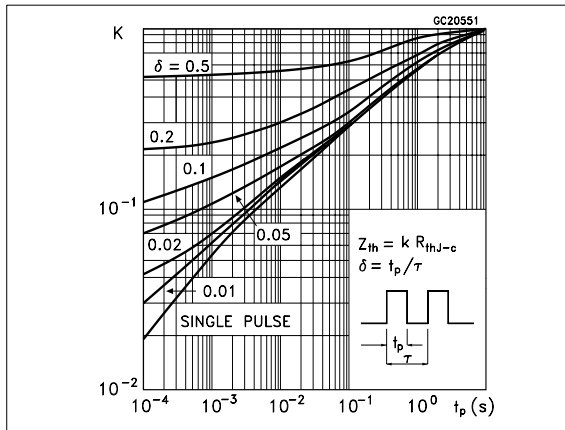
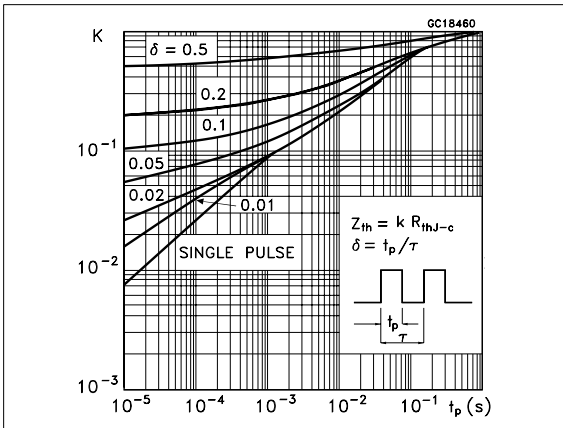
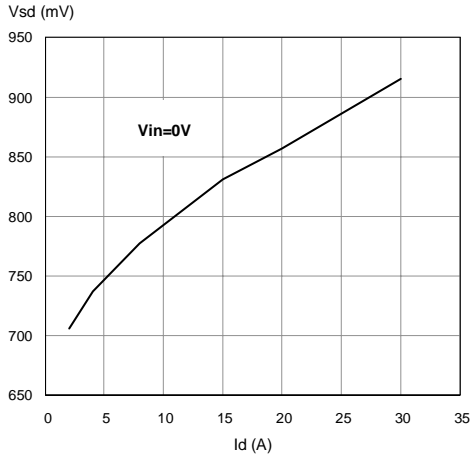


Fig. 7: Thermal Impedance for TO-247

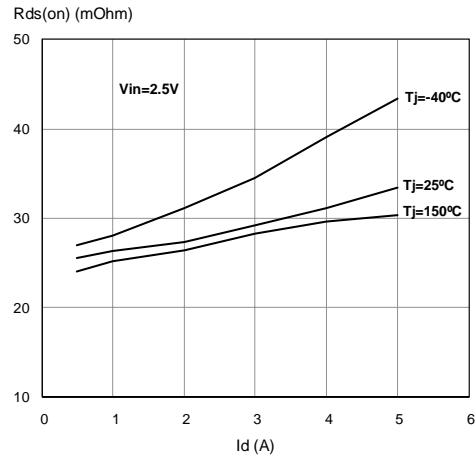




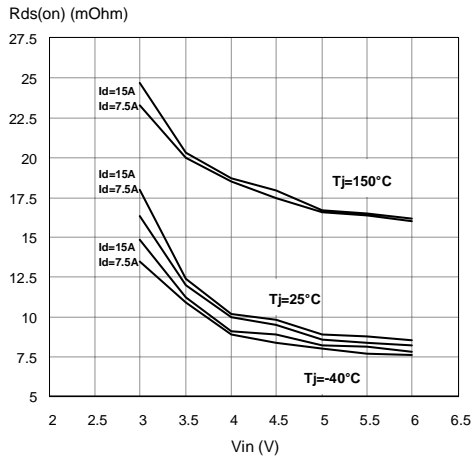
Source-Drain Diode Forward Characteristics



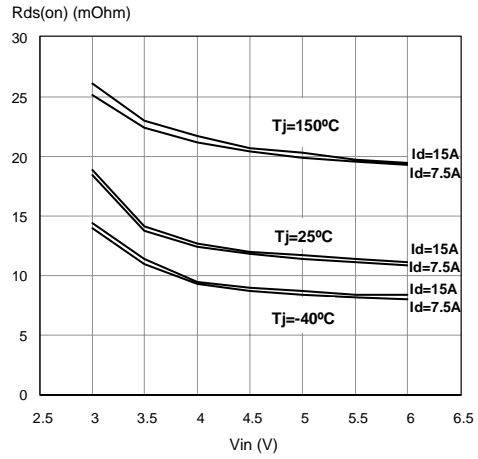
Static Drain Source On Resistance



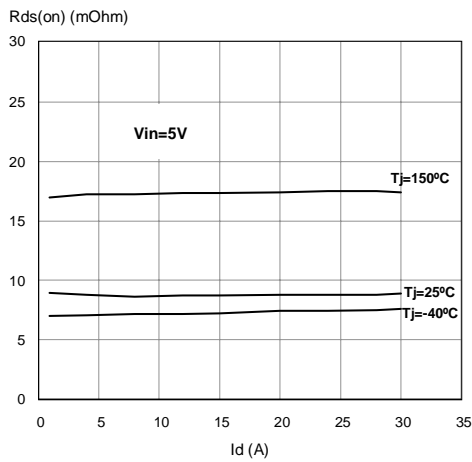
PowerSO-10 Static Drain-Source On resistance Vs. Input Voltage



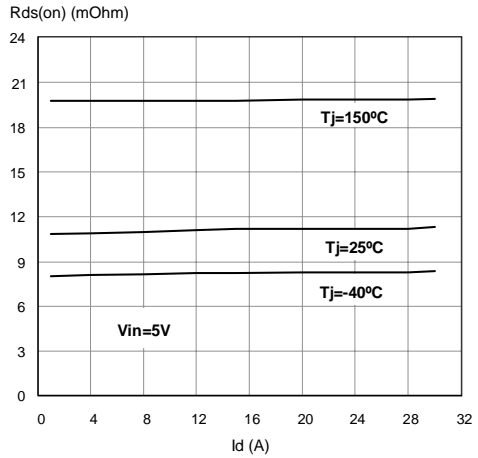
D2PAK, TO-220 & TO-247 Static Drain-Source On resistance Vs. Input Voltage



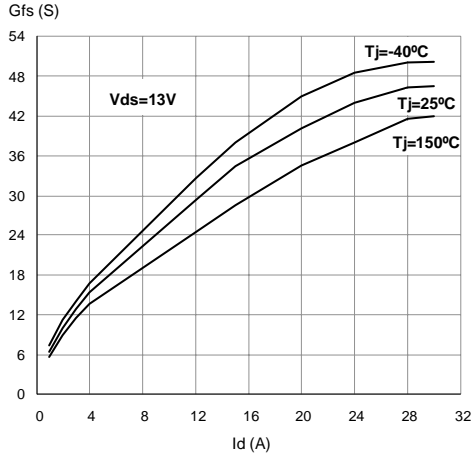
PowerSO-10 Static Drain-Source On Resistance Vs. Id



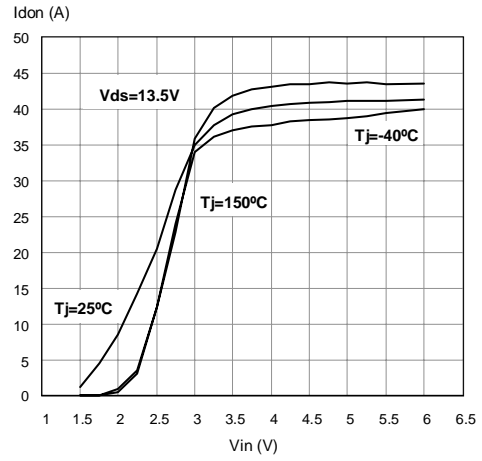
D2PAK, TO-220 & TO-247 Static Drain-Source On Resistance Vs. Id



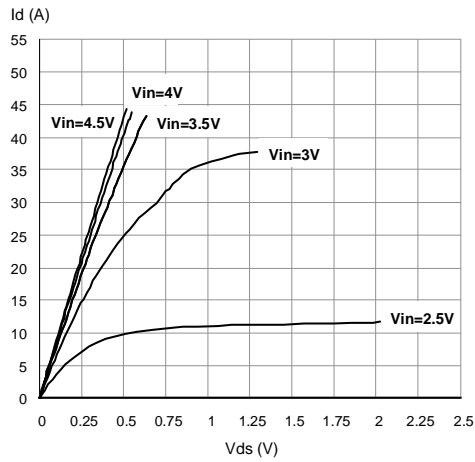
Transconductance



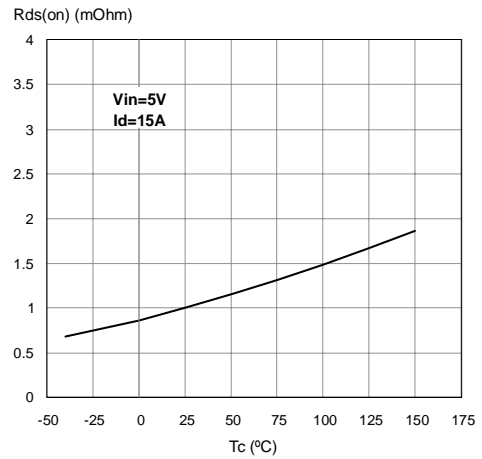
Transfer Characteristics



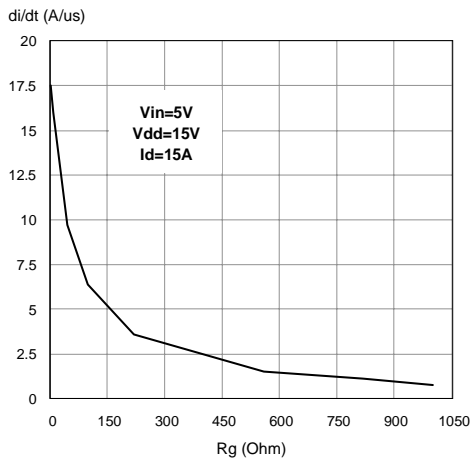
Output Characteristics



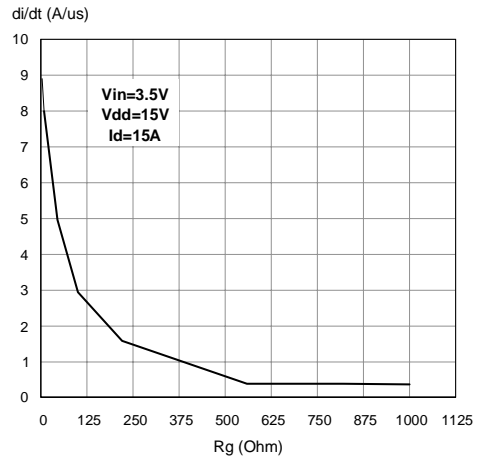
Normalized On Resistance Vs. Temperature



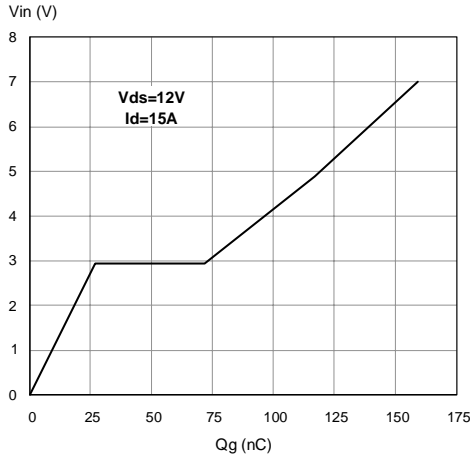
Turn On Current Slope



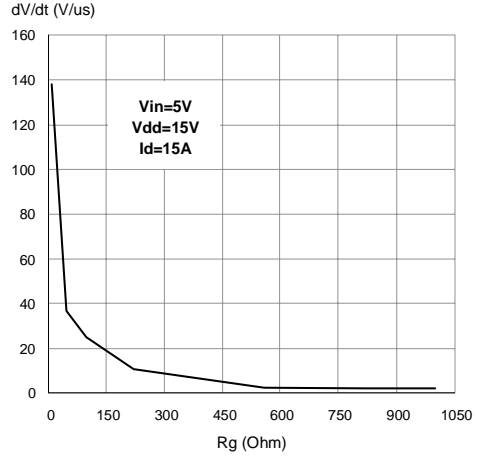
Turn On Current Slope



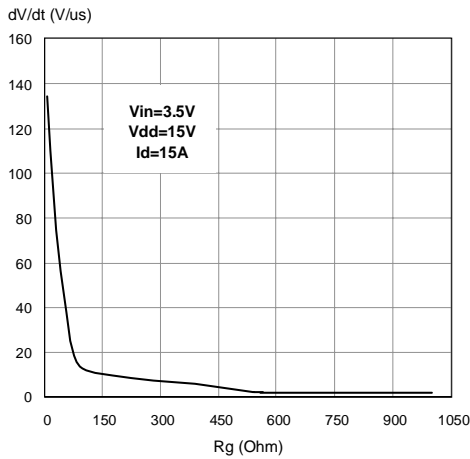
Input Voltage Vs. Input Charge



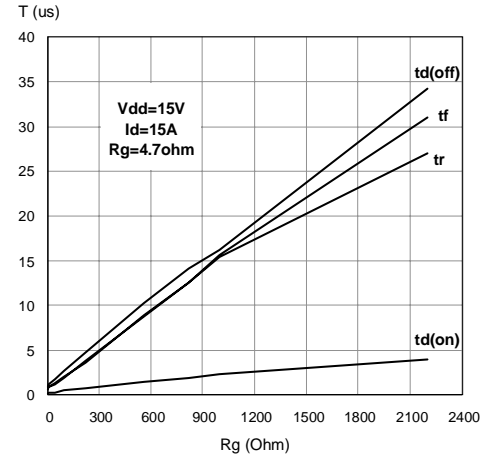
Turn off drain source voltage slope



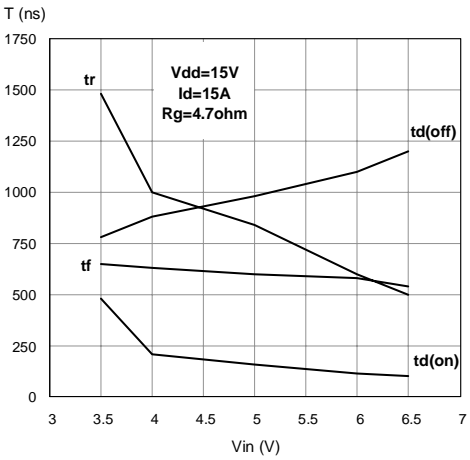
Turn Off Drain-Source Voltage Slope



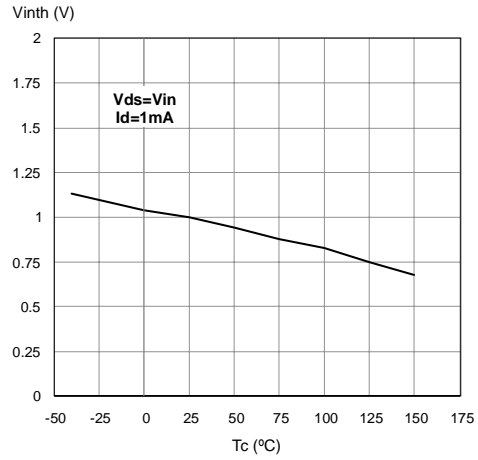
Switching Time Resistive Load



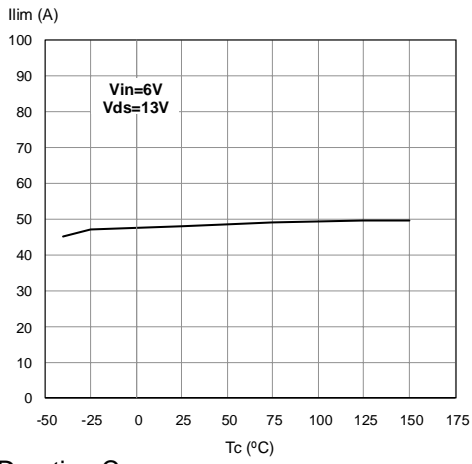
Switching Time Resistive Load



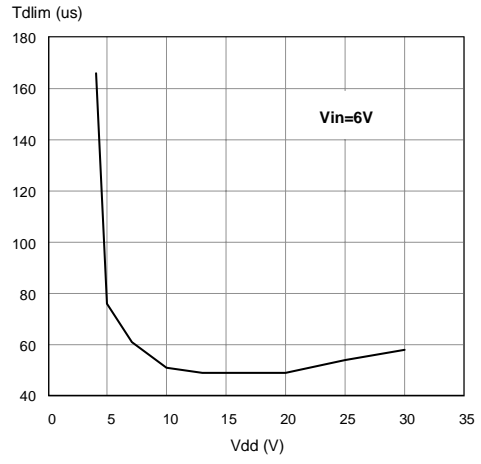
Normalized Input Threshold Voltage Vs. Temperature



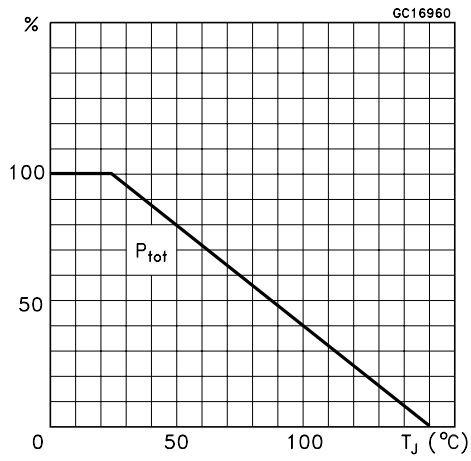
Current Limit Vs. Junction Temperature



Step Response Current Limit

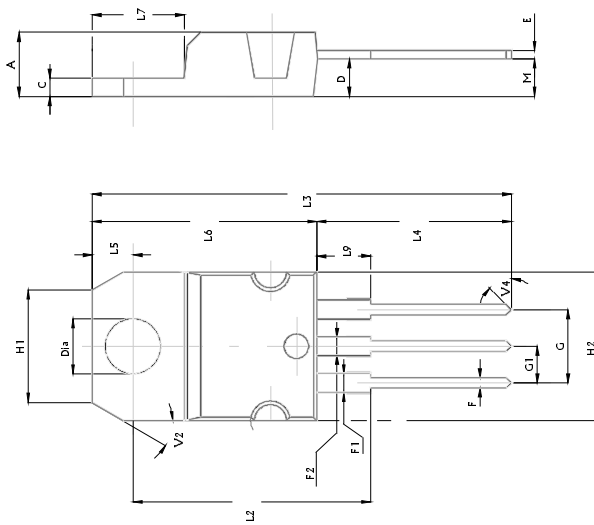


Derating Curve



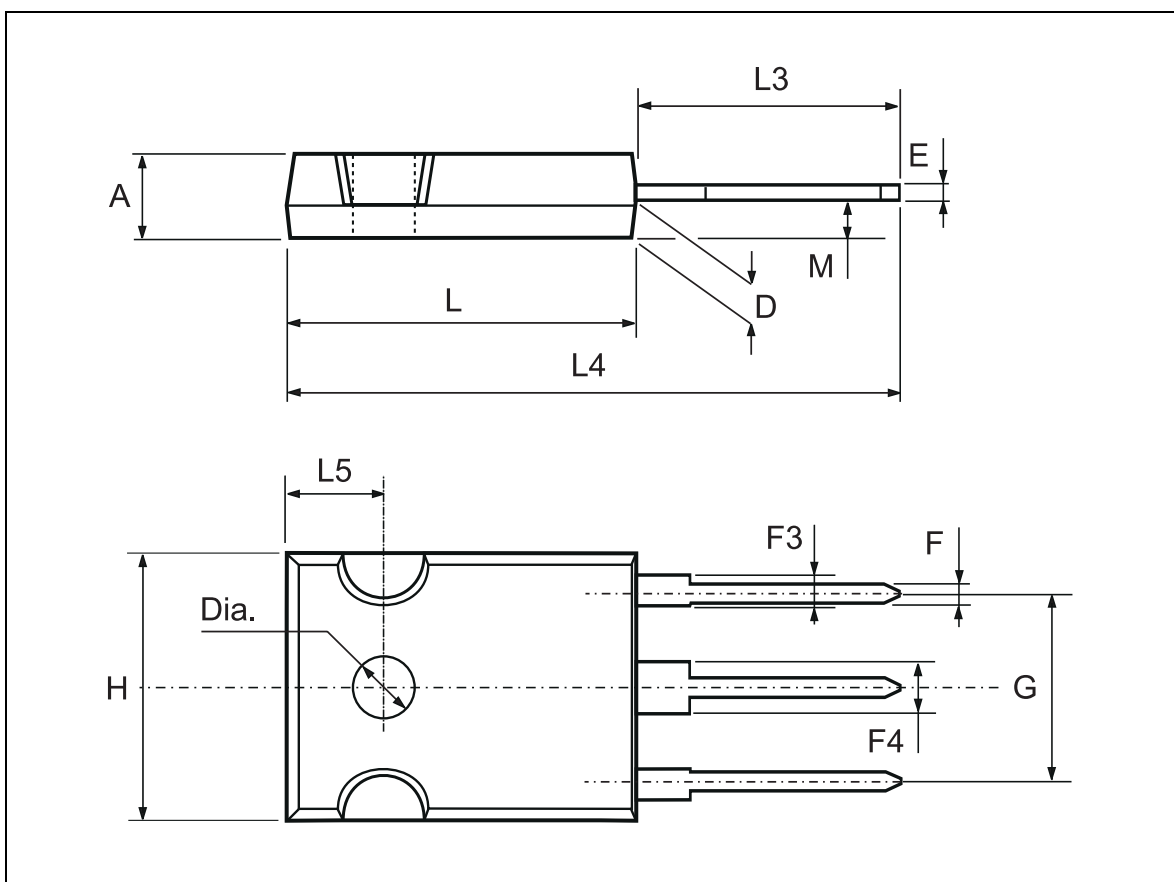
**TO-220 MECHANICAL DATA**

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.40		4.60	0.173		0.181
C	1.23		1.32	0.048		0.051
D	2.40		2.72	0.094		0.107
E	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	
M		2.6			0.102	
DIA.	3.75		3.85	0.147		0.151



**TO-247 MECHANICAL DATA**

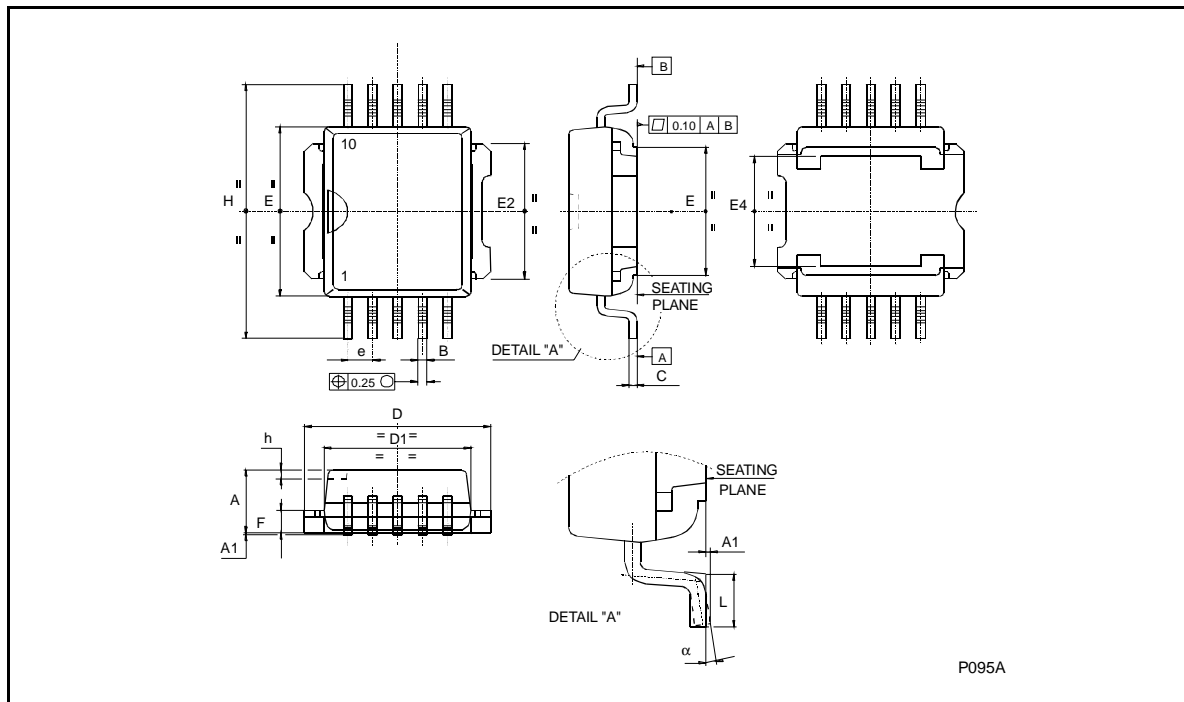
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.7		5.3	0.185		0.209
D	2.2		2.6	0.087		0.102
E	0.4		0.8	0.016		0.031
F	1		1.4	0.039		0.055
F3	2		2.4	0.079		0.094
F4	3		3.4	0.118		0.134
G		10.9			0.429	
H	15.3		15.9	0.602		0.626
L	19.7		20.3	0.776		0.779
L3	14.2		14.8	0.559		0.582
L4		34.6			1.362	
L5		5.5			0.217	
M	2		3	0.079		0.118
Dia.	3.55		3.65	0.140		0.144



**PowerSO-10™ MECHANICAL DATA**

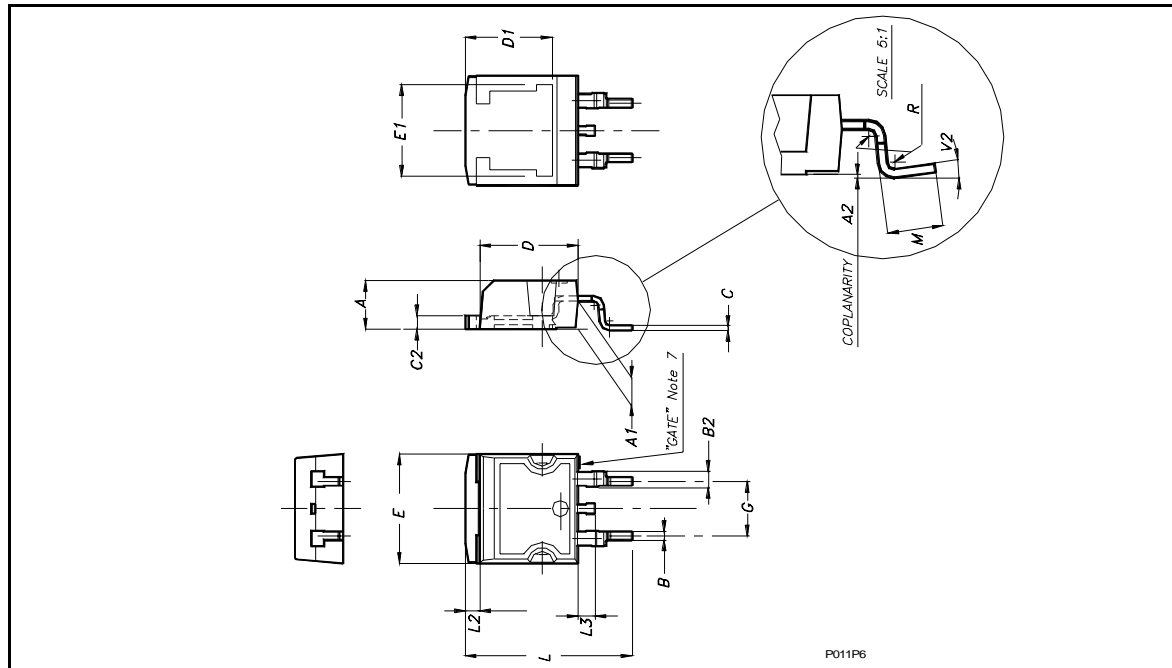
DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	3.35		3.65	0.132		0.144
A (*)	3.4		3.6	0.134		0.142
A1	0.00		0.10	0.000		0.004
B	0.40		0.60	0.016		0.024
B (*)	0.37		0.53	0.014		0.021
C	0.35		0.55	0.013		0.022
C (*)	0.23		0.32	0.009		0.0126
D	9.40		9.60	0.370		0.378
D1	7.40		7.60	0.291		0.300
E	9.30		9.50	0.366		0.374
E2	7.20		7.60	0.283		300
E2 (*)	7.30		7.50	0.287		0.295
E4	5.90		6.10	0.232		0.240
E4 (*)	5.90		6.30	0.232		0.248
e		1.27			0.050	
F	1.25		1.35	0.049		0.053
F (*)	1.20		1.40	0.047		0.055
H	13.80		14.40	0.543		0.567
H (*)	13.85		14.35	0.545		0.565
h		0.50			0.002	
L	1.20		1.80	0.047		0.070
L (*)	0.80		1.10	0.031		0.043
α	0°		8°	0°		8°
α (*)	2°		8°	2°		8°

(\*) Muar only POA P013P



**D<sup>2</sup>PAK MECHANICAL DATA**

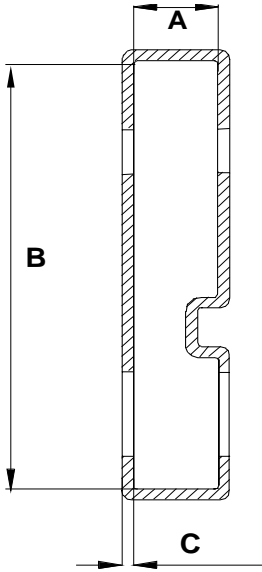
DIM.	mm.		
	MIN.	TYP	MAX.
A	4.4		4.6
A1	2.49		2.69
A2	0.03		0.23
B	0.7		0.93
B2	1.14		1.7
C	0.45		0.6
C2	1.23		1.36
D	8.95		9.35
D1		8	
E	10		10.4
E1		8.5	
G	4.88		5.28
L	15		15.85
L2	1.27		1.4
L3	1.4		1.75
M	2.4		3.2
R		0.4	
V2	0°		8°



P011P6



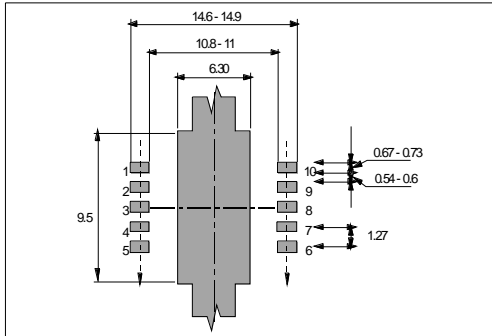
TO-220 TUBE SHIPMENT (no suffix)



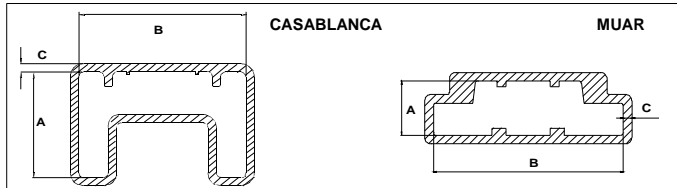
Base Q.ty	50
Bulk Q.ty	1000
Tube length ( $\pm 0.5$ )	532
A	5.5
B	31.4
C ( $\pm 0.1$ )	0.75

All dimensions are in mm.

**PowerSO-10™ SUGGESTED PAD LAYOUT**



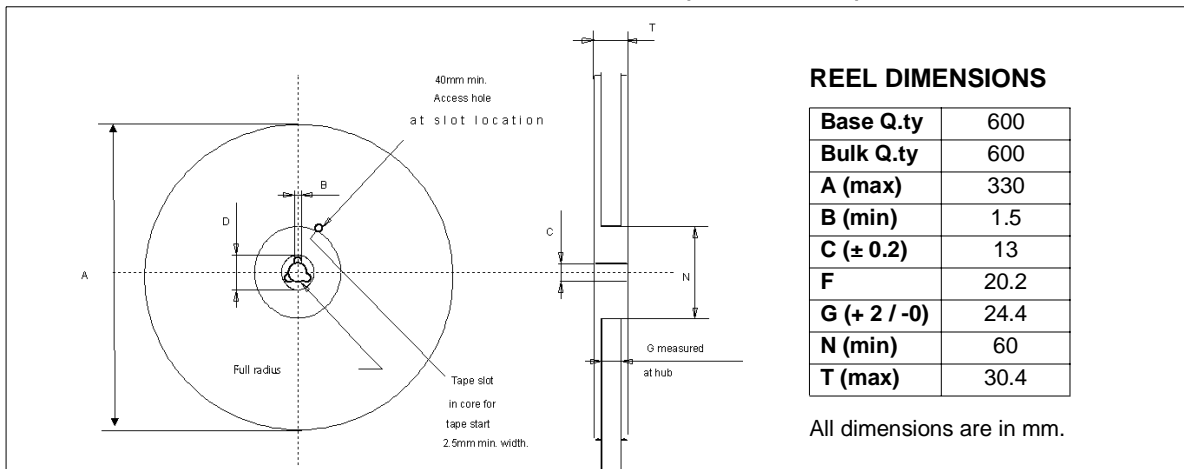
**TUBE SHIPMENT (no suffix)**



All dimensions are in mm.

	Base Q.ty	Bulk Q.ty	Tube length (±0.5)	A	B	C (±0.1)
<b>Casablanca</b>	50	1000	532	10.4	16.4	0.8
<b>Muar</b>	50	1000	532	4.9	17.2	0.8

**TAPE AND REEL SHIPMENT (suffix "13TR")**



**REEL DIMENSIONS**

<b>Base Q.ty</b>	600
<b>Bulk Q.ty</b>	600
<b>A (max)</b>	330
<b>B (min)</b>	1.5
<b>C (±0.2)</b>	13
<b>F</b>	20.2
<b>G (+2 / -0)</b>	24.4
<b>N (min)</b>	60
<b>T (max)</b>	30.4

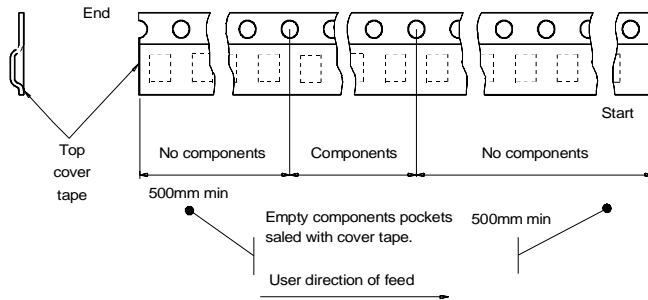
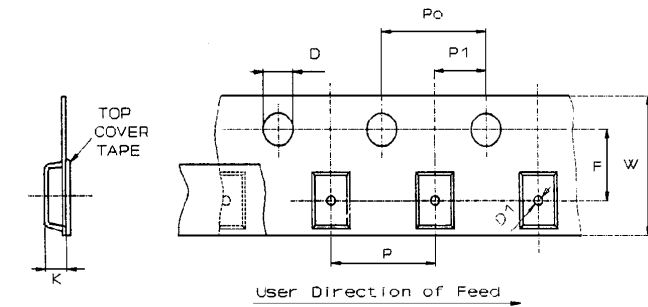
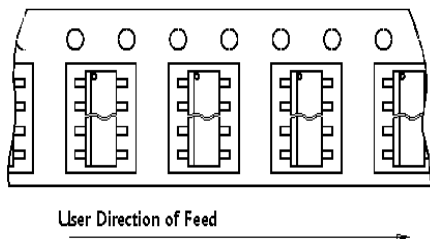
All dimensions are in mm.

**TAPE DIMENSIONS**

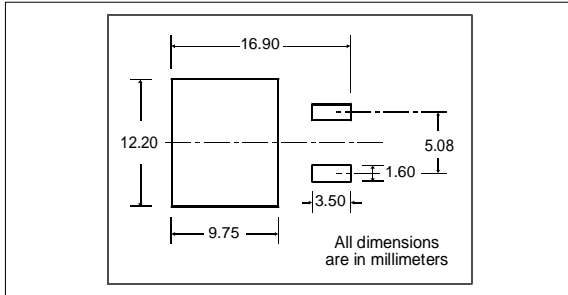
According to Electronic Industries Association (EIA) Standard 481 rev. A, Feb 1986

<b>Tape width</b>	<b>W</b>	24
<b>Tape Hole Spacing</b>	<b>P0 (±0.1)</b>	4
<b>Component Spacing</b>	<b>P</b>	24
<b>Hole Diameter</b>	<b>D (±0.1/-0)</b>	1.5
<b>Hole Diameter</b>	<b>D1 (min)</b>	1.5
<b>Hole Position</b>	<b>F (±0.05)</b>	11.5
<b>Compartment Depth</b>	<b>K (max)</b>	6.5
<b>Hole Spacing</b>	<b>P1 (±0.1)</b>	2

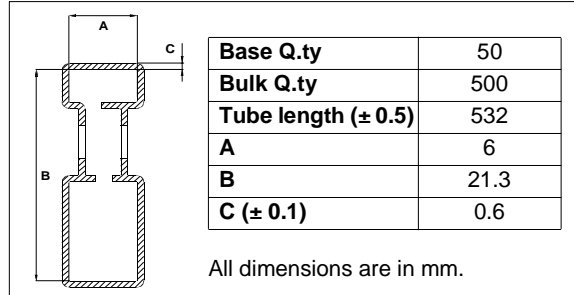
All dimensions are in mm.



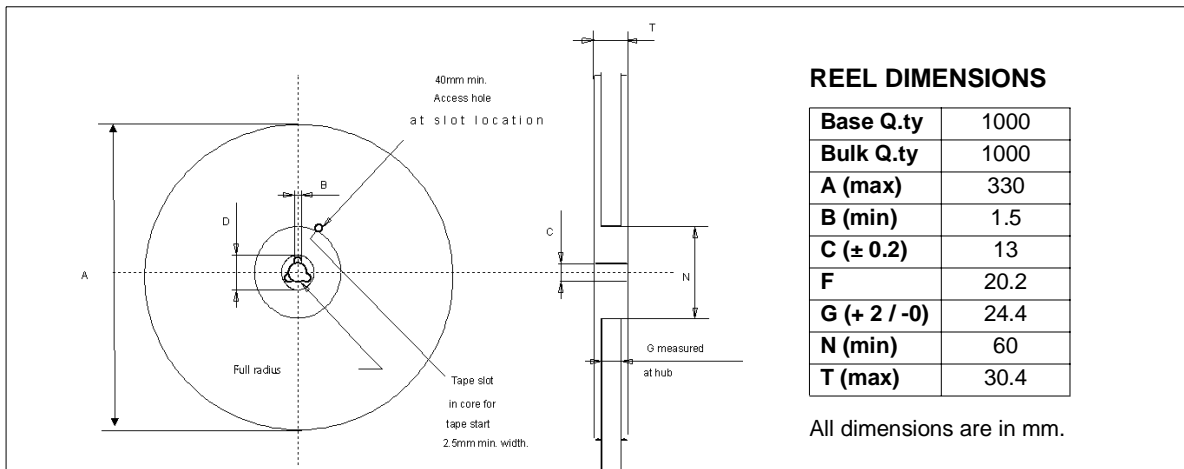
**D<sup>2</sup>PAK FOOTPRINT**



**TUBE SHIPMENT (no suffix)**



**TAPE AND REEL SHIPMENT (suffix "13TR")**

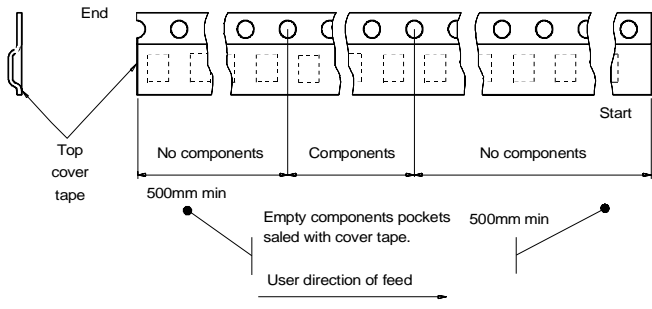
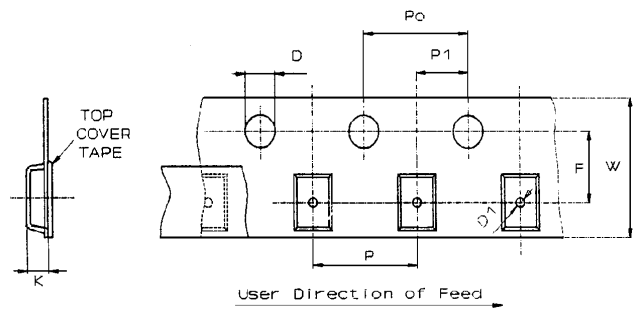
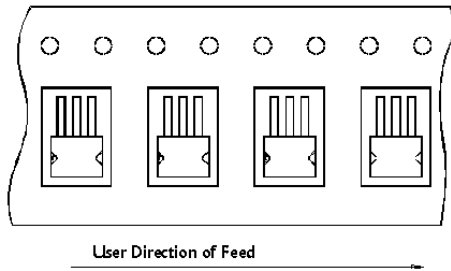


**TAPE DIMENSIONS**

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

<b>Tape width</b>	<b>W</b>	24
<b>Tape Hole Spacing</b>	<b>P0 (± 0.1)</b>	4
<b>Component Spacing</b>	<b>P</b>	16
<b>Hole Diameter</b>	<b>D (± 0.1/-0)</b>	1.5
<b>Hole Diameter</b>	<b>D1 (min)</b>	1.5
<b>Hole Position</b>	<b>F (± 0.05)</b>	11.5
<b>Compartment Depth</b>	<b>K (max)</b>	6.5
<b>Hole Spacing</b>	<b>P1 (± 0.1)</b>	2

All dimensions are in mm.



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