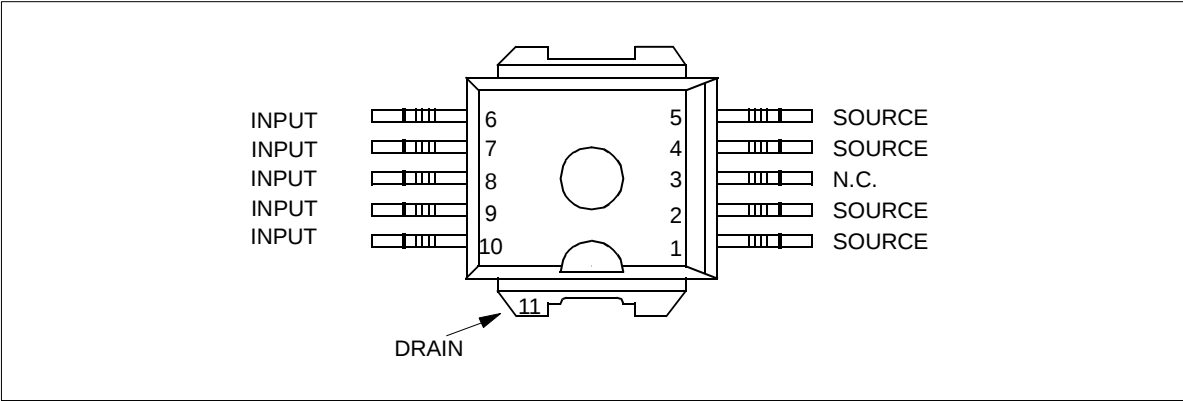


ABSOLUTE MAXIMUM RATING

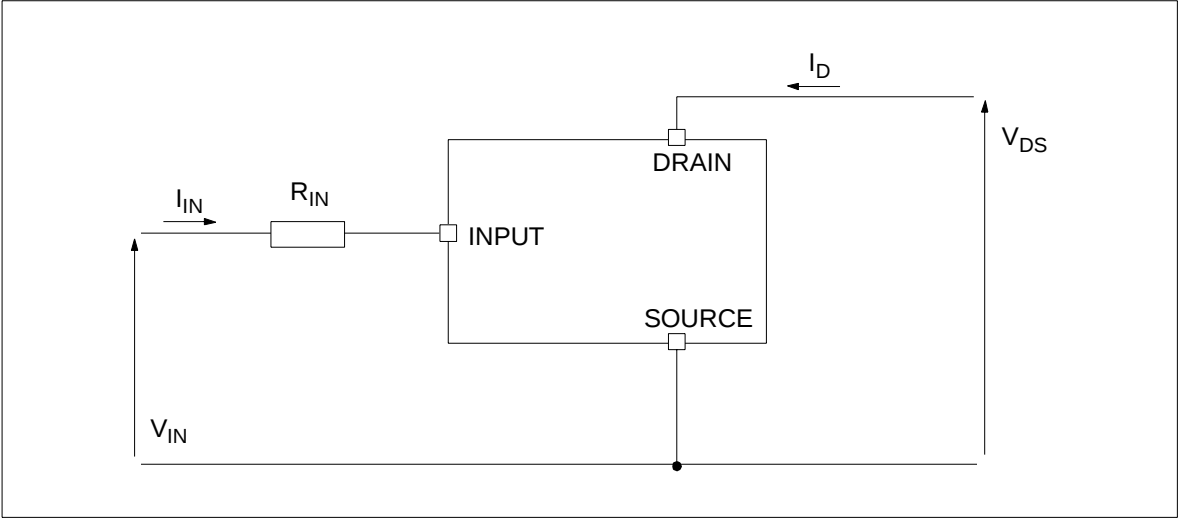
Symbol	Parameter	Value				Unit
		PowerSO-10™	D ² PAK	TO-220	TO-247	
V _{DS}	Drain-source Voltage (V _{IN} =0V)	Internally Clamped				V
V _{IN}	Input Voltage	Internally Clamped				V
I _{IN}	Input Current	+/-20				mA
R _{IN MIN}	Minimum Input Series Impedance	4.7				Ω
I _D	Drain Current	Internally Limited				A
I _R	Reverse DC Output Current	-30				A
V _{ESD1}	Electrostatic Discharge (R=1.5KΩ, C=100pF)	4000				V
V _{ESD2}	Electrostatic Discharge on output pin only (R=330Ω, C=150pF)	16500				V
P _{tot}	Total Dissipation at T _c =25°C	125	125	125	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

CONNECTION DIAGRAM (TOP VIEW)



(*) For the pins configuration related to TO-220, TO-247, D²PAK, see outlines at page 1.

CURRENT AND VOLTAGE CONVENTIONS



THERMAL DATA

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

(*) When mounted on a standard single-sided FR4 board with 50mm² of Cu (at least 35 µm thick) connected to all DRAIN pins.

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

OFF

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V _{CLAMP}	Drain-source Clamp Voltage	V _{IN} =0V; I _D =15A	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	Max		Unit
			PowerSO-10	D ² PAK TO-220 / TO-247	
R _{DS(on)}	Static Drain-source On Resistance	V _{IN} =5V; I _D =15A; T _j =25°C V _{IN} =5V; I _D =15A; T _j =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	$V_{DD}=15\text{V}; I_D=15\text{A}$ $V_{gen}=5\text{V}; R_{gen}=R_{IN\text{ MIN}}=4.7\Omega$ (see figure 1)		150	500	ns
t_r	Rise Time			840	2500	ns
$t_{d(off)}$	Turn-off Delay Time			980	3000	ns
t_f	Fall Time			600	1500	ns
$t_{d(on)}$	Turn-on Delay Time	$V_{DD}=15\text{V}; I_D=15\text{A}$ $V_{gen}=5\text{V}; R_{gen}=2.2\text{K}\Omega$ (see figure 1)		4	12	μs
t_r	Rise Time			27	100	μs
$t_{d(off)}$	Turn-off Delay Time			34	120	μs
t_f	Fall Time			31	110	μs
$(di/dt)_{on}$	Turn-on Current Slope	$V_{DD}=15\text{V}; I_D=15\text{A}$ $V_{gen}=5\text{V}; R_{gen}=R_{IN\text{ MIN}}=4.7\Omega$		18		A/ μs
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		μC
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		μs
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 $T_j=25^\circ\text{C}; V_{DD}=24\text{V}$ $V_{IN}=5\text{V}; R_{gen}=R_{IN\text{ MIN}}=4.7\Omega; L=24\text{mH}$ (see figures 3 & 4)	1.7			J

(*) Pulsed: Pulse duration = 300 μs , 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 μ 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

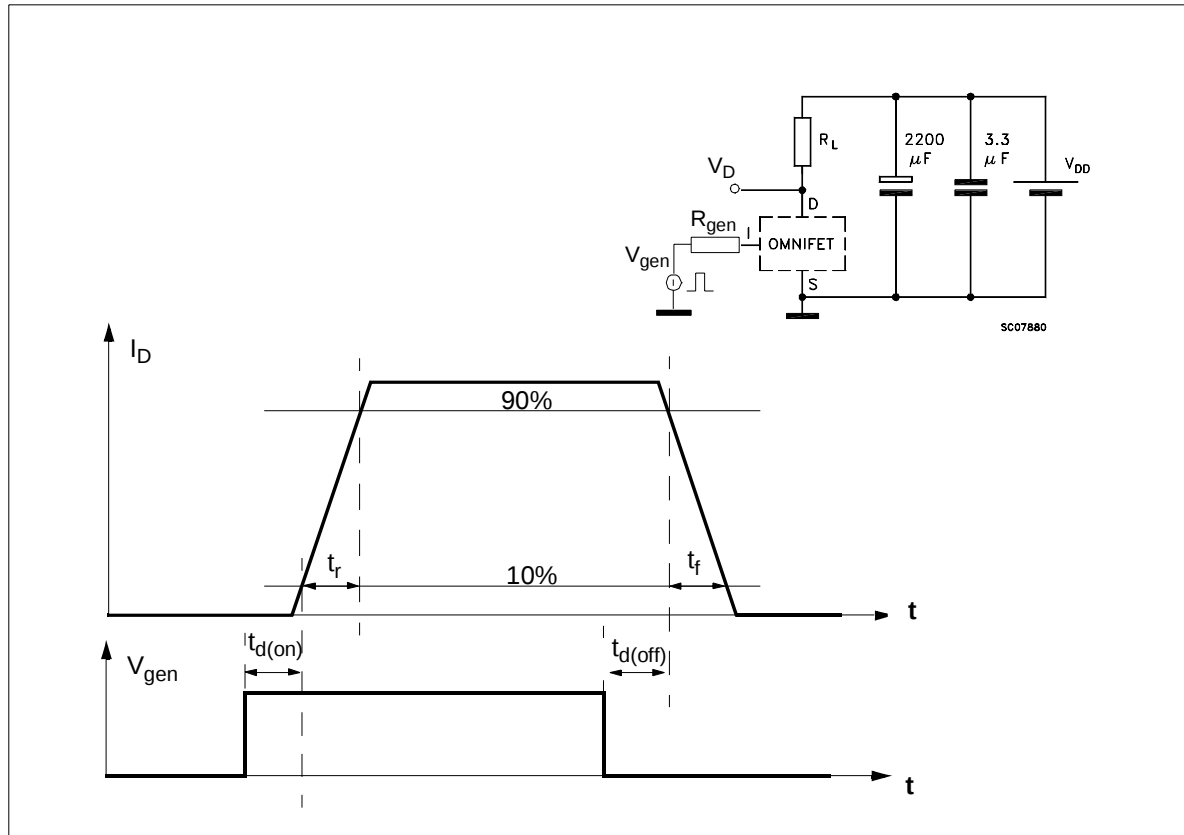


Fig.2: Test Circuit for Diode Recovery Times

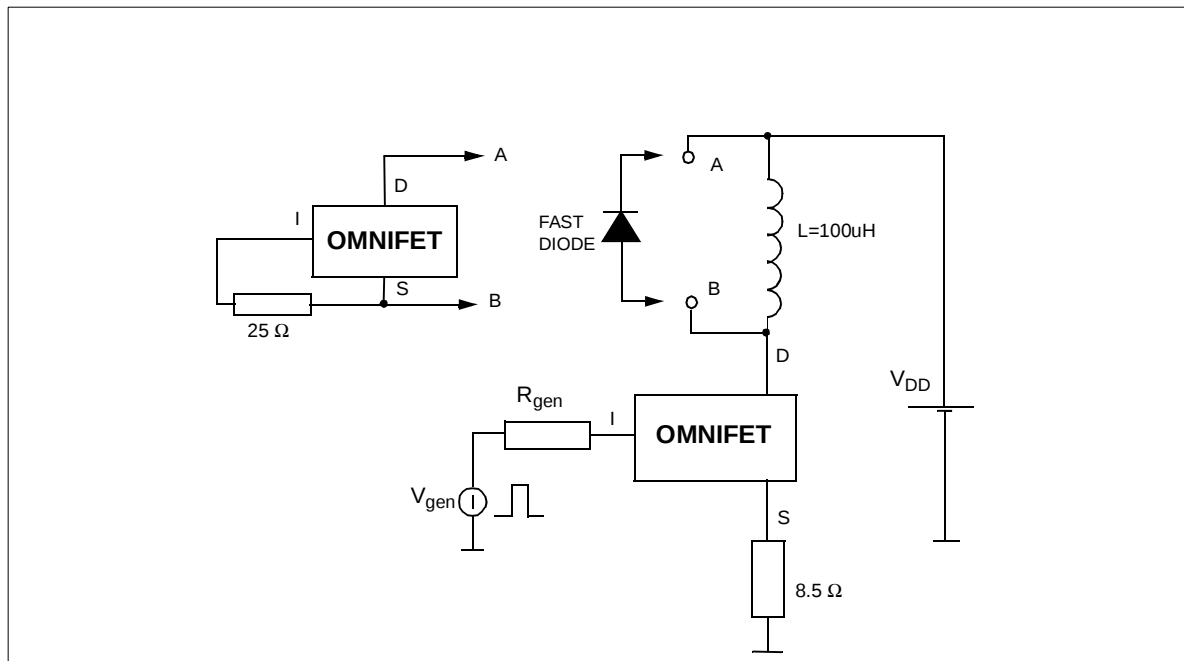


Fig. 3: Unclamped Inductive Load Test Circuits

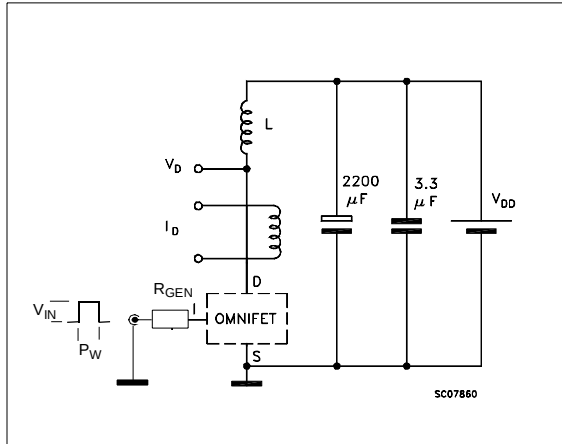


Fig. 4: Unclamped Inductive Waveforms

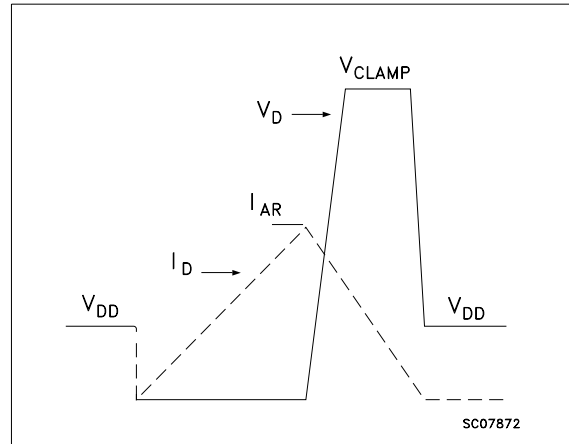


Fig. 5: Input Charge Test Circuit

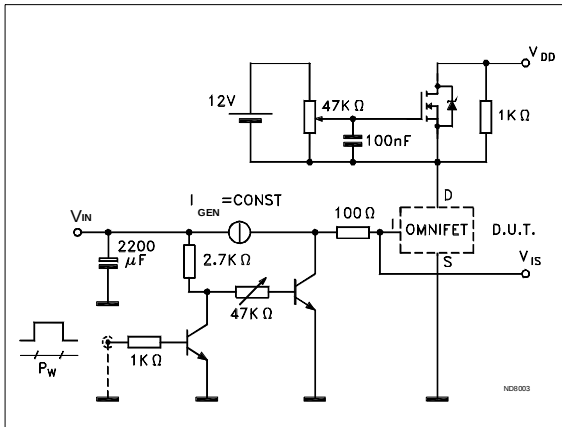


Fig 6 : Thermal Impedance for TO-220

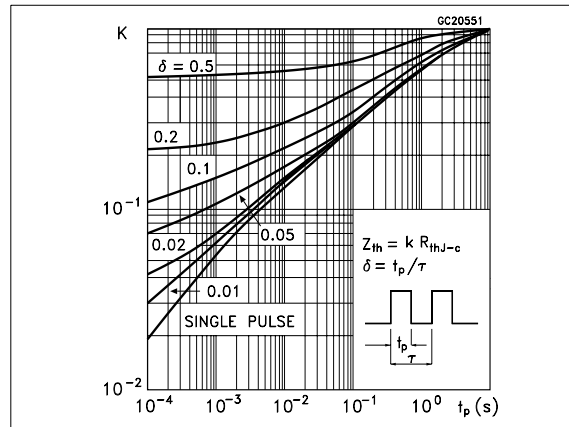
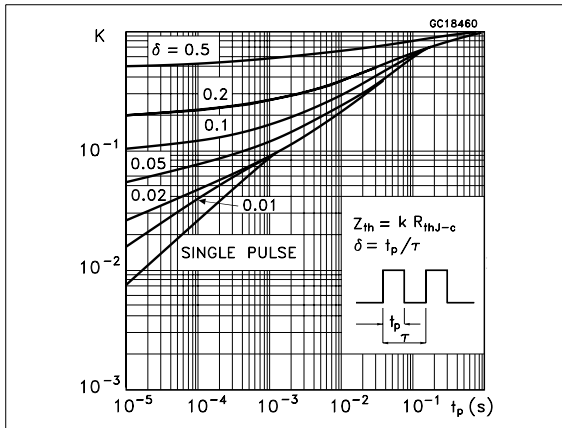
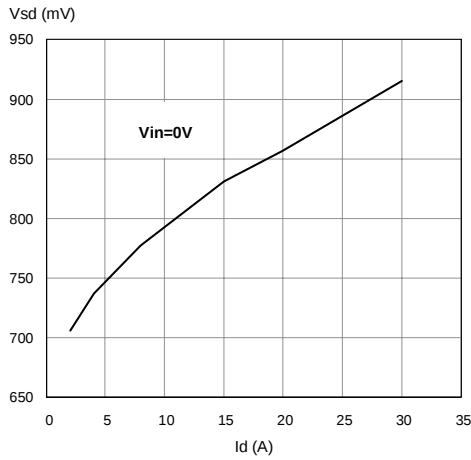


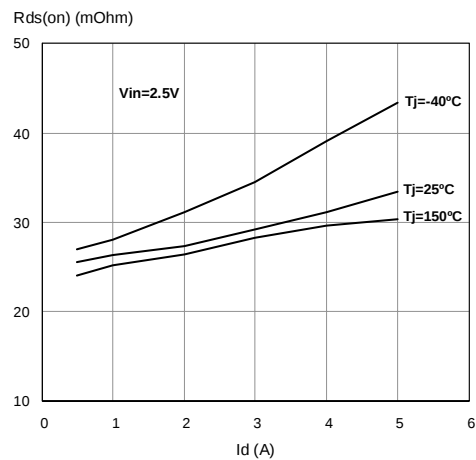
Fig. 7: Thermal Impedance for TO-247



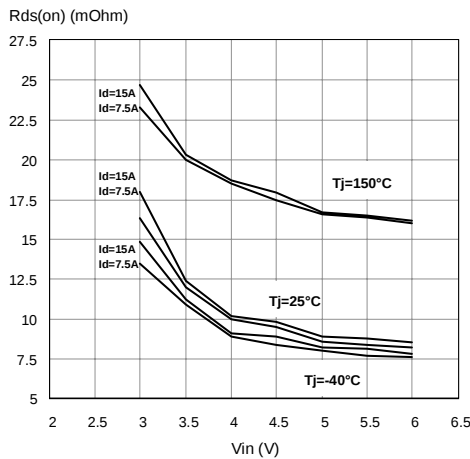
Source-Drain Diode Forward Characteristics



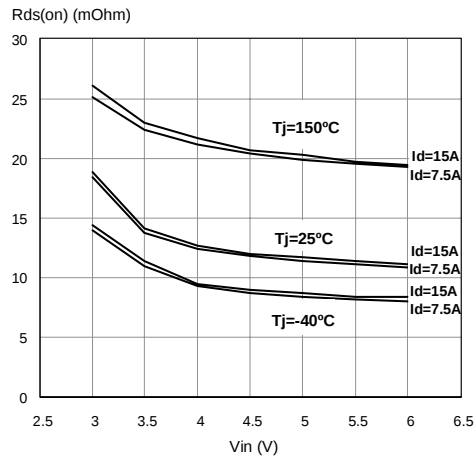
Static Drain Source On Resistance



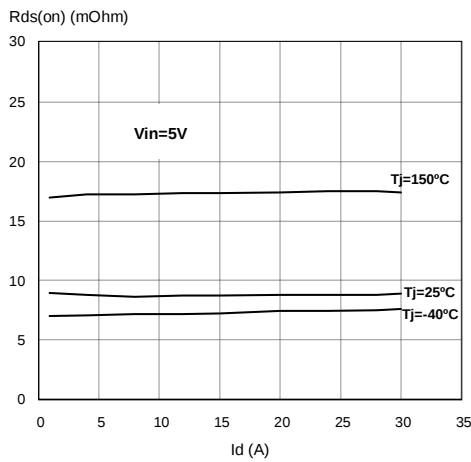
PowerSO-10 Static Drain-Source On resistance Vs. Input Voltage



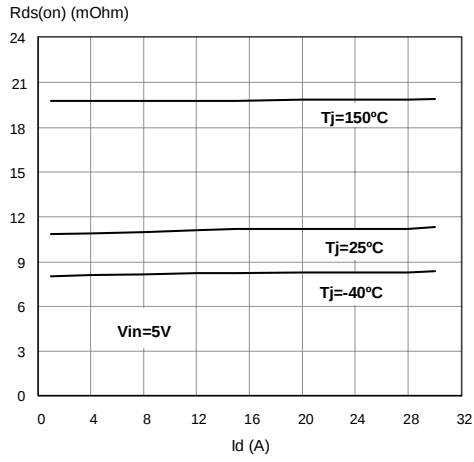
D2PAK, TO-220 & TO-247 Static Drain-Source On resistance Vs. Input Voltage



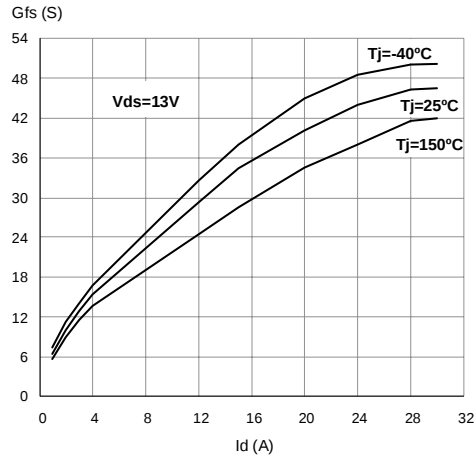
PowerSO-10 Static Drain-Source On Resistance Vs. Id



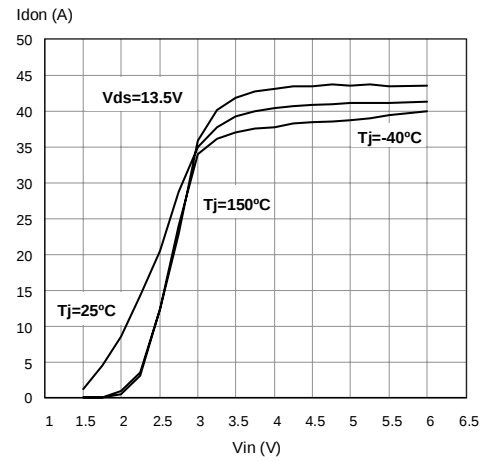
D2PAK, TO-220 & TO-247 Static Drain-Source On Resistance Vs. Id



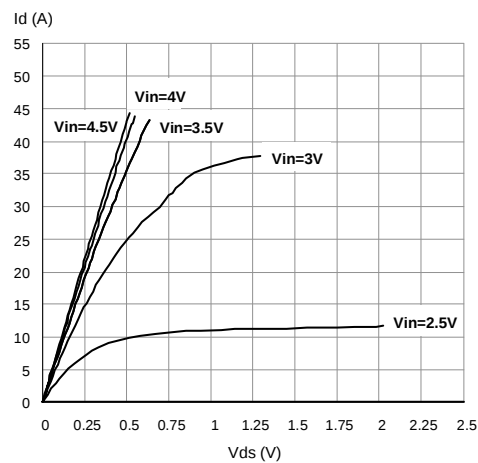
Transconductance



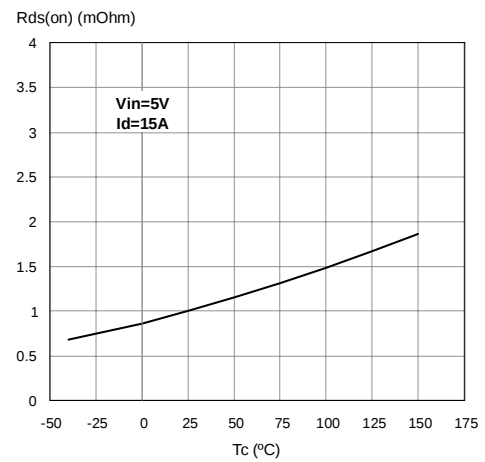
Transfer Characteristics



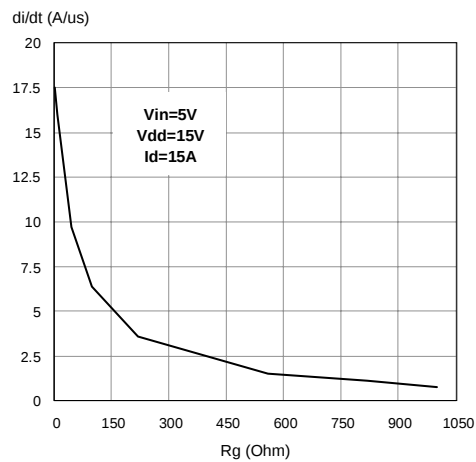
Output Characteristics



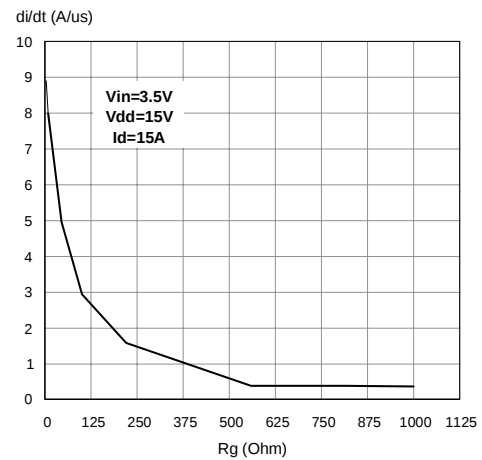
Normalized On Resistance Vs. Temperature



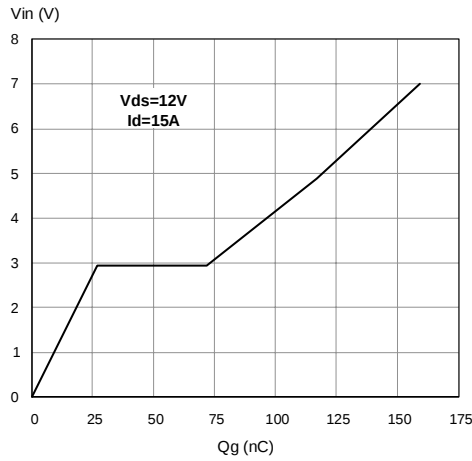
Turn On Current Slope



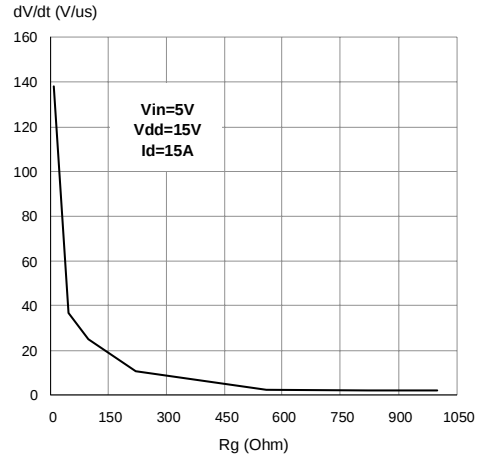
Turn On Current Slope



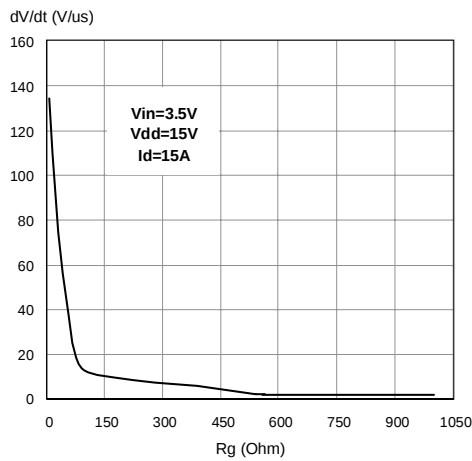
Input Voltage Vs. Input Charge



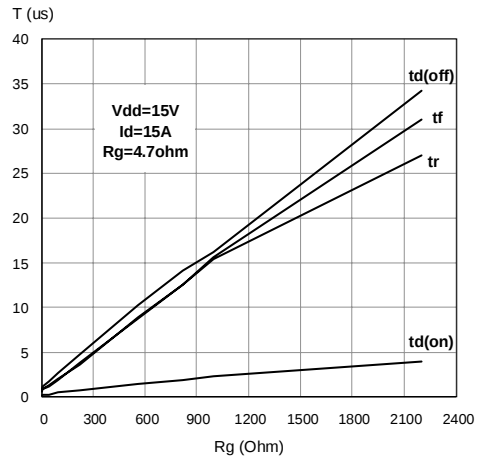
Turn off drain source voltage slope



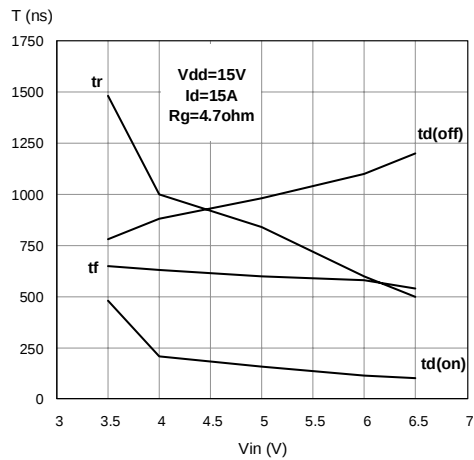
Turn Off Drain-Source Voltage Slope



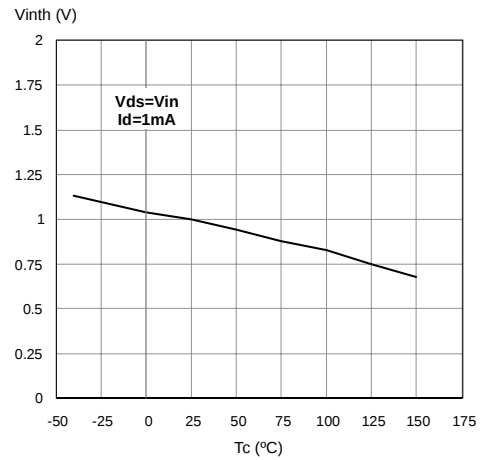
Switching Time Resistive Load



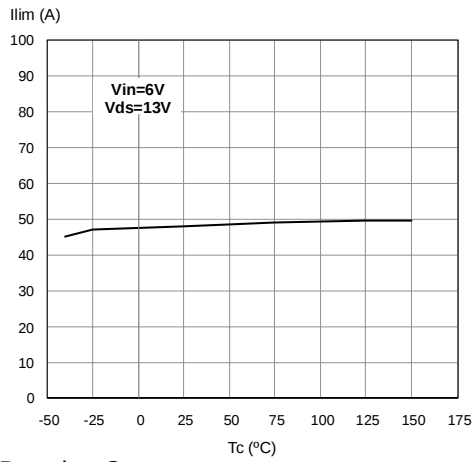
Switching Time Resistive Load



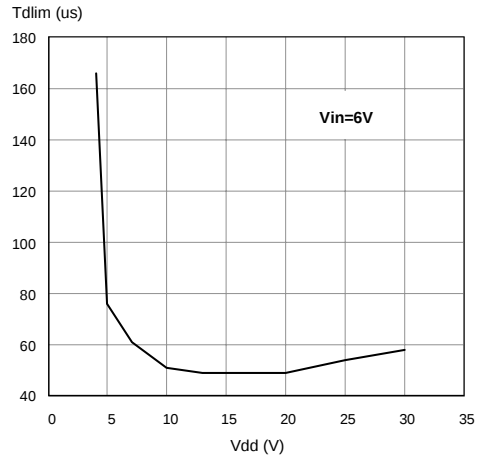
Normalized Input Threshold Voltage Vs. Temperature



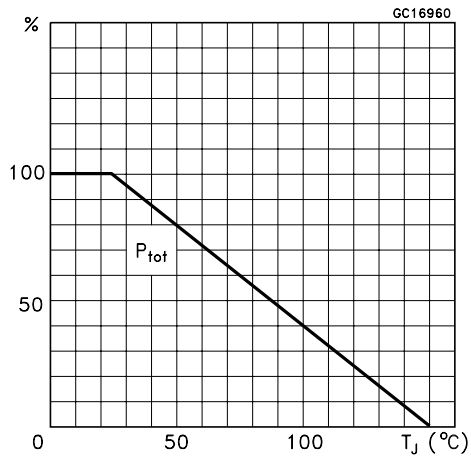
Current Limit Vs. Junction Temperature



Step Response Current Limit

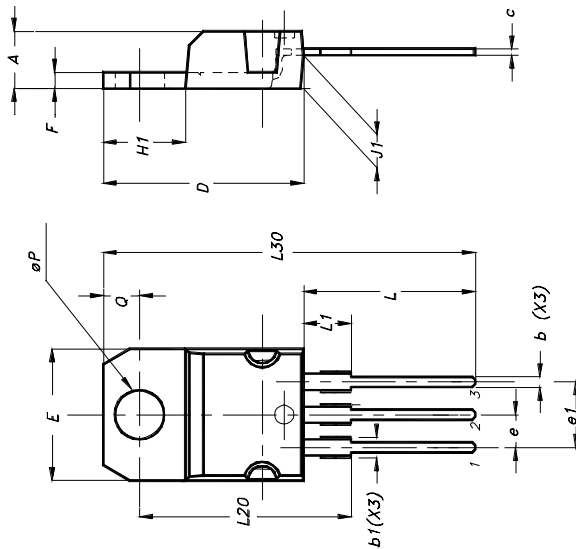


Derating Curve



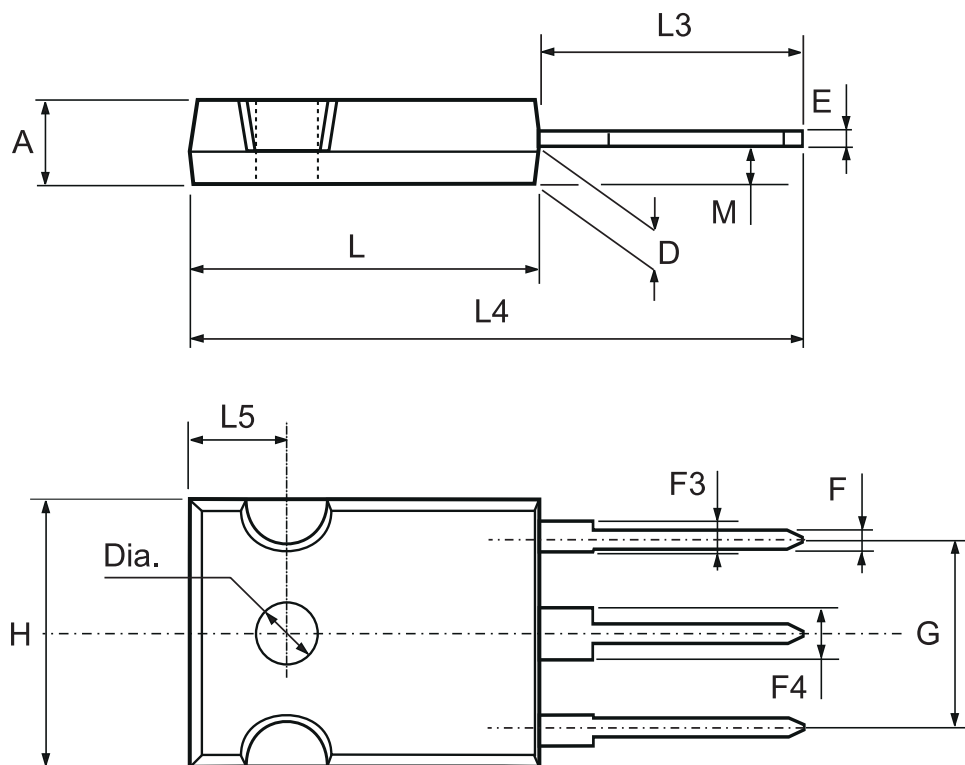
TO-220 MECHANICAL DATA

DIM.	mm.		
	MIN.	TYP	MAX.
A	4.40		4.60
b	0.61		0.88
b1	1.15		1.70
c	0.49		0.70
D	15.25		15.75
E	10		10.40
e	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.)		



TO-247 MECHANICAL DATA

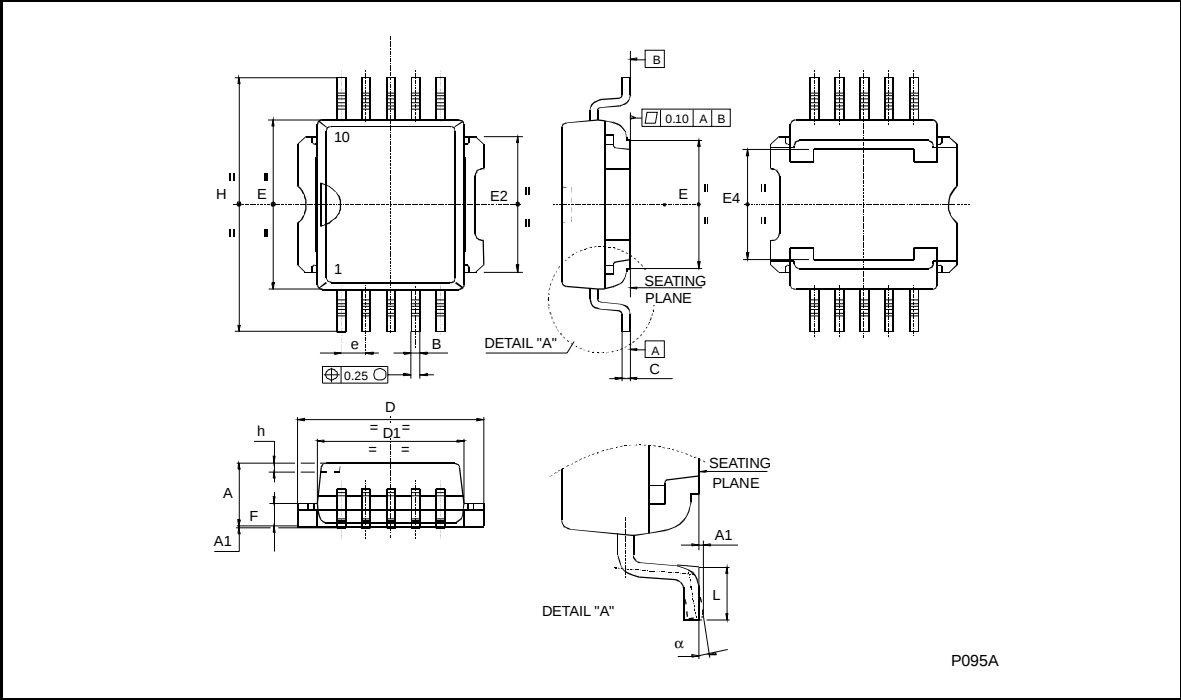
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.7		5.3	0.185		0.209
D	2.2		2.6	0.087		0.102
E	0.4		0.8	0.016		0.031
F	1		1.4	0.039		0.055
F3	2		2.4	0.079		0.094
F4	3		3.4	0.118		0.134
G		10.9			0.429	
H	15.3		15.9	0.602		0.626
L	19.7		20.3	0.776		0.779
L3	14.2		14.8	0.559		0.582
L4		34.6			1.362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

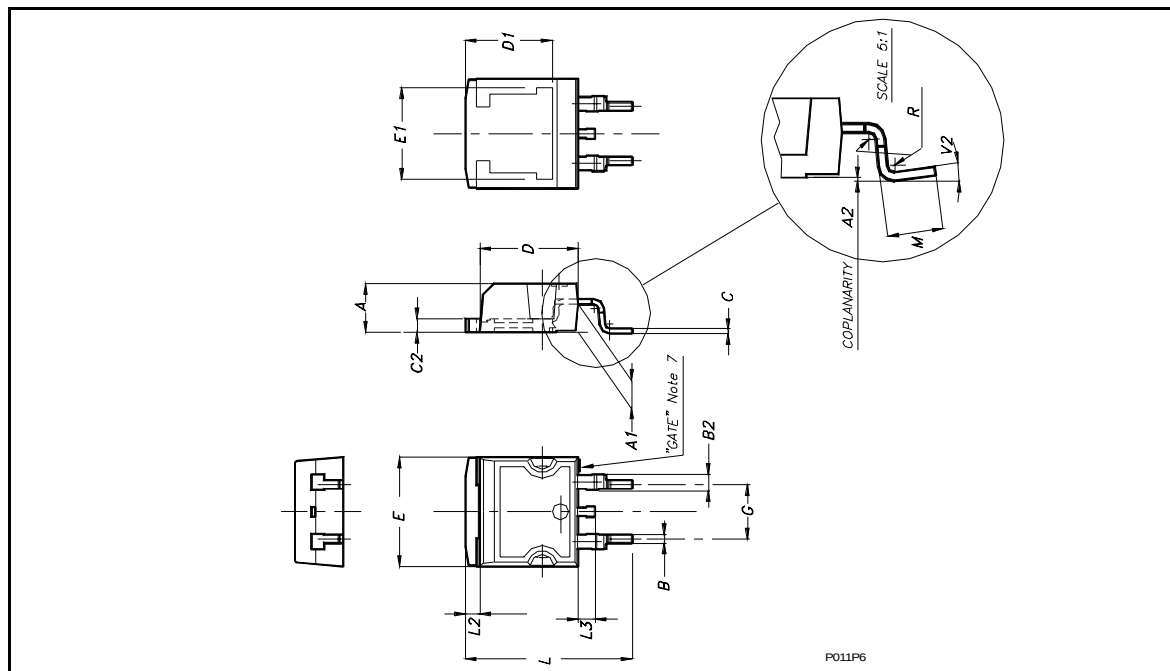
DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	3.35		3.65	0.132		0.144
A (*)	3.4		3.6	0.134		0.142
A1	0.00		0.10	0.000		0.004
B	0.40		0.60	0.016		0.024
B (*)	0.37		0.53	0.014		0.021
C	0.35		0.55	0.013		0.022
C (*)	0.23		0.32	0.009		0.0126
D	9.40		9.60	0.370		0.378
D1	7.40		7.60	0.291		0.300
E	9.30		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

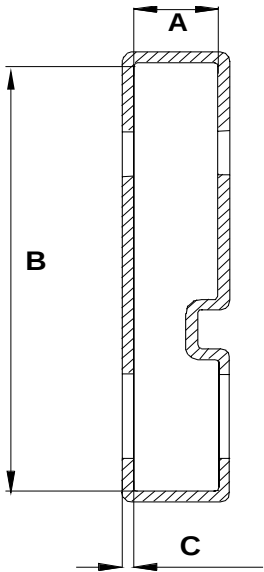


D²PAK MECHANICAL DATA

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°



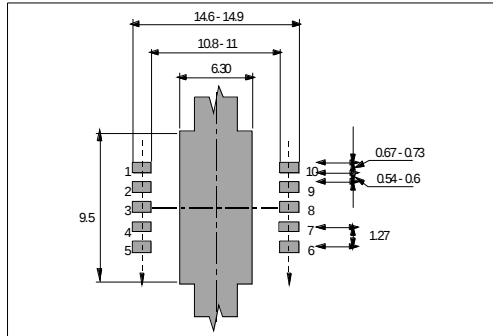
TO-220 TUBE SHIPMENT (no suffix)



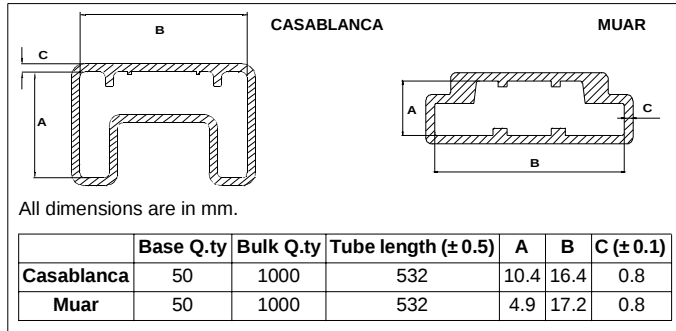
Base Q.ty	50
Bulk Q.ty	1000
Tube length (± 0.5)	532
A	5.5
B	31.4
C (± 0.1)	0.75

All dimensions are in mm.

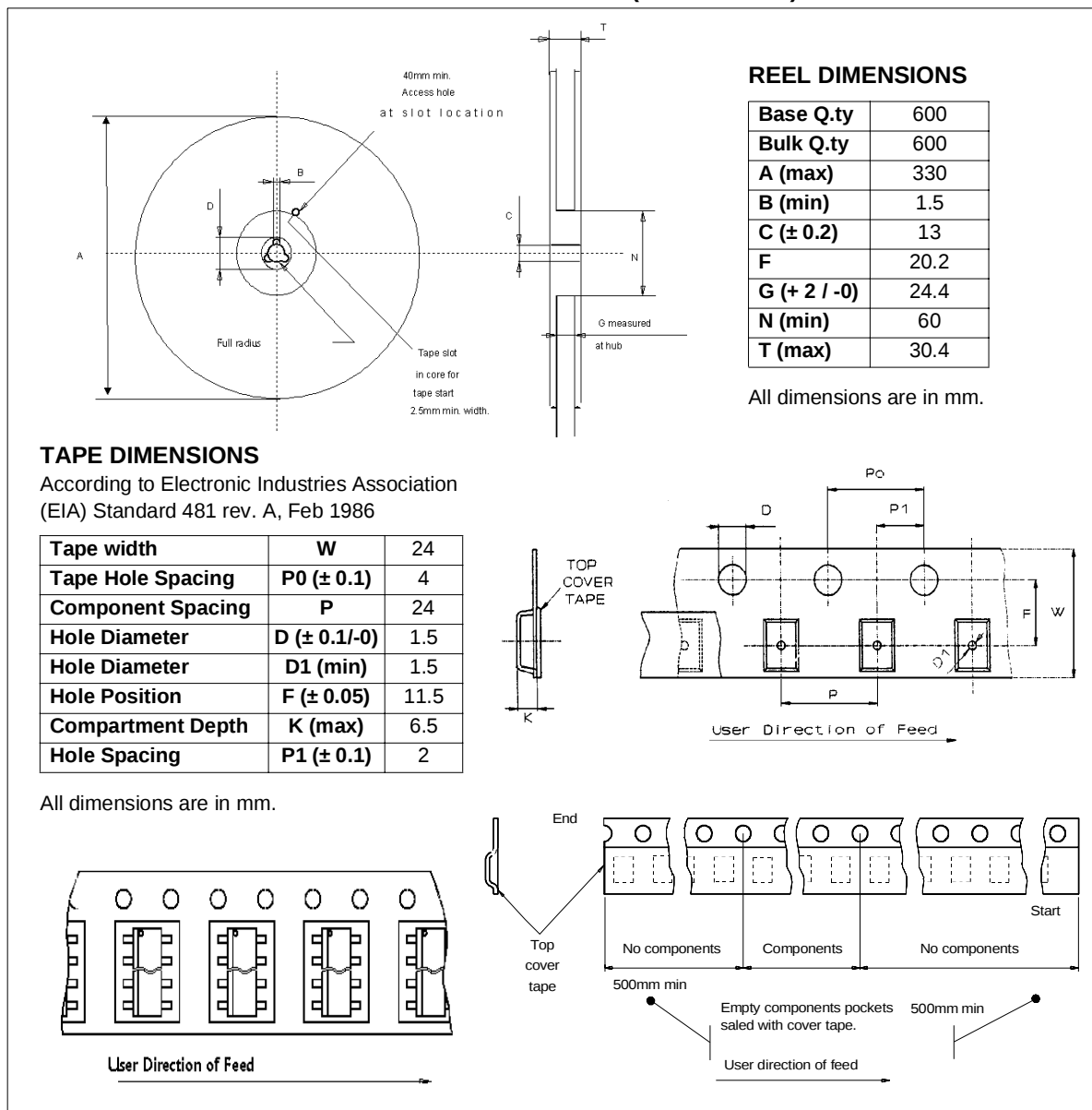
PowerSO-10™ SUGGESTED PAD LAYOUT



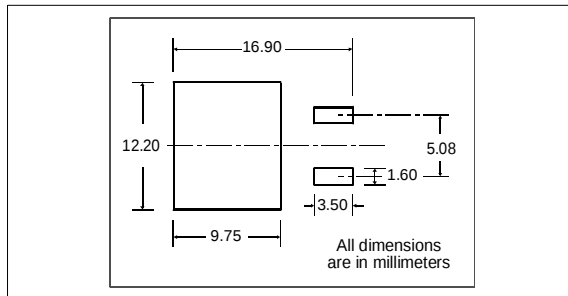
TUBE SHIPMENT (no suffix)



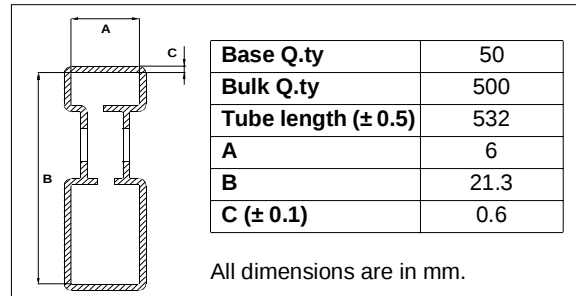
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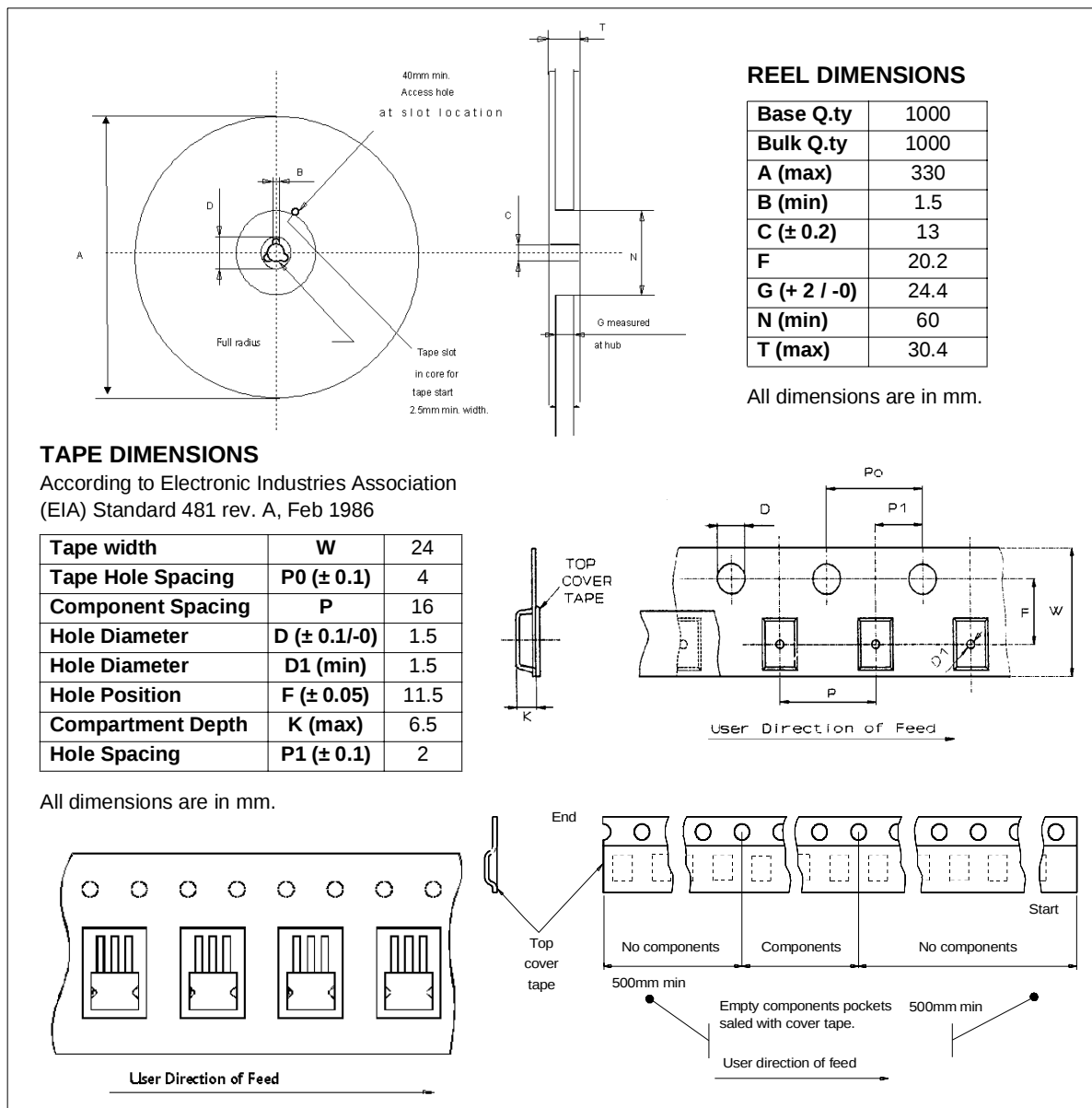
D²PAK FOOTPRINT



TUBE SHIPMENT (no suffix)



TAPE AND REEL SHIPMENT (suffix "13TR")



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