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# VNP49N04FI VNB49N04 / VNV49N04

“OMNIFET”:  
FULLY AUTOPROTECTED POWER MOSFET

TYPE	V <sub>CLAMP</sub>	R <sub>DS(ON)</sub>	I <sub>LIM</sub>
VNP49N04FI	42 V	20 mΩ	49 A
VNB49N04			
VNV49N04			

- 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 VNP49N04FI, VNB49N04, VNV49N04 are monolithic devices designed in STMicroelectronics VIPower M0 Technology, intended for replacement of standard Power

**ISOWATT220**

**TO-263 (D<sup>2</sup>PAK)**

**PowerSO-10™**

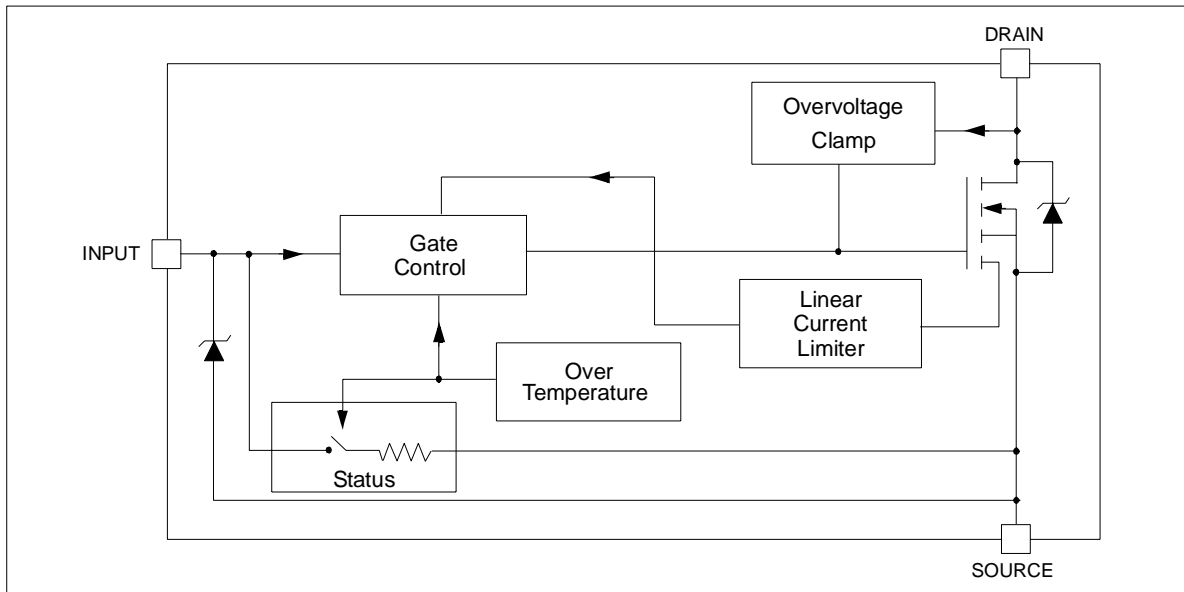
**ORDER CODES:**

ISOWATT220	VNP49N04FI
PowerSO-10™	VNV49N04
TO-263 (D <sup>2</sup> PAK)	VNB49N04

MOSFETS from DC up to 50KHz 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.

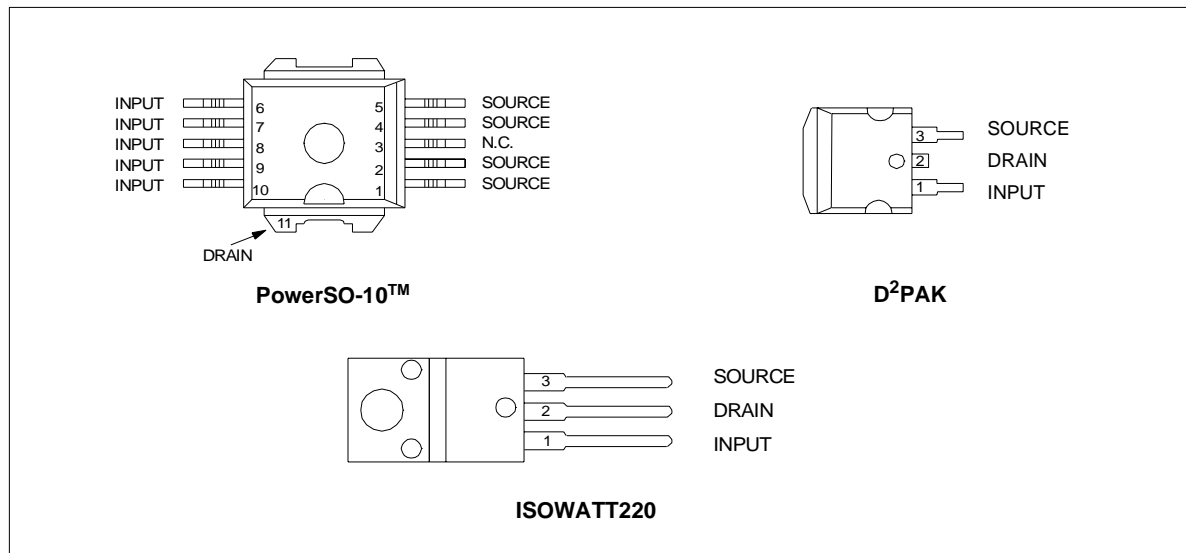
## BLOCK DIAGRAM



**ABSOLUTE MAXIMUM RATING**

Symbol	Parameter	Value			Unit
		PowerSO-10™	D <sup>2</sup> PAK	ISOWATT220	
V <sub>DS</sub>	Drain-source Voltage (V <sub>IN</sub> =0V)	Internally Clamped			V
V <sub>IN</sub>	Input Voltage	18			V
I <sub>D</sub>	Drain Current	Internally Limited			A
I <sub>R</sub>	Reverse DC Output Current	-50			A
V <sub>ESD</sub>	Electrostatic Discharge (R=1.5KΩ, C=100pF)	2000			V
P <sub>tot</sub>	Total Dissipation at T <sub>c</sub> =25°C	125	125	40	W
T <sub>j</sub>	Operating Junction Temperature	Internally limited			°C
T <sub>c</sub>	Case Operating Temperature	Internally limited			°C
T <sub>stg</sub>	Storage Temperature	-55 to 150			°C

**CONNECTION DIAGRAM (TOP VIEW)**



**THERMAL DATA**

Symbol	Parameter	Value			Unit
		PowerSO-10	D <sup>2</sup> PAK	ISOWATT220	
R <sub>thj-case</sub>	Thermal Resistance Junction-case MAX	1	1	3.12	°C/W
R <sub>thj-amb</sub>	Thermal Resistance Junction-ambient MAX	50	62.5	62.5	°C/W

**ELECTRICAL CHARACTERISTICS** (-40°C < T<sub>j</sub> < 125°C, unless otherwise specified)

OFF

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V <sub>CLAMP</sub>	Drain-source Clamp Voltage	I <sub>D</sub> =200 mA; V <sub>IN</sub> =0	34	42	50	V
V <sub>CLTH</sub>	Drain-source Clamp Threshold Voltage	I <sub>D</sub> =2mA; V <sub>IN</sub> =0	33			V
V <sub>INCL</sub>	Input-Source Reverse Clamp Voltage	I <sub>IN</sub> = -1mA	-1.2		-0.1	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			70	μA
		V <sub>DS</sub> =25V; V <sub>IN</sub> =0V			220	μA
I <sub>ISS</sub>	Supply Current from Input Pin	V <sub>DS</sub> =0V; V <sub>IN</sub> =10V		250	550	μA

ON (\*)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V <sub>IN(th)</sub>	Input Threshold Voltage	V <sub>DS</sub> =V <sub>IN</sub> ; I <sub>D</sub> + I <sub>IN</sub> =1mA	0.8		3	V
R <sub>DS(on)</sub>	Static Drain-source On Resistance	V <sub>IN</sub> =10V; I <sub>D</sub> =25A			0.04	Ω
		V <sub>IN</sub> =5V; I <sub>D</sub> =25A			0.05	Ω

DYNAMIC

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
g <sub>fs</sub> (*)	Forward Transconductance	V <sub>DS</sub> =13V; I <sub>D</sub> =25A; T <sub>C</sub> =25°C	25	30		S
C <sub>OSS</sub>	Output Capacitance	V <sub>DS</sub> =13V; f=1MHz; V <sub>IN</sub> =0V; T <sub>C</sub> =25°C		1100	1500	pF

SWITCHING (\*\*)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
t <sub>d(on)</sub>	Turn-on Delay Time	V <sub>DS</sub> =15V; I <sub>D</sub> =25A V <sub>gen</sub> =10V; R <sub>gen</sub> =10 Ω		200	600	ns
t <sub>r</sub>	Rise Time			1300	3600	ns
t <sub>d(off)</sub>	Turn-off Delay Time	(see figure 3)		800	2400	ns
t <sub>f</sub>	Fall Time			300	900	ns
t <sub>d(on)</sub>	Turn-on Delay Time	V <sub>DS</sub> =15V; I <sub>D</sub> =25A V <sub>gen</sub> =10V; R <sub>gen</sub> =1000Ω		1.3	3.8	μs
t <sub>r</sub>	Rise Time			3.8	10.4	μs
t <sub>d(off)</sub>	Turn-off Delay Time	(see figure 3)		12	24	μs
t <sub>f</sub>	Fall Time			6.1	17	μs
(di/dt) <sub>on</sub>	Turn-on Current Slope	V <sub>DS</sub> =15V; I <sub>D</sub> =25A V <sub>IN</sub> =10V; R <sub>gen</sub> =10 Ω		25		A/μs
Q <sub>i</sub>	Total Input Charge	V <sub>DS</sub> =15V; I <sub>D</sub> =25A; V <sub>IN</sub> =10V		100		nC

## VNP49N04FI / VNB49N04 / VNV49N04

### SOURCE DRAIN DIODE

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$V_{SD}$ (*)	Forward On Voltage	$I_{SD}=25A$ ; $V_{IN}=0V$			1.8	V
$t_{rr}$ (**)	Reverse Recovery Time	$I_{SD}=25A$ ; $di/dt=100A/\mu s$		250		ns
$Q_{rr}$ (**)	Reverse Recovery Charge	$V_{DS}=30V$ ; $T_j=25^\circ C$		910		nC
$I_{RRM}$ (**)	Reverse Recovery Current	(see test circuit, figure 5)		7.5		A

### PROTECTIONS

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$I_{LIM}$	Drain Current Limit	$V_{IN}=10V$ ; $V_{DS}=13V$	28	49	70	A
		$V_{IN}=5V$ ; $V_{DS}=13V$	28	49	70	A
$t_{dlim}$ (**)	Step Response Current Limit	$V_{IN}=10V$		35	50	$\mu s$
		$V_{IN}=5V$		90	150	$\mu s$
$T_{jsh}$ (**)	Overtemperature Shutdown		150			$^\circ C$
$T_{jrs}$ (**)	Overtemperature Reset		135			$^\circ C$
$I_{gf}$ (**)	Fault Sink Current	$V_{IN}=10V$ ; $V_{DS}=13V$		50		mA
		$V_{IN}=5V$ ; $V_{DS}=13V$		20		mA
$E_{as}$ (**)	Single Pulse Avalanche Energy	Starting $T_j=25^\circ C$ ; $V_{DS}=20V$ $V_{IN}=10V$ ; $R_{gen}=1K\Omega$ ; $L=6mH$	4			J

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

(\*\*) Parameters guaranteed by design/characterization

## 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 up to 50KHz. 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  $T_{jsh}$ .

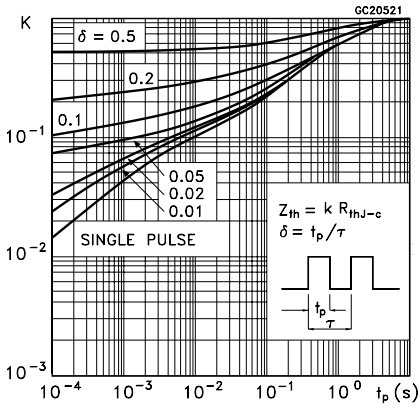
### - OVERTEMPERATURE AND SHORT CIRCUIT PROTECTION:

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 at minimum 150°C. The device is automatically restarted when the chip temperature falls below 135°C.

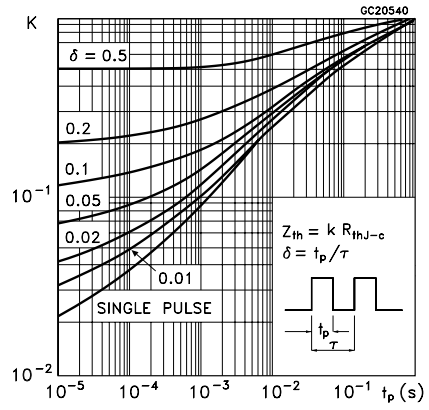
### - STATUS FEEDBACK:

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 100Ω. 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  $R_{DS(ON)}$ ).

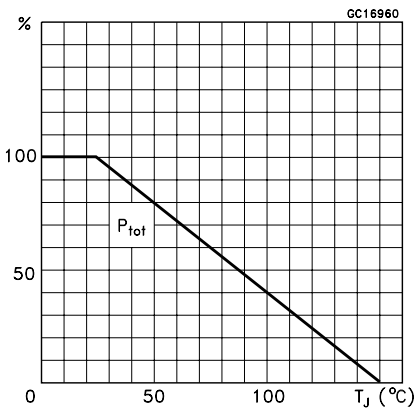
Thermal Impedance for ISOWATT220



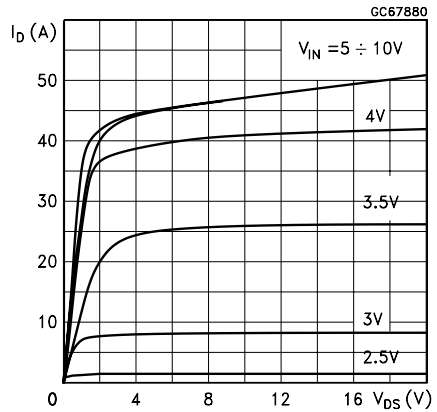
Thermal Impedance for D2PAK / PowerSO-10



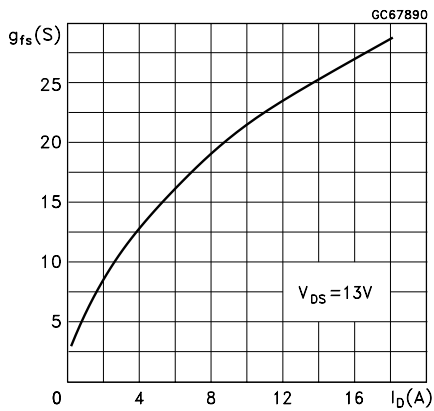
Derating Curve



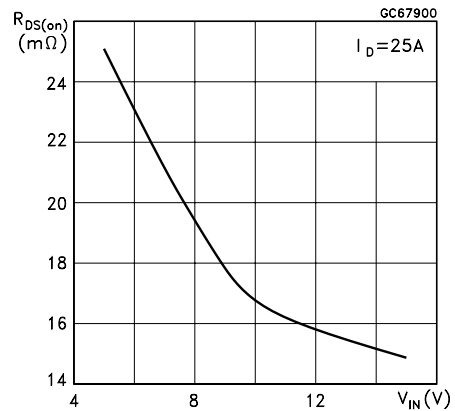
Output Characteristics



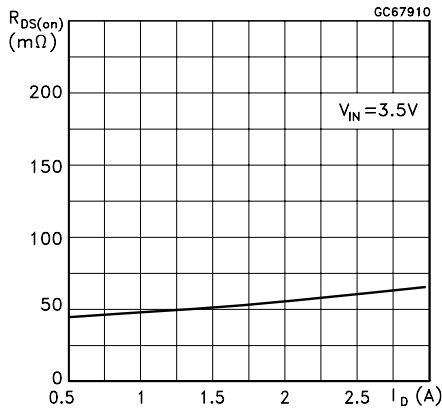
Transconductance



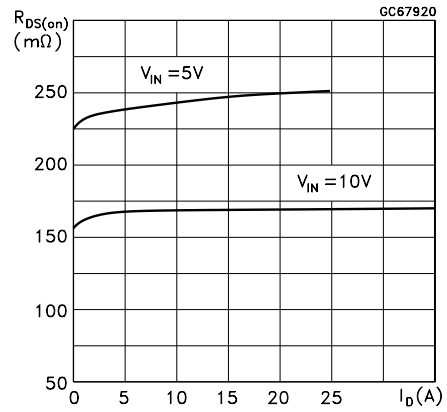
Static Drain-Source On Resistance vs Input Voltage



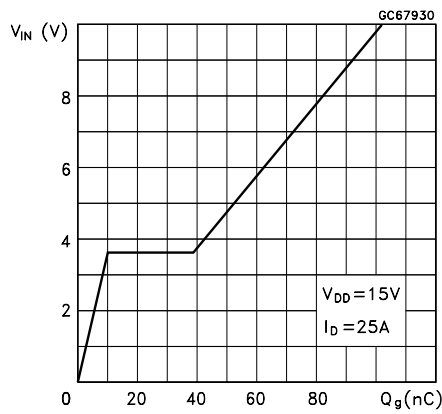
Static Drain-Source On Resistance



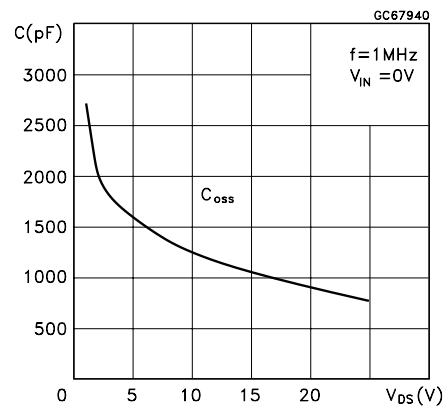
Static Drain-Source On Resistance



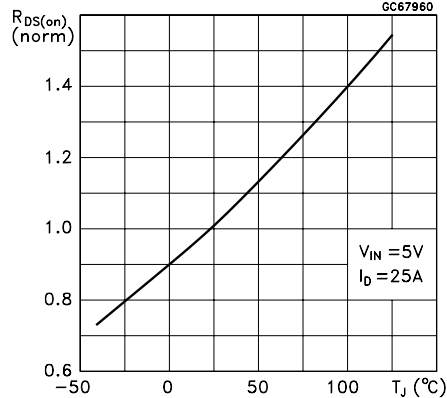
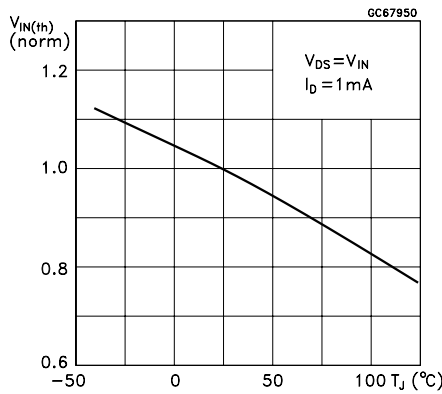
Input Charge vs Input Voltage



Capacitance Variations

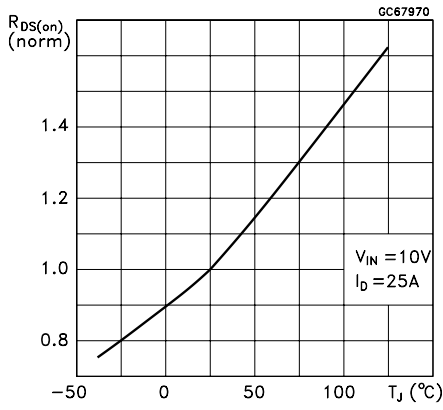


Normalized Input Threshold Voltage vs Normalized On Resistance vs. Temperature

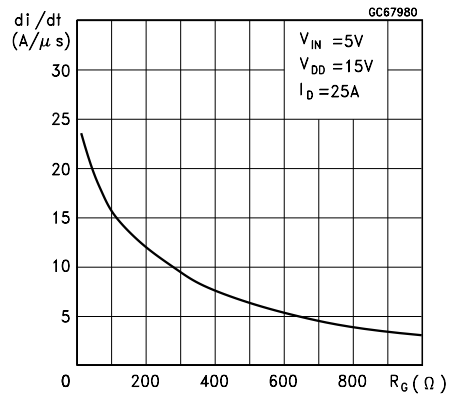




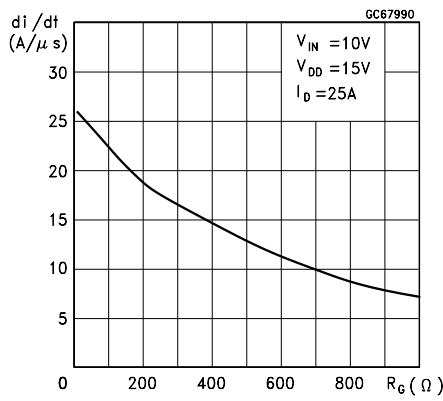
Normalized On Resistance vs. Temperature



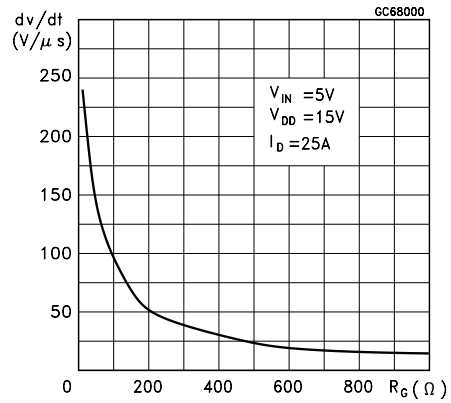
Turn-on Current Slope



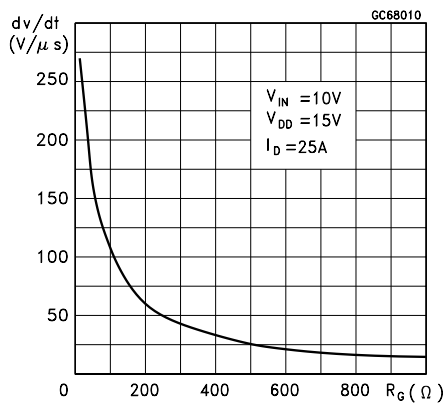
Turn-on Current Slope



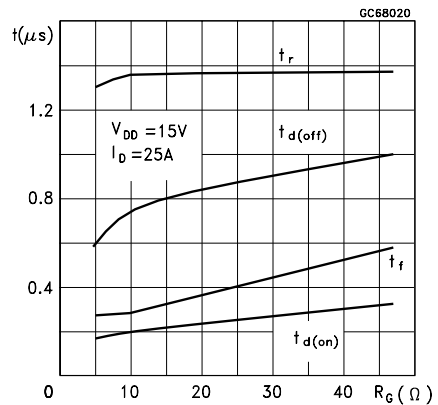
Turn-off Drain-Source Voltage Slope



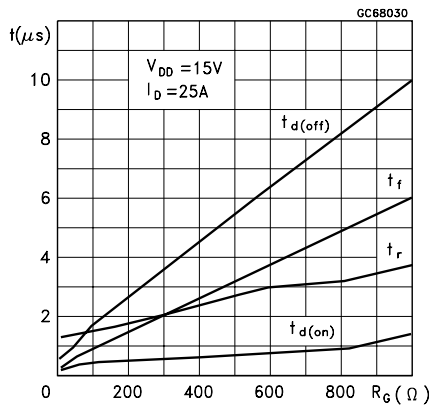
Turn-off Drain-Source Voltage Slope



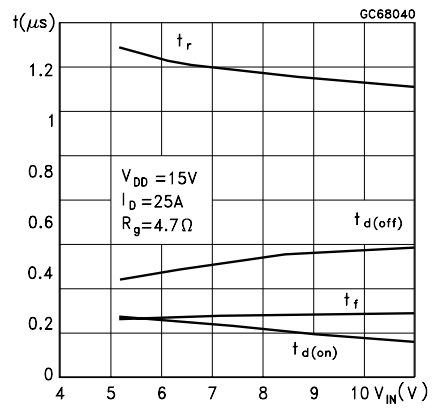
Switching Time Resistive Load



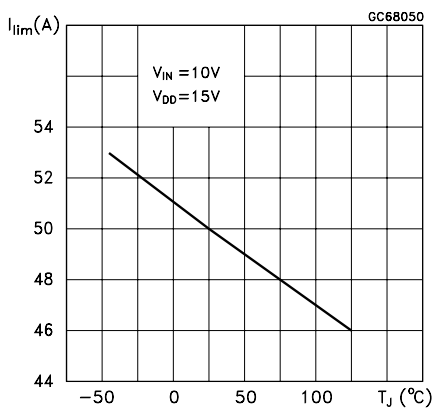
Switching Time Resistive Load



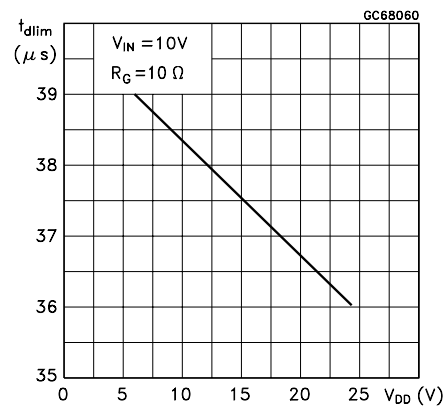
Switching Time Resistive Load



Current Limit vs. Junction Temperature



Step Response Current Limit



Source Drain Diode Forward Characteristics

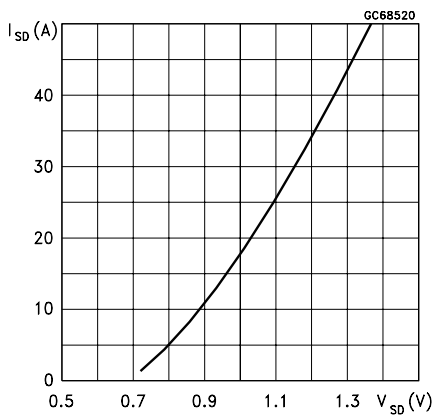


Figure 1: Unclamped Inductive Load Test Circuits

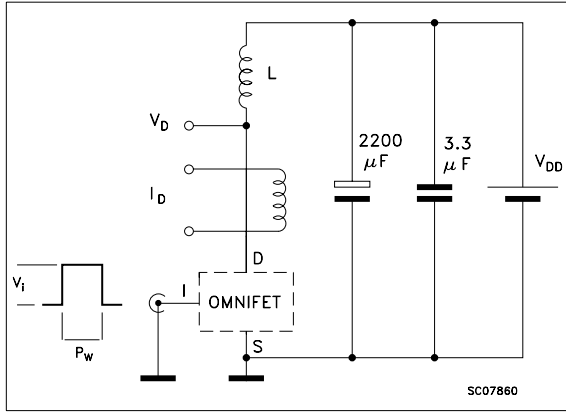


Figure 2: Unclamped Inductive Waveforms

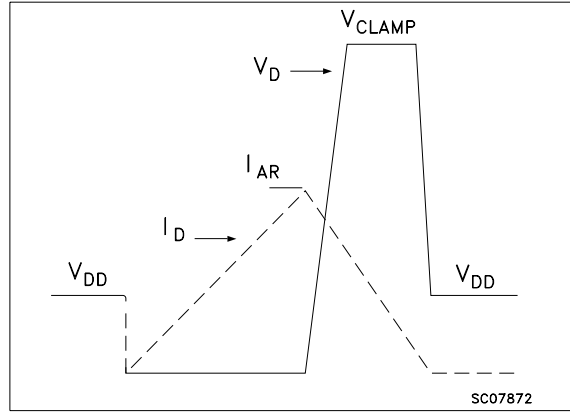


Figure 3: Switching Time Test Circuits for Resistive Load

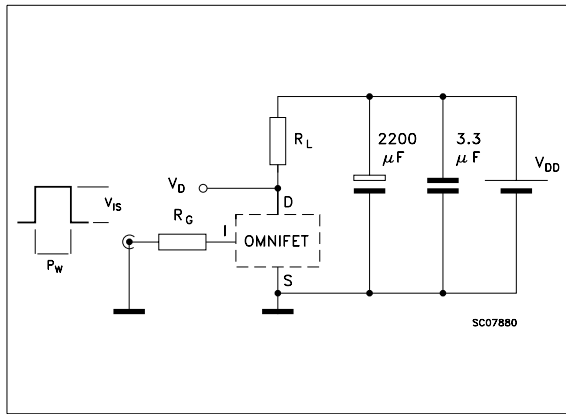


Figure 4: Input Charge Test Circuit

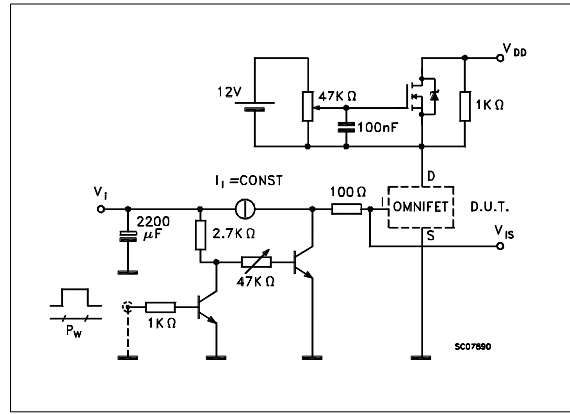


Figure 5: Test Circuit for Inductive Load Switching and Diode Recovery Times

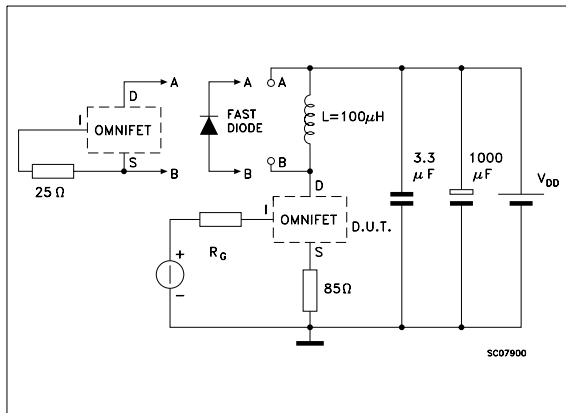
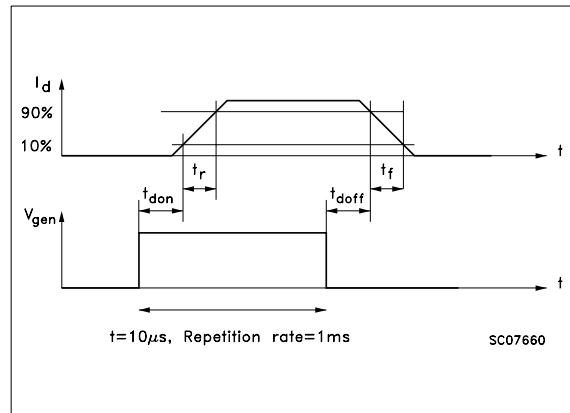
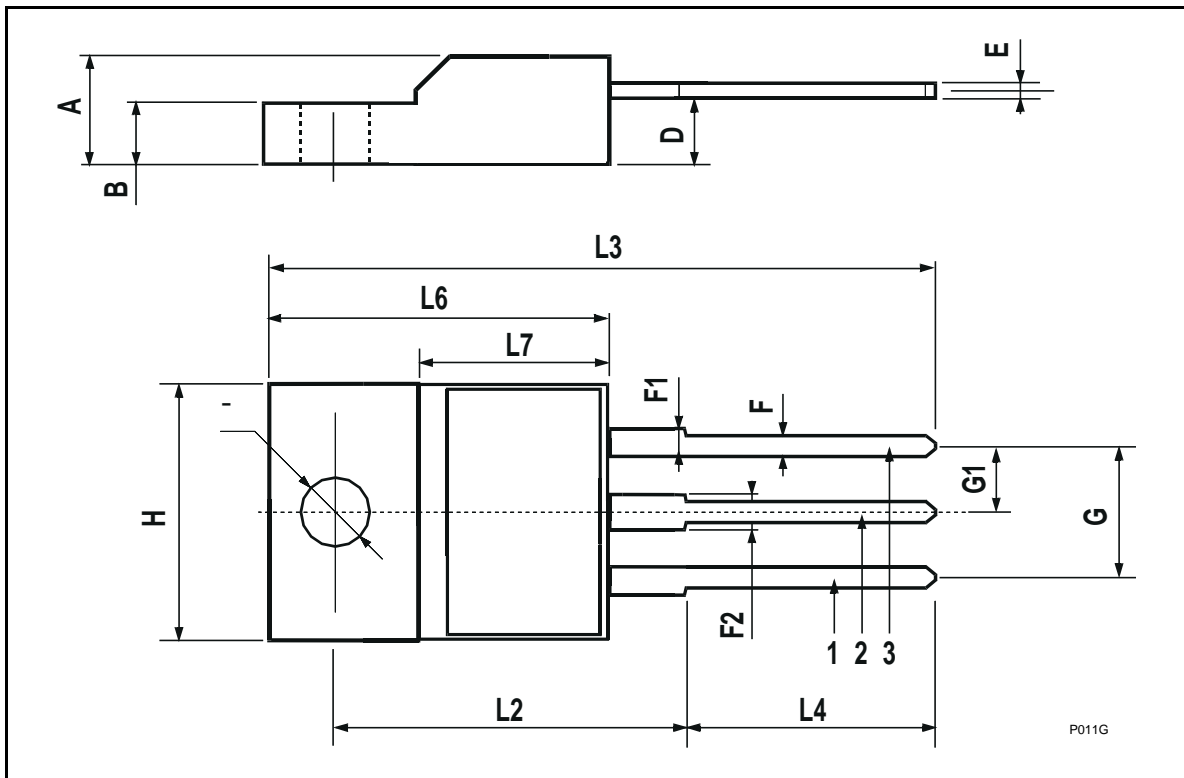


Figure 6: Waveforms



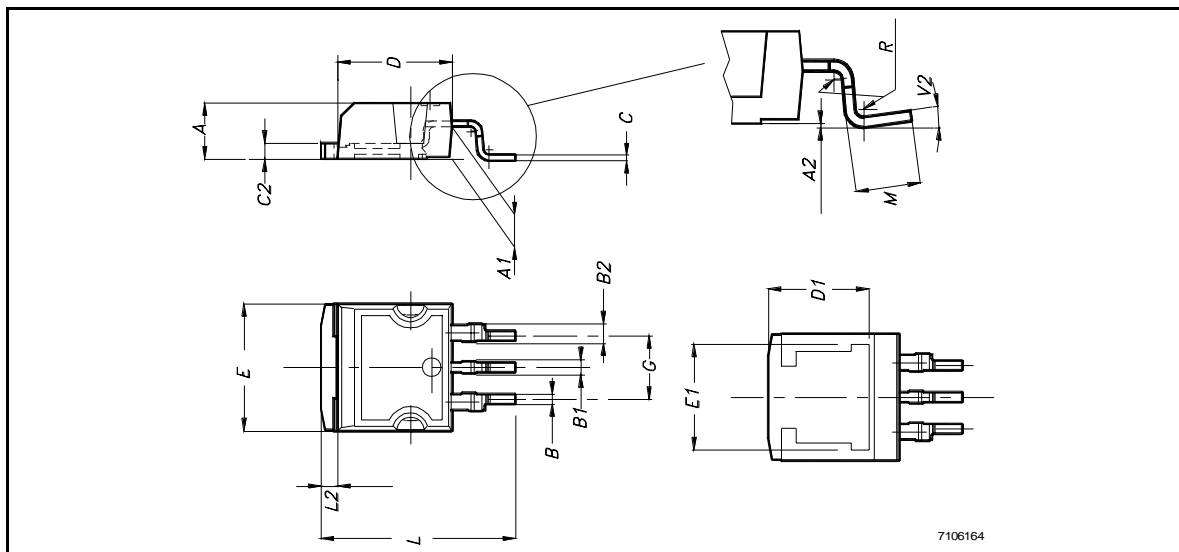
**ISOWATT220 MECHANICAL DATA**

DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
B	2.5		2.7	0.098		0.106
D	2.5		2.75	0.098		0.108
E	0.4		0.7	0.015		0.027
F	0.75		1	0.030		0.039
F1	1.15		1.7	0.045		0.067
F2	1.15		1.7	0.045		0.067
G	4.95		5.2	0.195		0.204
G1	2.4		2.7	0.094		0.106
H	10		10.4	0.393		0.409
L2		16			0.630	
L3	28.6		30.6	1.126		1.204
L4	9.8		10.6	0.385		0.417
L6	15.9		16.4	0.626		0.645
L7	9		9.3	0.354		0.366
	3		3.2	0.118		0.126



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

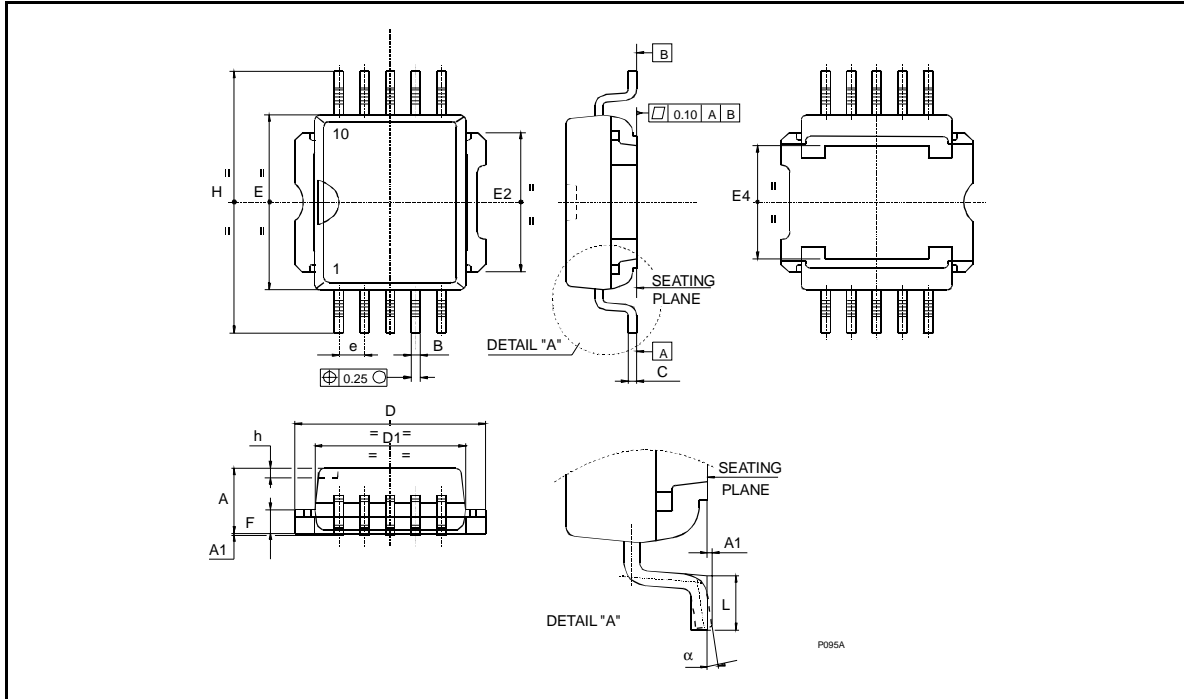
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
A1	2.49		2.69	0.098		0.106
A2	0.03		0.23	0.001		0.009
B	0.7		0.93	0.027		0.036
B1	0.8		1.3	0.031		0.051
B2	1.14		1.7	0.044		0.067
C	0.45		0.6	0.017		0.023
C2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
D1		8			0.315	
E	10		10.4	0.393		
E1		8.5			0.334	
G	4.88		5.28	0.192		0.208
L	15		15.85	0.590		0.625
L2	1.27		1.4	0.050		0.055
M	2.4		3.2	0.094		0.126
R		0.4			0.015	
V2	0°		8°			



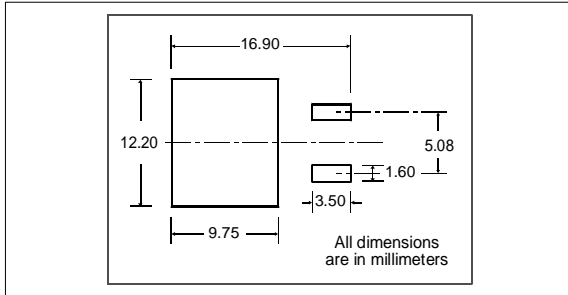
**PowerSO-10™ MECHANICAL DATA**

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°

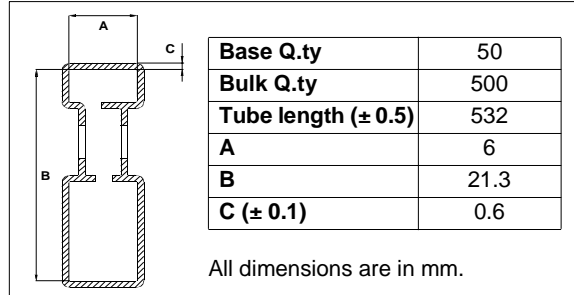
(\*) Muar only POA P013P



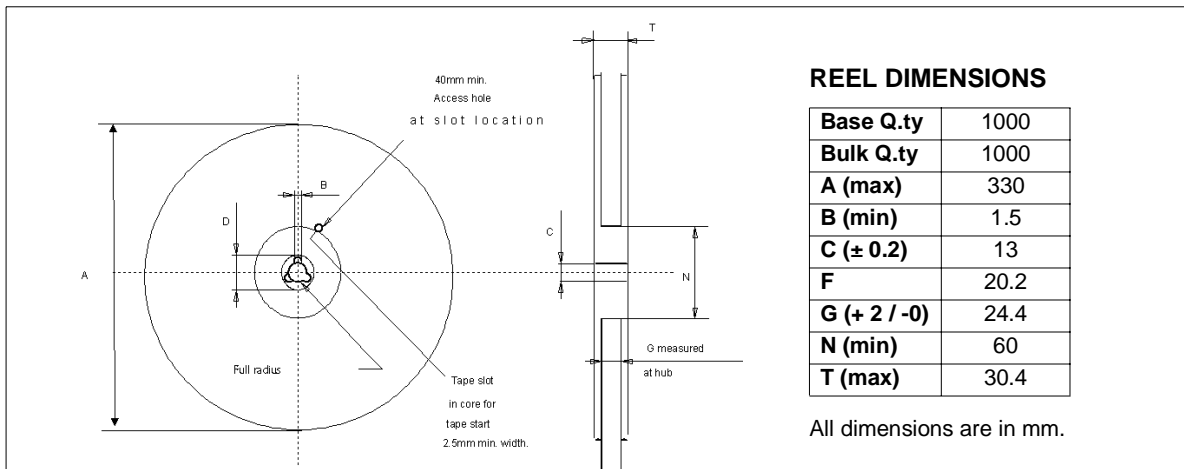
**D<sup>2</sup>PAK FOOTPRINT**



**TUBE SHIPMENT (no suffix)**



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

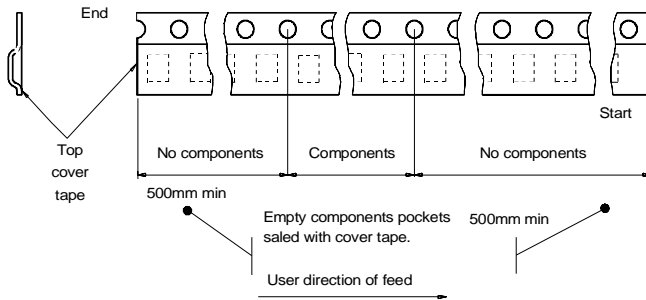
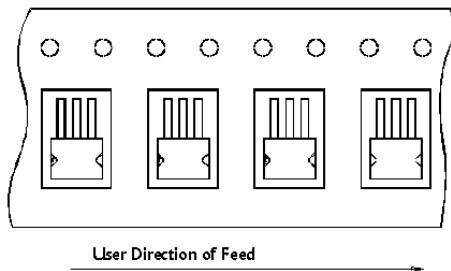
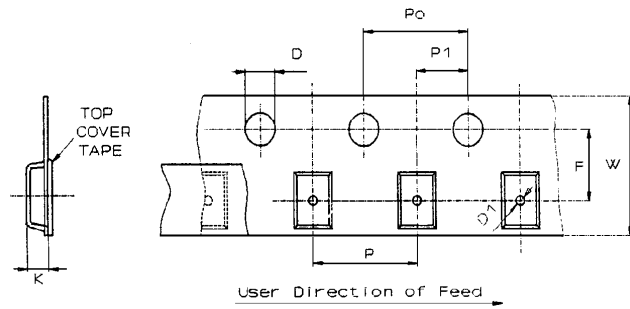


**TAPE DIMENSIONS**

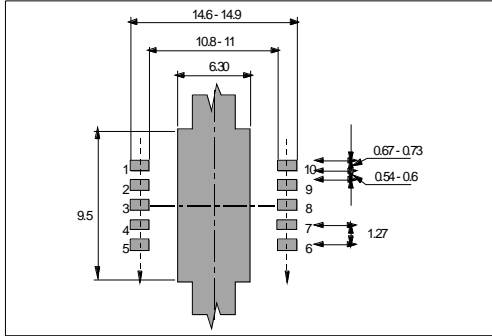
According to Electronic Industries Association (EIA) Standard 481 rev. A, Feb. 1986

<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.



**PowerSO-10™ SUGGESTED PAD LAYOUT**



**TUBE SHIPMENT (no suffix)**

CASABLANCA

MUAR

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**

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

All dimensions are in mm.

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

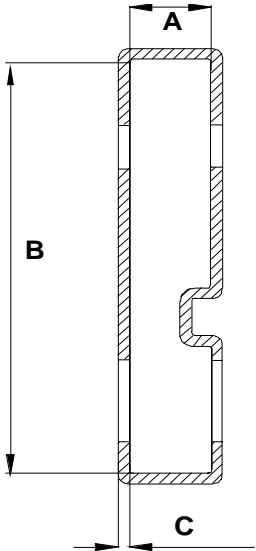
Tape width	W	24
Tape Hole Spacing	P0 (± 0.1)	4
Component Spacing	P	24
Hole Diameter	D (± 0.1/-0)	1.5
Hole Diameter	D1 (min.)	1.5
Hole Position	F (± 0.05)	11.5
Compartment Depth	K (max)	6.5
Hole Spacing	P1 (± 0.1)	2

All dimensions are in mm.

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**ISOWATT220 TUBE SHIPMENT (no suffix)**



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

All dimensions are in mm.

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