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VN820 / VN820SO VN820SP / VN820-B5 / VN820PT

HIGH SIDE DRIVER

TYPE	$R_{DS(on)}$	I_{OUT}	V_{CC}
VN820	40 m Ω	9 A	36 V
VN820SP			
VN820-B5			
VN820SO			
VN820PT			

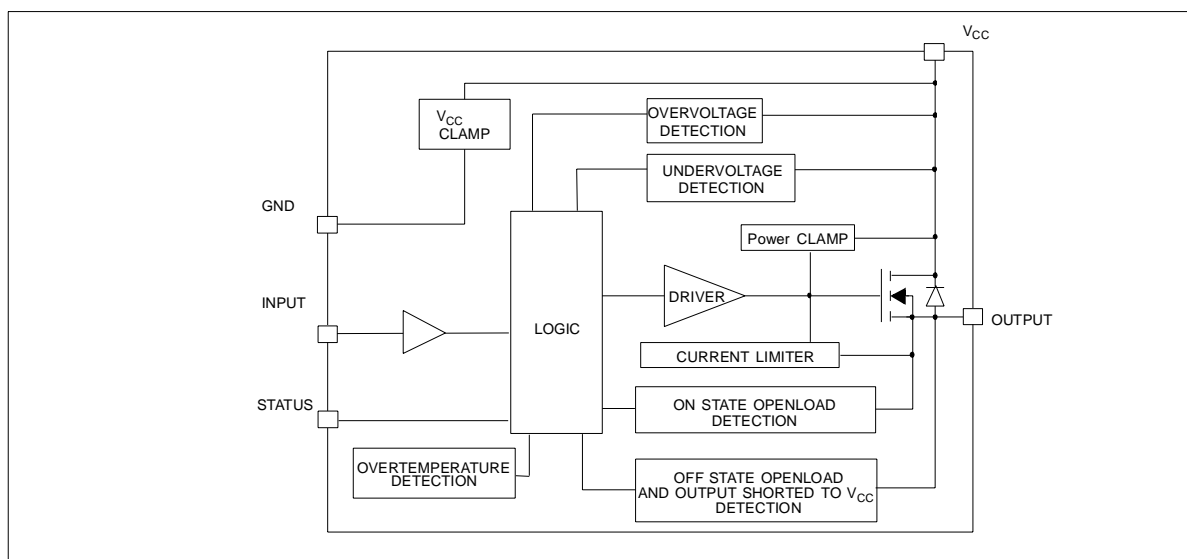
- CMOS COMPATIBLE INPUT
- ON STATE OPEN LOAD DETECTION
- OFF STATE OPEN LOAD DETECTION
- SHORTED LOAD PROTECTION
- UNDERVOLTAGE AND OVERVOLTAGE SHUTDOWN
- PROTECTION AGAINST LOSS OF GROUND
- VERY LOW STAND-BY CURRENT
- REVERSE BATTERY PROTECTION (*)

DESCRIPTION

The VN820, VN820SP, VN820-B5, VN820SO, VN820PT are monolithic devices made by using STMicroelectronics VIPower M0-3 Technology, intended for driving any kind of load with one side connected to ground.

Active V_{CC} pin voltage clamp protects the device against low energy spikes (see ISO7637 transient

BLOCK DIAGRAM



(*) See application schematic at page 9
June 2003

ORDER CODES

PACKAGE	TUBE	T&R
PENTAWATT	VN820	-
PowerSO-10™	VN820SP	VN820SP13TR
P ² PAK	VN820-B5	VN820-B513TR
SO-16L	VN820SO	VN820SO13TR
PPAK	VN820PT	VN820PT13TR

compatibility table). Active current limitation combined with thermal shutdown and automatic restart protect the device against overload.

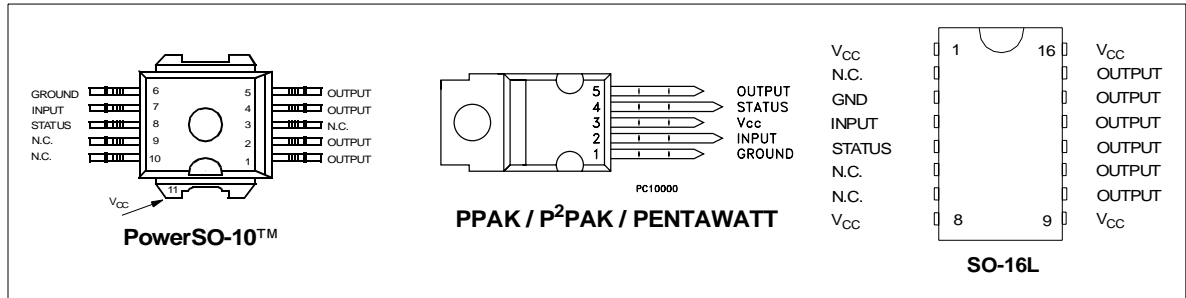
The device detects open load condition both is on and off state. Output shorted to V_{CC} is detected in the off state. Device automatically turns off in case of ground pin disconnection.

VN820 / VN820SO / VN820SP / VN820-B5 / VN820PT

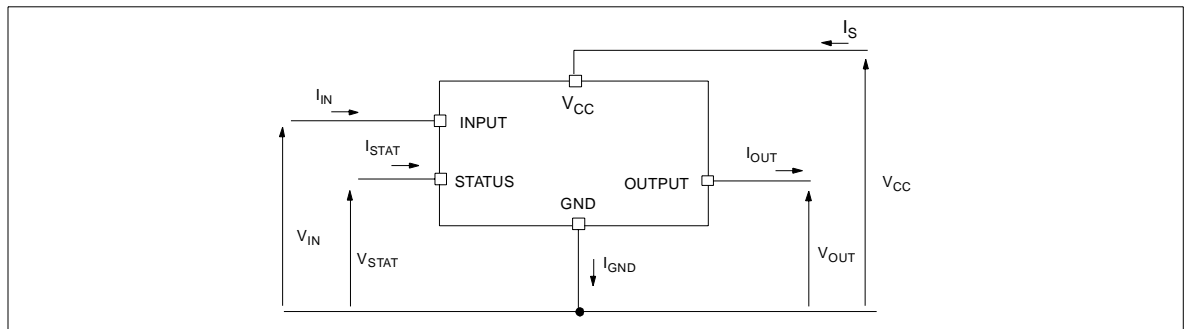
ABSOLUTE MAXIMUM RATING

Symbol	Parameter	Value					Unit
		PowerSO-10™	PENTAWATT	P ² PAK	SO-16L	PPAK	
V _{CC}	DC Supply Voltage	41					V
- V _{CC}	Reverse DC Supply Voltage	- 0.3					V
- I _{GND}	DC Reverse Ground Pin Current	- 200					mA
I _{OUT}	DC Output Current	Internally Limited					A
- I _{OUT}	Reverse DC Output Current	- 9					A
I _{IN}	DC Input Current	+/- 10					mA
I _{STAT}	DC Status Current	+/- 10					mA
V _{ESD}	Electrostatic Discharge (Human Body Model: R=1.5KΩ; C=100pF)						
	- INPUT	4000					V
	- STATUS	4000					V
	- OUTPUT	5000					V
	- V _{CC}	5000					V
E _{MAX}	Maximum Switching Energy (L=4mH; R _L =0Ω; V _{bat} =13.5V; T _{jstart} =150°C; I _L =13A)	481		481			mJ
E _{MAX}	Maximum Switching Energy (L=3.7mH; R _L =0Ω; V _{bat} =13.5V; T _{jstart} =150°C; I _L =13A)				438		mJ
E _{MAX}	Maximum Switching Energy (L=4.48mH; R _L =0Ω; V _{bat} =13.5V; T _{jstart} =150°C; I _L =13A)					526	mJ
P _{tot}	Power Dissipation T _C =25°C	65.8	65.8	65.8	8.3	65.8	W
T _j	Junction Operating Temperature	Internally Limited					°C
T _C	Case Operating Temperature	- 40 to 150					°C
T _{stg}	Storage Temperature	- 55 to 150					°C

CONNECTION DIAGRAM (TOP VIEW)



CURRENT AND VOLTAGE CONVENTIONS



THERMAL DATA

Symbol	Parameter	Value					Unit
		PowerSO-10™	PENTAWATT	P ² PAK	SO-16L	PPAK	
R _{thj-case}	Thermal Resistance Junction-case Max	1.9	1.9	1.9	-	1.9	°C/W
R _{thj-lead}	Thermal Resistance Junction-lead Max	-	-	-	15	-	°C/W
R _{thj-amb}	Thermal Resistance Junction-ambient Max	51.9 (*)	61.9 (*)	51.9 (*)	65 (**)	76.9 (*)	°C/W

(*) When mounted on a standard single-sided FR-4 board with 0.5cm² of Cu (at least 35µm thick).

(**) When mounted on FR4 printed circuit board with 0.5cm² of Cu (at least 35µ thick) connected to all V_{CC} pins.

ELECTRICAL CHARACTERISTICS (8V < V_{CC} < 36V; -40°C < T_j < 150°C unless otherwise specified)

POWER

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V _{CC}	Operating Supply Voltage		5.5	13	36	V
V _{USD}	Undervoltage Shut-down		3	4	5.5	V
V _{USDhyst}	Undervoltage Shut-down hysteresis			0.5		V
V _{OV}	Overvoltage Shut-down		36			V
R _{ON}	On State Resistance	I _{OUT} =3A; T _j =25°C; V _{CC} >8V I _{OUT} =3A; V _{CC} >8V			40 80	mΩ mΩ
I _S	Supply Current	Off State; V _{CC} =13V; V _{IN} =V _{OUT} =0V Off State; V _{CC} =13V; V _{IN} =V _{OUT} =0V; T _j =25°C On State; V _{CC} =13V; V _{IN} =5V; I _{OUT} =0A		10 10 2	25 20 3.5	µA µA mA
I _{L(off1)}	Off State Output Current	V _{IN} =V _{OUT} =0V	0		50	µA
I _{L(off2)}	Off State Output Current	V _{IN} =0V; V _{OUT} =3.5V	-75		0	µA
I _{L(off3)}	Off State Output Current	V _{IN} =V _{OUT} =0V; V _{CC} =13V; T _j =125°C			5	µA
I _{L(off4)}	Off State Output Current	V _{IN} =V _{OUT} =0V; V _{CC} =13V; T _j =25°C			3	µA

SWITCHING (V_{CC}=13V)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
t _{d(on)}	Turn-on Delay Time	R _L =4.3Ω from V _{IN} rising edge to V _{OUT} =1.3V		30		µs
t _{d(off)}	Turn-off Delay Time	R _L =4.3Ω from V _{IN} falling edge to V _{OUT} =11.7V		30		µs
dV _{OUT} /dt _(on)	Turn-on Voltage Slope	R _L =4.3Ω from V _{OUT} =1.3 to V _{OUT} =10.4V		See relative diagram		V/µs
dV _{OUT} /dt _(off)	Turn-off Voltage Slope	R _L =4.3Ω from V _{OUT} =11.7 to V _{OUT} =1.3V		See relative diagram		V/µs

INPUT PIN

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V _{IL}	Input Low Level				1.25	V
I _{IL}	Low Level Input Current	V _{IN} =1.25V	1			µA
V _{IH}	Input High Level		3.25			V
I _{IH}	High Level Input Current	V _{IN} =3.25V			10	µA
V _{I(hyst)}	Input Hysteresis Voltage		0.5			V
V _{ICL}	Input Clamp Voltage	I _{IN} =1mA I _{IN} =-1mA	6	6.8 -0.7	8	V V

ELECTRICAL CHARACTERISTICS (continued)

STATUS PIN

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{STAT}	Status Low Output Voltage	$I_{STAT}=1.6mA$			0.5	V
I_{LSTAT}	Status Leakage Current	Normal Operation $V_{STAT}=5V$			10	μA
C_{STAT}	Status Pin Input Capacitance	Normal Operation $V_{STAT}=5V$			100	pF
V_{SCL}	Status Clamp Voltage	$I_{STAT}=1mA$	6	6.8	8	V
		$I_{STAT}=-1mA$		-0.7		V

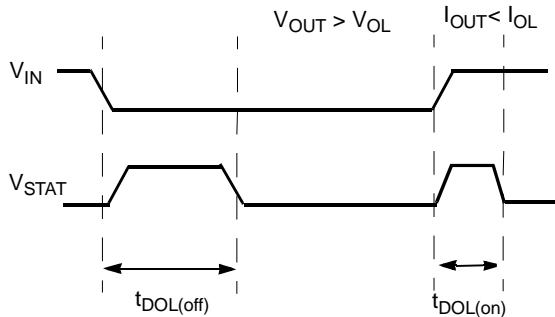
PROTECTIONS

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
T_{TSD}	Shut-down Temperature		150	175	200	$^{\circ}C$
T_R	Reset Temperature		135			$^{\circ}C$
T_{hyst}	Thermal Hysteresis		7	15		$^{\circ}C$
t_{SDL}	Status delay in overload condition	$T_j > T_{TSD}$			20	μs
I_{lim}	Current limitation	$5.5V < V_{CC} < 36V$	9	13	20	A
V_{demag}	Turn-off Output Clamp Voltage	$I_{OUT}=3A; V_{IN}=0V; L=6mH$	$V_{CC}-41$	$V_{CC}-48$	$V_{CC}-55$	V

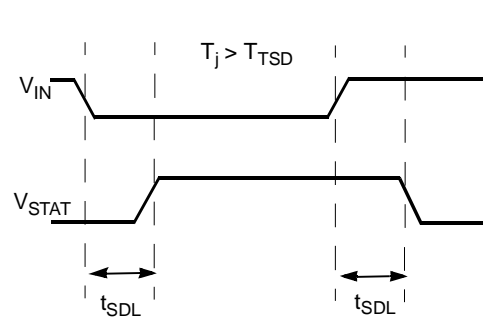
OPENLOAD DETECTION

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
I_{OL}	Openload ON State Detection Threshold	$V_{IN}=5V$	70	150	300	mA
$t_{DOL(on)}$	Openload ON State Detection Delay	$I_{OUT}=0A$			200	μs
V_{OL}	Openload OFF State Voltage Detection Threshold	$V_{IN}=0V$	1.5	2.5	3.5	V
$t_{DOL(off)}$	Openload Detection Delay at Turn Off				1000	μs

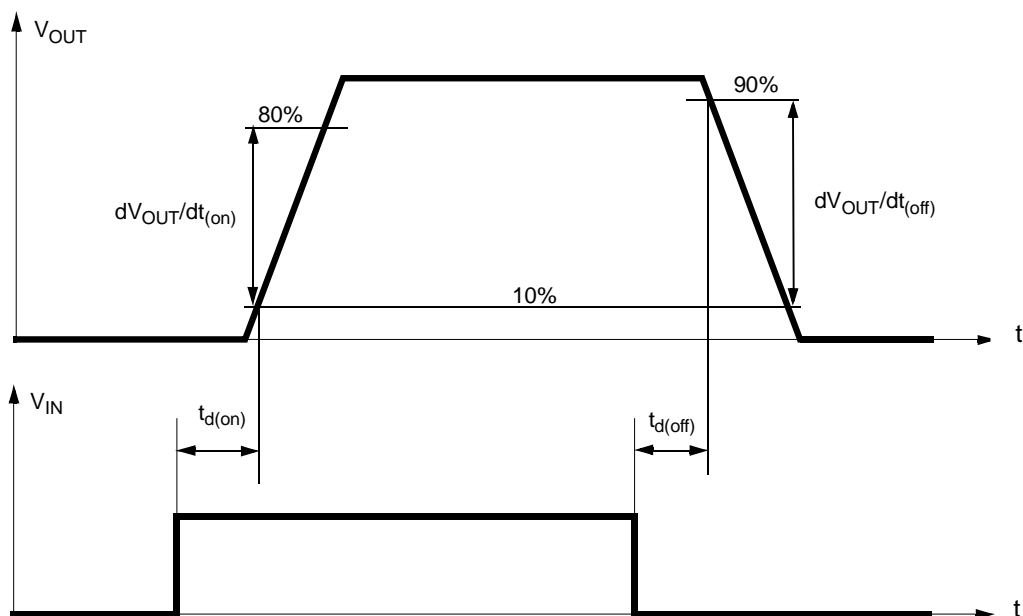
OPEN LOAD STATUS TIMING (with external pull-up)



OVERTEMP STATUS TIMING



Switching time Waveforms



TRUTH TABLE

CONDITIONS	INPUT	OUTPUT	STATUS
Normal Operation	L	L	H
	H	H	H
Current Limitation	L	L	H
	H	X	$(T_j < T_{TSD})$ H
	H	X	$(T_j > T_{TSD})$ L
Overtemperature	L	L	H
	H	L	L
Undervoltage	L	L	X
	H	L	X
Overvoltage	L	L	H
	H	L	H
Output Voltage > V_{OL}	L	H	L
	H	H	H
Output Current < I_{OL}	L	L	H
	H	H	L

OPEN LOAD DETECTION IN OFF STATE

Off state open load detection requires an external pull-up resistor (R_{PU}) connected between OUTPUT pin and a positive supply voltage (V_{PU}) like the +5V line used to supply the microprocessor.

The external resistor has to be selected according to the following requirements:

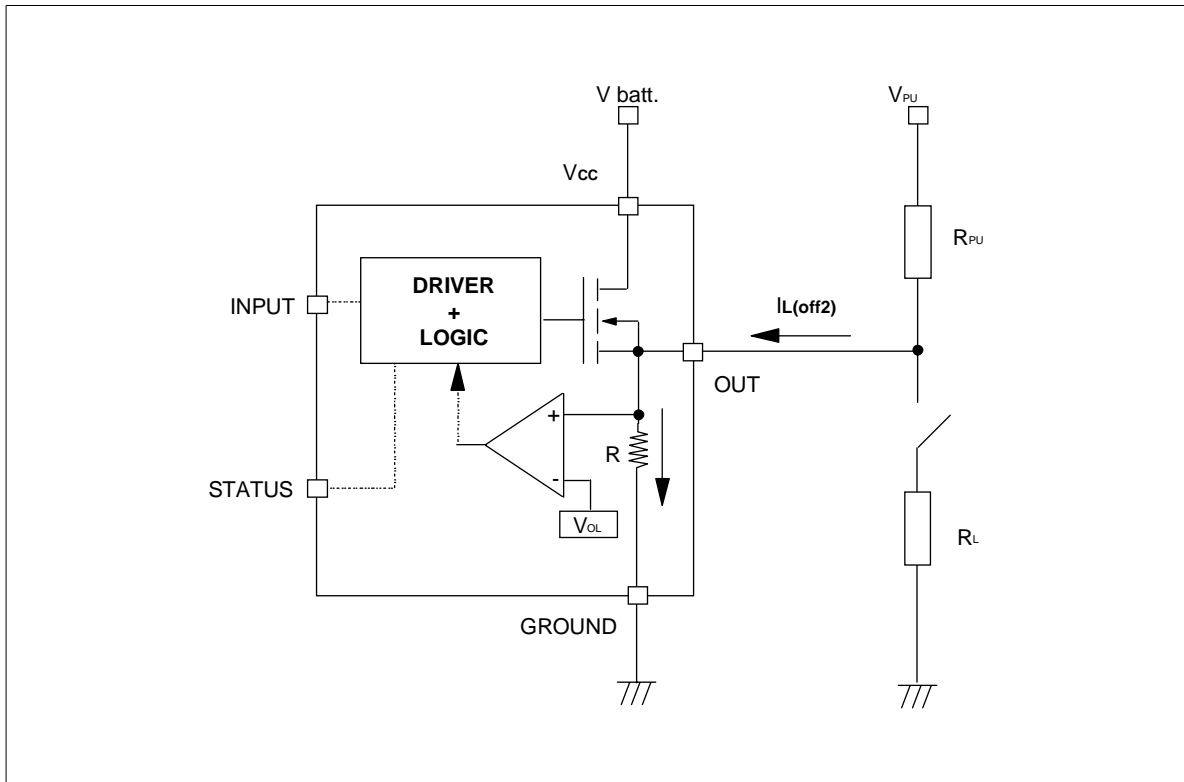
- 1) no false open load indication when load is connected: in this case we have to avoid V_{OUT} to be higher than V_{OLmin} ; this results in the following condition $V_{OUT} = (V_{PU} / (R_L + R_{PU})) R_L < V_{OLmin}$.

- 2) no misdetection when load is disconnected: in this case the V_{OUT} has to be higher than V_{OLmax} ; this results in the following condition $R_{PU} < (V_{PU} - V_{OLmax}) / I_{L(off2)}$.

Because $I_{S(OFF)}$ may significantly increase if V_{OUT} is pulled high (up to several mA), the pull-up resistor R_{PU} should be connected to a supply that is switched OFF when the module is in standby.

The values of V_{OLmin} , V_{OLmax} and $I_{L(off2)}$ are available in the Electrical Characteristics section.

Open Load detection in off state



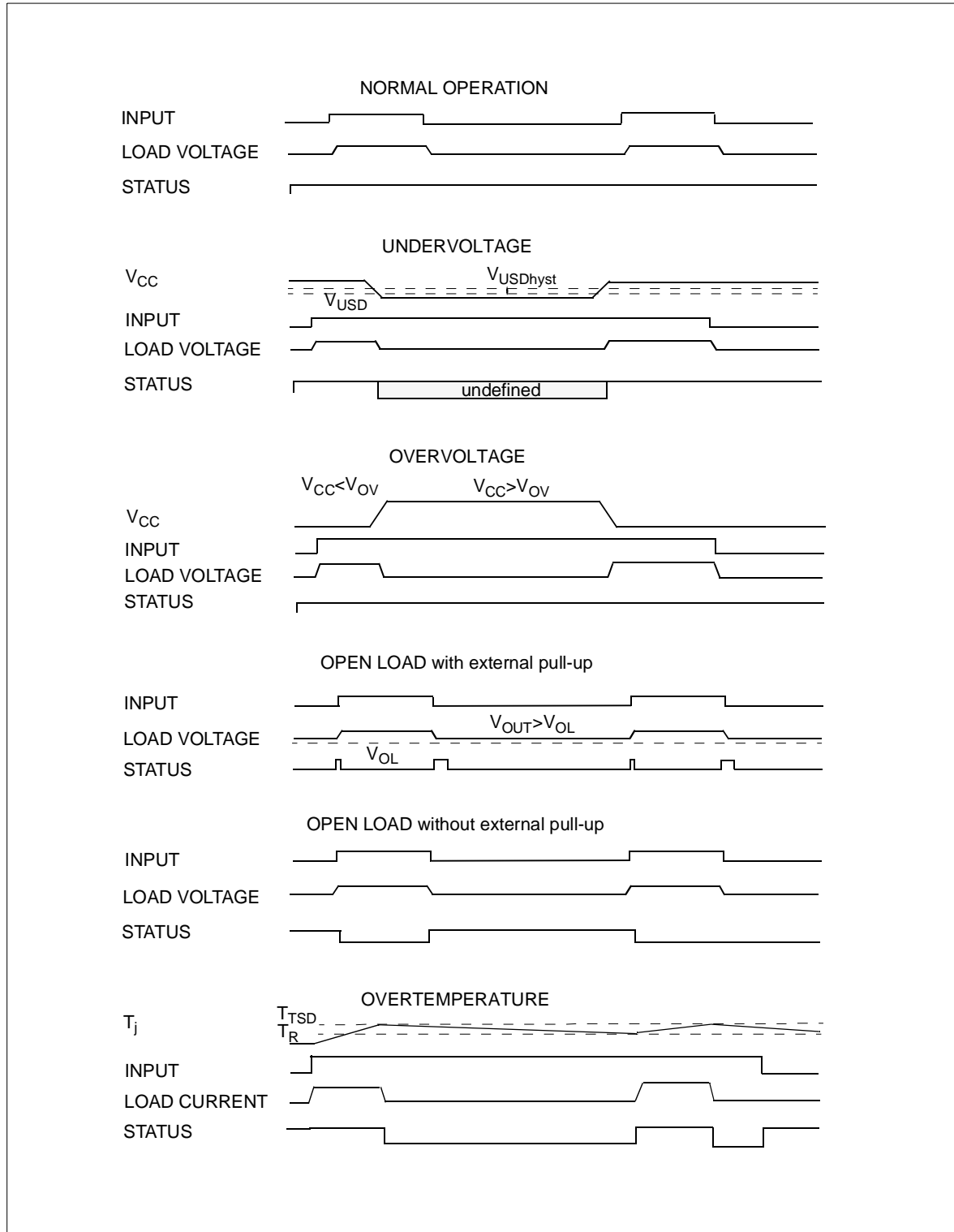
ELECTRICAL TRANSIENT REQUIREMENTS ON V_{CC} PIN

ISO T/R 7637/1 Test Pulse	TEST LEVELS				Delays and Impedance
	I	II	III	IV	
1	-25 V	-50 V	-75 V	-100 V	2 ms 10 Ω
2	+25 V	+50 V	+75 V	+100 V	0.2 ms 10 Ω
3a	-25 V	-50 V	-100 V	-150 V	0.1 μs 50 Ω
3b	+25 V	+50 V	+75 V	+100 V	0.1 μs 50 Ω
4	-4 V	-5 V	-6 V	-7 V	100 ms, 0.01 Ω
5	+26.5 V	+46.5 V	+66.5 V	+86.5 V	400 ms, 2 Ω

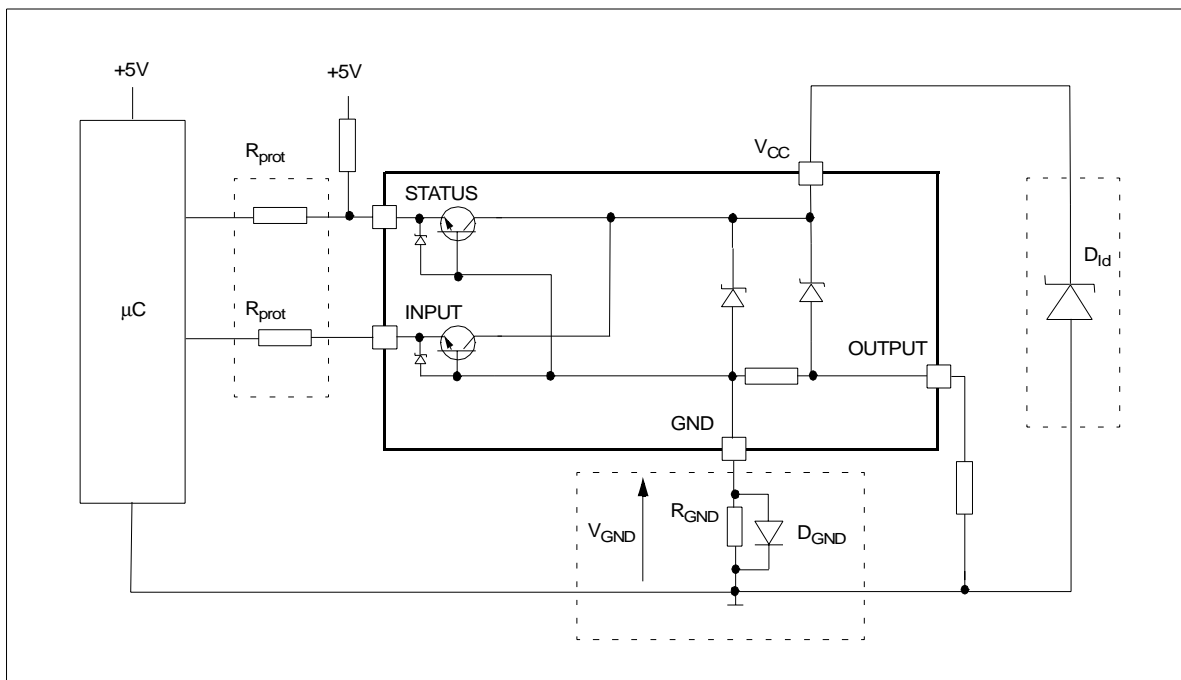
ISO T/R 7637/1 Test Pulse	TEST LEVELS RESULTS			
	I	II	III	IV
1	C	C	C	C
2	C	C	C	C
3a	C	C	C	C
3b	C	C	C	C
4	C	C	C	C
5	C	E	E	E

CLASS	CONTENTS
C	All functions of the device are performed as designed after exposure to disturbance.
E	One or more functions of the device is not performed as designed after exposure to disturbance and cannot be returned to proper operation without replacing the device.

Figure 1: Waveforms



APPLICATION SCHEMATIC



GND PROTECTION NETWORK AGAINST REVERSE BATTERY

Solution 1: Resistor in the ground line (R_{GND} only). This can be used with any type of load.

The following is an indication on how to dimension the R_{GND} resistor.

- 1) $R_{GND} \leq 600\text{mV} / (I_{S(on)max})$.
- 2) $R_{GND} \geq (-V_{CC}) / (-I_{GND})$

where $-I_{GND}$ is the DC reverse ground pin current and can be found in the absolute maximum rating section of the of the device's datasheet.

Power Dissipation in R_{GND} (when $V_{CC} < 0$: during reverse battery situations) is:

$$P_D = (-V_{CC})^2 / R_{GND}$$

This resistor can be shared amongst several different HSD. Please note that the value of this resistor should be calculated with formula (1) where $I_{S(on)max}$ becomes the sum of the maximum on-state currents of the different devices.

Please note that if the microprocessor ground is not common with the device ground then the R_{GND} will produce a shift ($I_{S(on)max} * R_{GND}$) in the input thresholds and the status output values. This shift will vary depending on many devices are ON in the case of several high side drivers sharing the same R_{GND} .

If the calculated power dissipation leads to a large resistor or several devices have to share the same resistor then the ST suggest to utilize Solution 2 (see below).

Solution 2: A diode (D_{GND}) in the ground line.

A resistor ($R_{GND} = 1\text{k}\Omega$) should be inserted in parallel to D_{GND} if the device will be driving an inductive load.

This small signal diode can be safely shared amongst several different HSD. Also in this case, the presence of the ground network will produce a shift ($\approx 600\text{mV}$) in the input threshold and the status output values if the microprocessor ground is not common with the device ground. This shift will not vary if more than one HSD shares the same diode/resistor network.

LOAD DUMP PROTECTION

D_{Id} is necessary (Voltage Transient Suppressor) if the load dump peak voltage exceeds V_{CC} max DC rating. The same applies if the device will be subject to transients on the V_{CC} line that are greater than the ones shown in the ISO T/R 7637/1 table.

µC I/Os PROTECTION:

If a ground protection network is used and negative transient are present on the V_{CC} line, the control pins will be pulled negative. ST suggests to insert a resistor (R_{prot}) in line to prevent the μC I/Os pins to latch-up.

The value of these resistors is a compromise between the leakage current of μC and the current required by the HSD I/Os (Input levels compatibility) with the latch-up limit of μC I/Os.

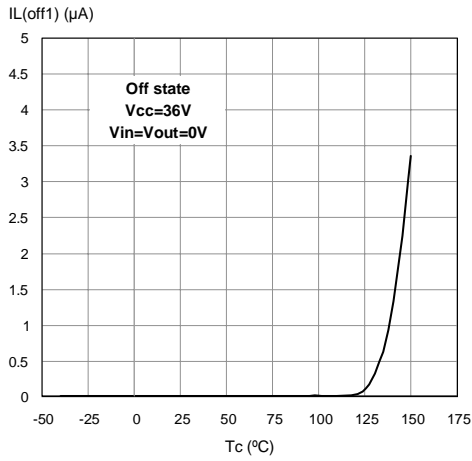
$$-V_{CCpeak} / I_{latchup} \leq R_{prot} \leq (V_{OH\mu C} - V_{IH} - V_{GND}) / I_{IHmax}$$

Calculation example:

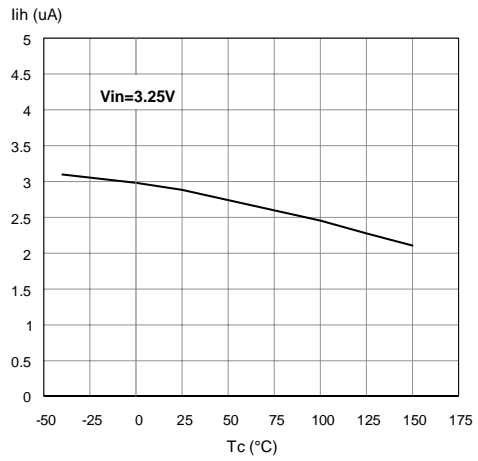
For $V_{CCpeak} = -100\text{V}$ and $I_{latchup} \geq 20\text{mA}$; $V_{OH\mu C} \geq 4.5\text{V}$
 $5\text{k}\Omega \leq R_{prot} \leq 65\text{k}\Omega$.

Recommended R_{prot} value is $10\text{k}\Omega$.

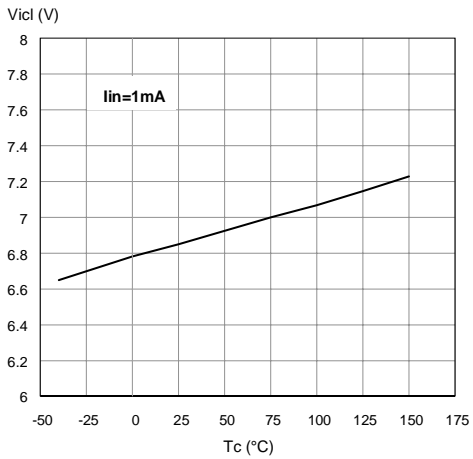
Off State Output Current



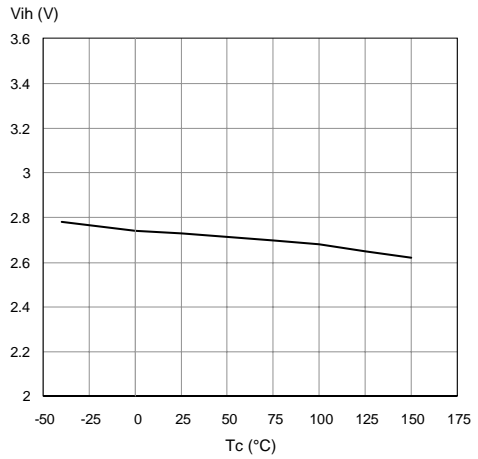
High Level Input Current



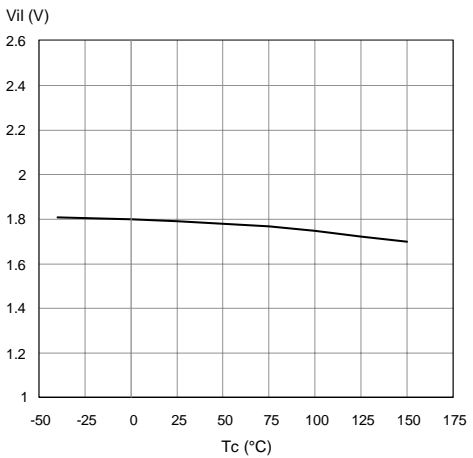
Input Clamp Voltage



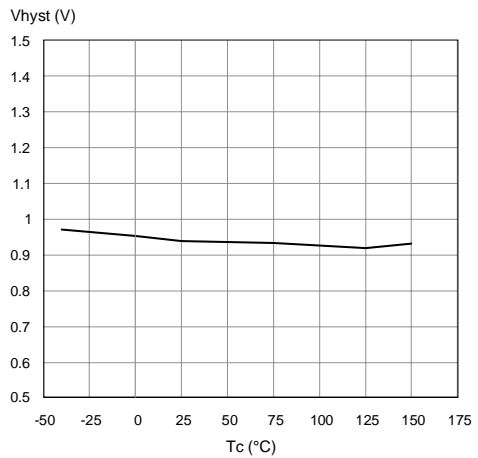
Input High Level



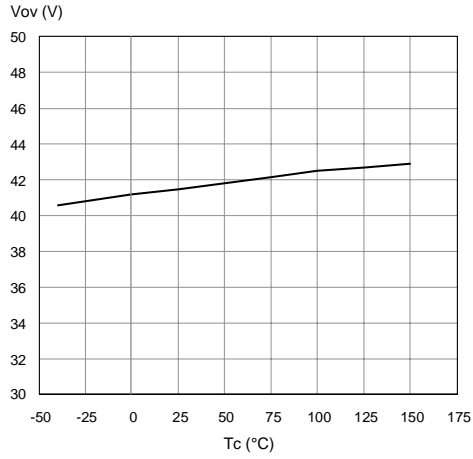
Input Low Level



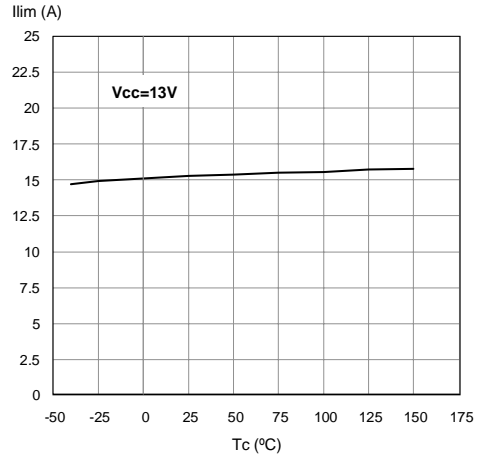
Input Hysteresis Voltage



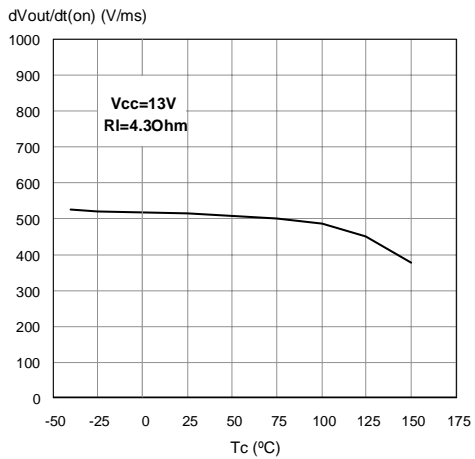
Overvoltage Shutdown



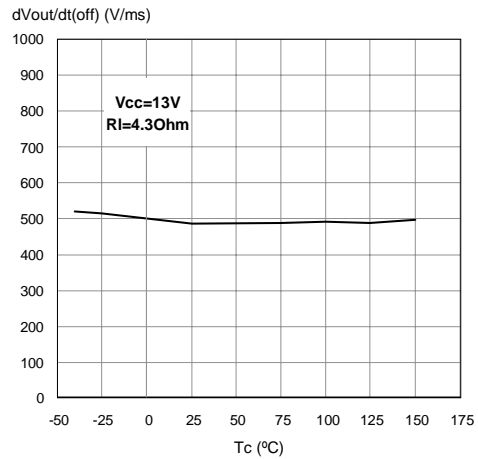
I_{LIM} Vs T_{case}



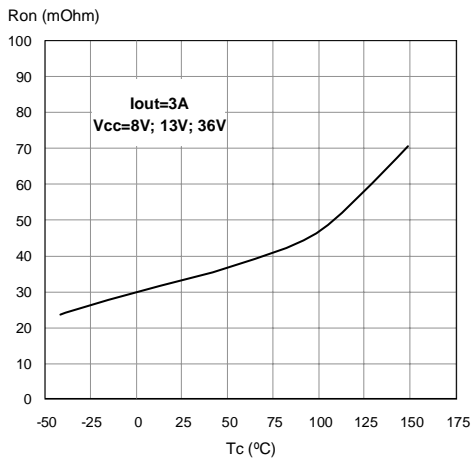
Turn-on Voltage Slope



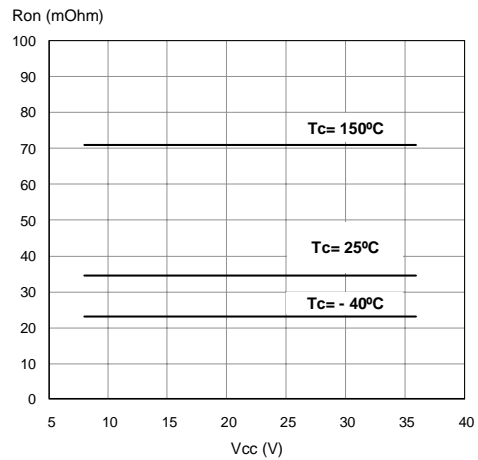
Turn-off Voltage Slope



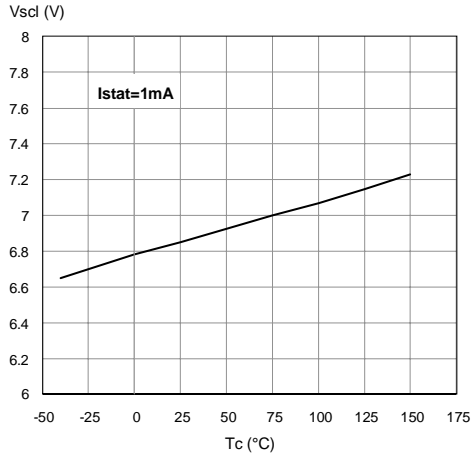
On State Resistance Vs T_{case}



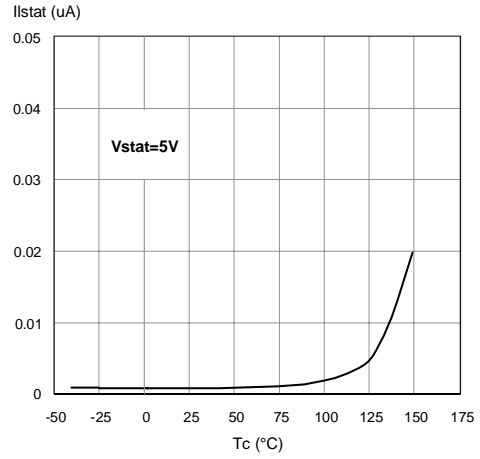
On State Resistance Vs V_{CC}



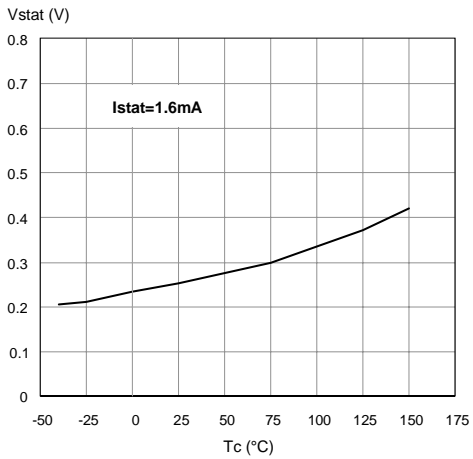
Status Clamp Voltage



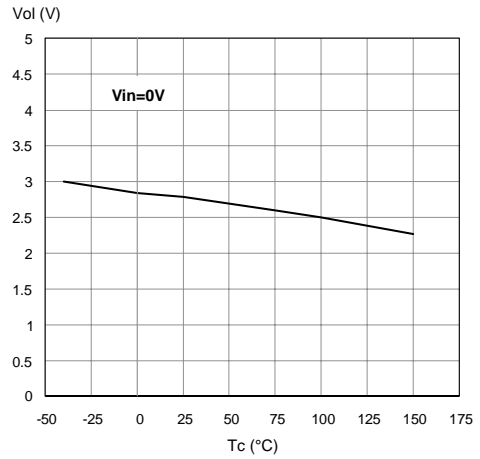
Status Leakage Current



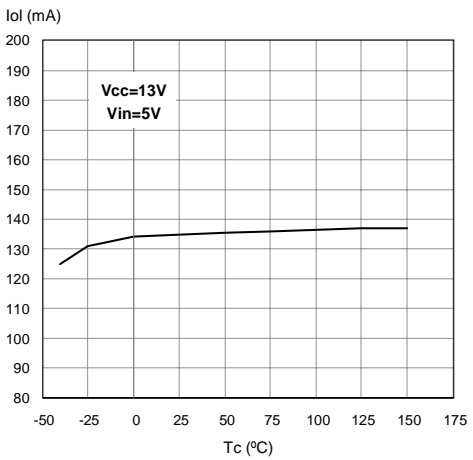
Status Low Output Voltage



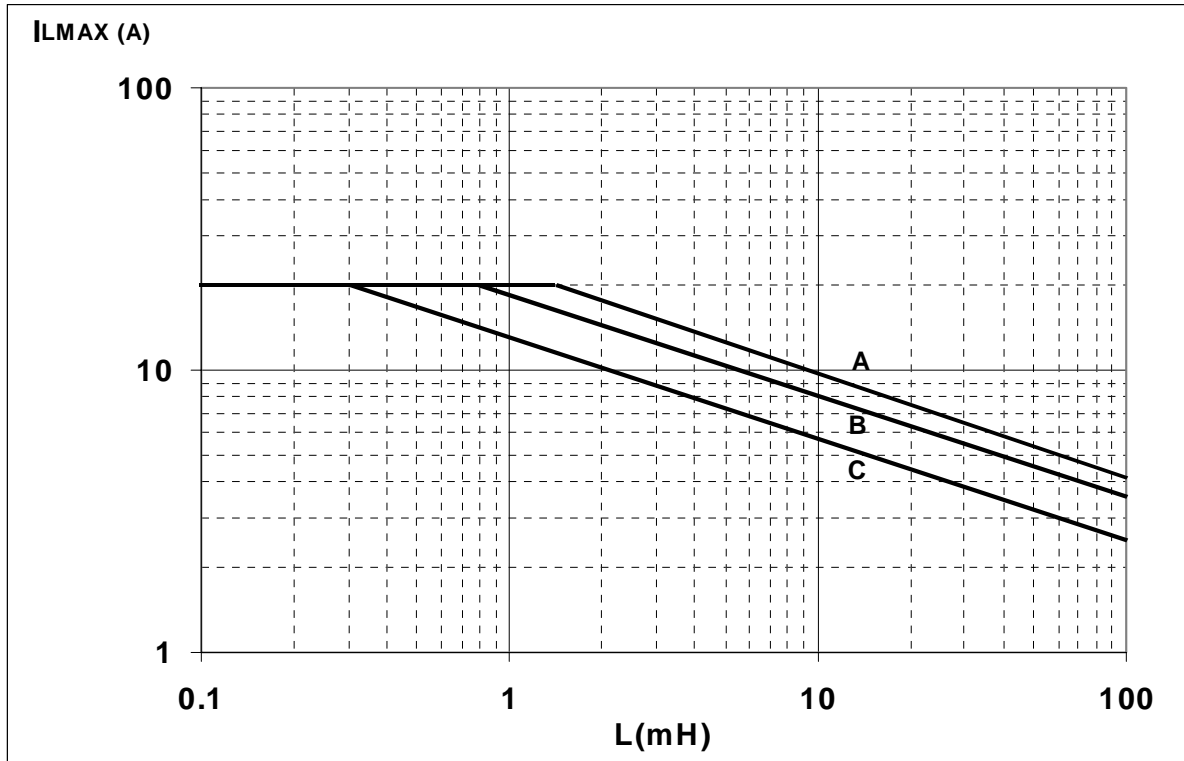
Open Load Off State Voltage Detection Threshold



Open Load On State Detection Threshold



PowerSO-10, P²PAK, PENTAWATT Maximum turn off current versus load inductance



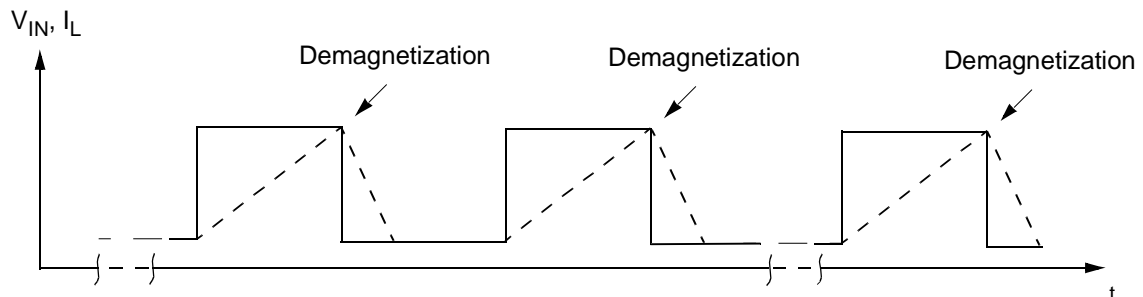
- A = Single Pulse at $T_{Jstart}=150^{\circ}C$
- B= Repetitive pulse at $T_{Jstart}=100^{\circ}C$
- C= Repetitive Pulse at $T_{Jstart}=125^{\circ}C$

Conditions:

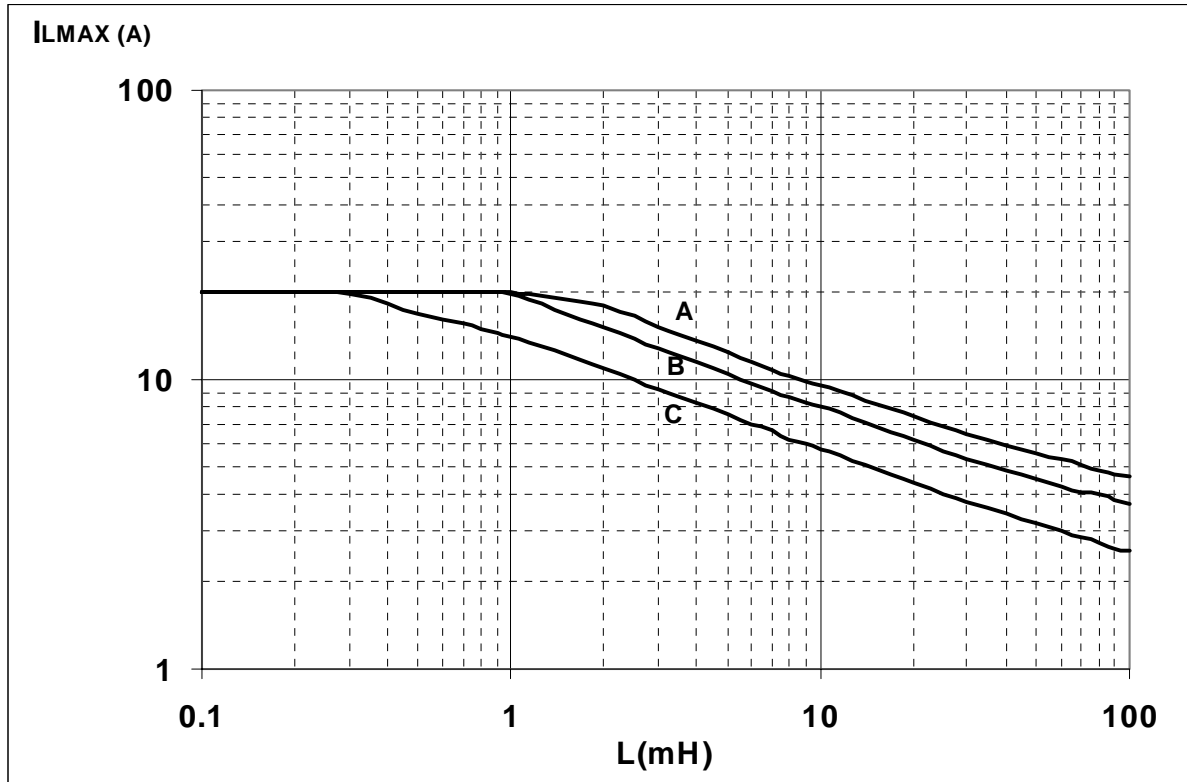
$V_{CC}=13.5V$

Values are generated with $R_L=0\Omega$

In case of repetitive pulses, T_{Jstart} (at beginning of each demagnetization) of every pulse must not exceed the temperature specified above for curves B and C.



PPAK Maximum turn off current versus load inductance



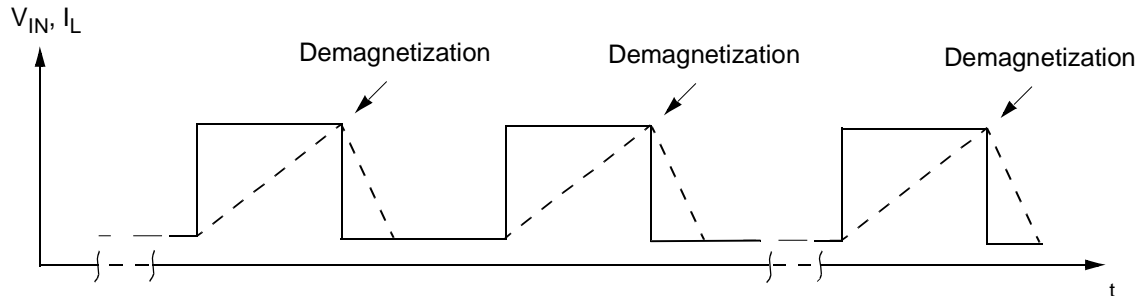
- A = Single Pulse at $T_{jstart} = 150^\circ\text{C}$
- B = Repetitive pulse at $T_{jstart} = 100^\circ\text{C}$
- C = Repetitive Pulse at $T_{jstart} = 125^\circ\text{C}$

Conditions:

$V_{CC} = 13.5\text{V}$

Values are generated with $R_L = 0\Omega$

In case of repetitive pulses, T_{jstart} (at beginning of each demagnetization) of every pulse must not exceed the temperature specified above for curves B and C.



SO-16L Maximum turn off current versus load inductance



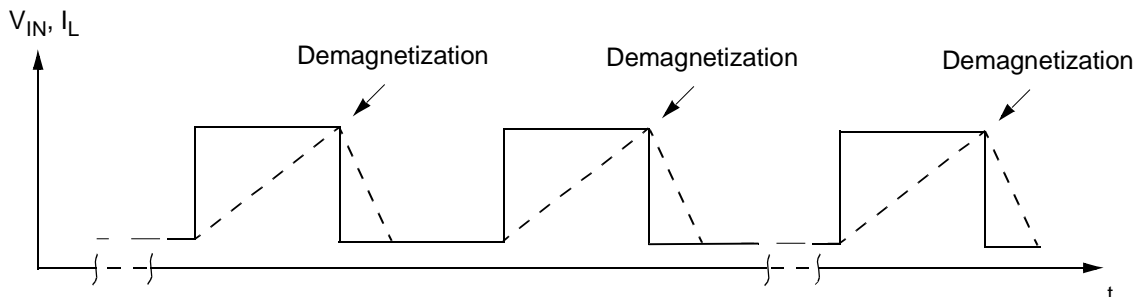
- A = Single Pulse at $T_{Jstart}=150^{\circ}C$
- B = Repetitive pulse at $T_{Jstart}=100^{\circ}C$
- C = Repetitive Pulse at $T_{Jstart}=125^{\circ}C$

Conditions:

$V_{CC}=13.5V$

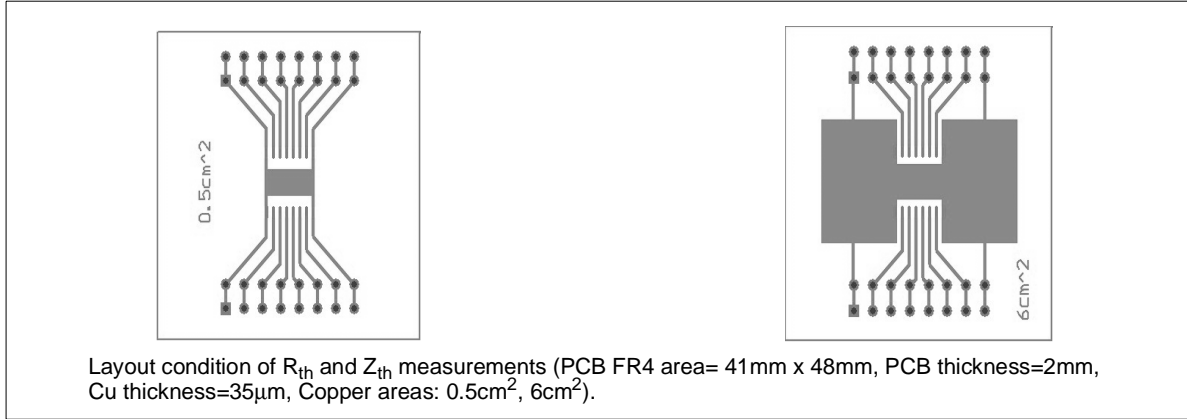
Values are generated with $R_L=0\Omega$

In case of repetitive pulses, T_{Jstart} (at beginning of each demagnetization) of every pulse must not exceed the temperature specified above for curves B and C.

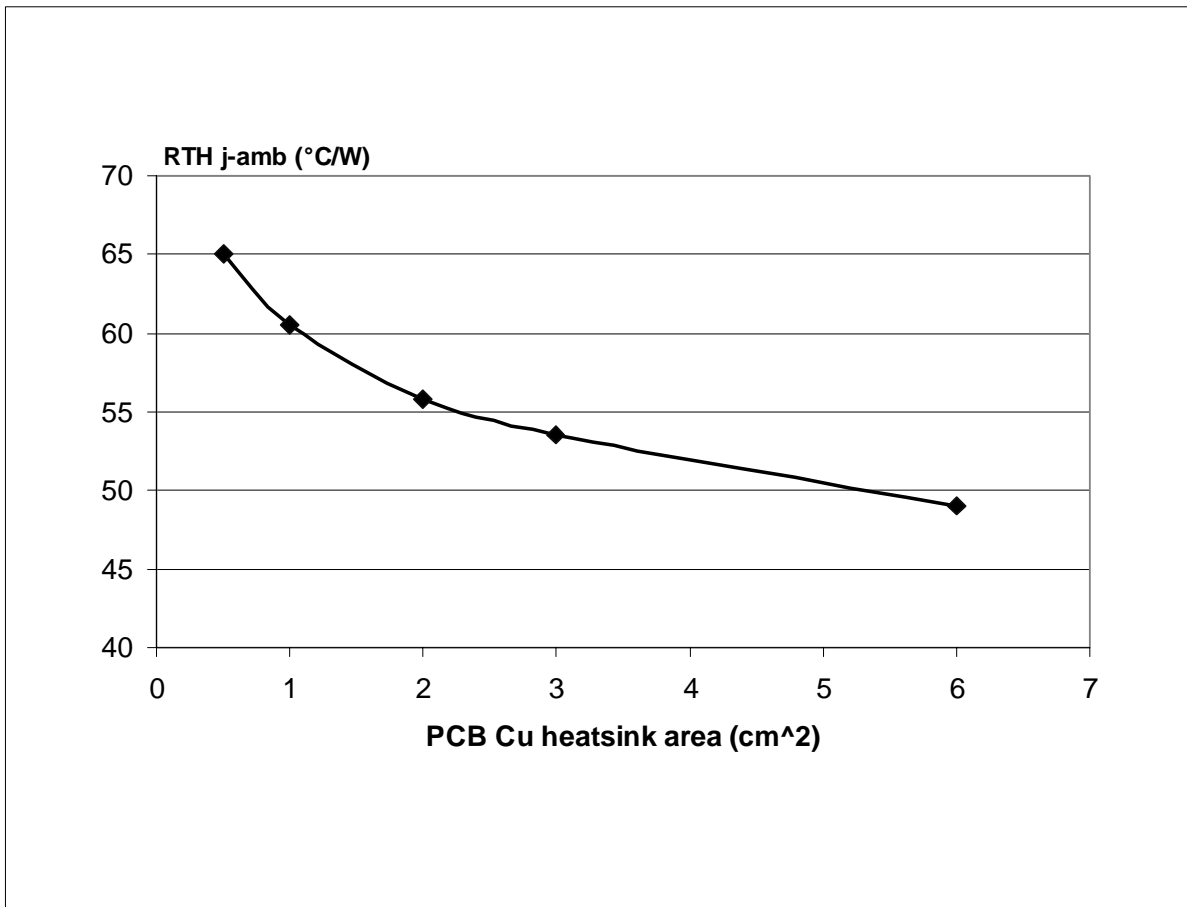


SO-16L THERMAL DATA

SO-16L PC Board

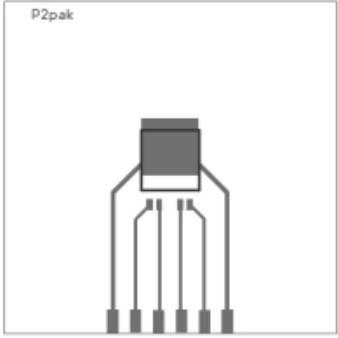


$R_{thj-amb}$ Vs PCB copper area in open box free air condition

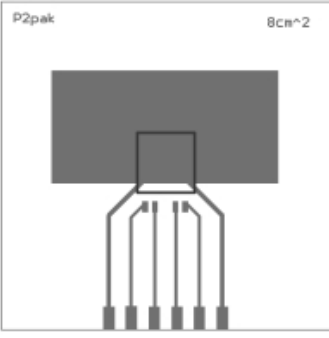


P²PAK THERMAL DATA

P²PAK PC Board



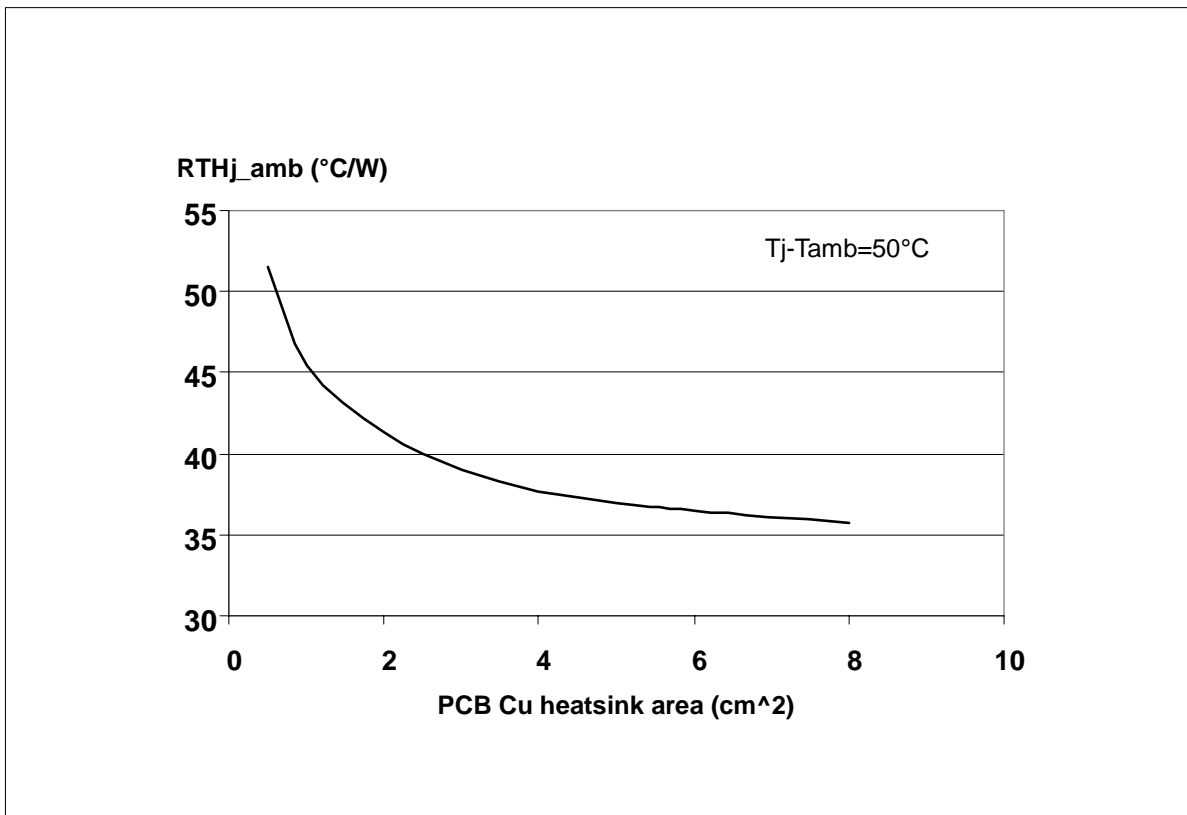
P2pak



P2pak 8cm²

Layout condition of R_{th} and Z_{th} measurements (PCB FR4 area= 60mm x 60mm, PCB thickness=2mm, Cu thickness=35 μ m, Copper areas: 0.97cm², 8cm²).

$R_{thj-amb}$ Vs PCB copper area in open box free air condition



PPAK THERMAL DATA

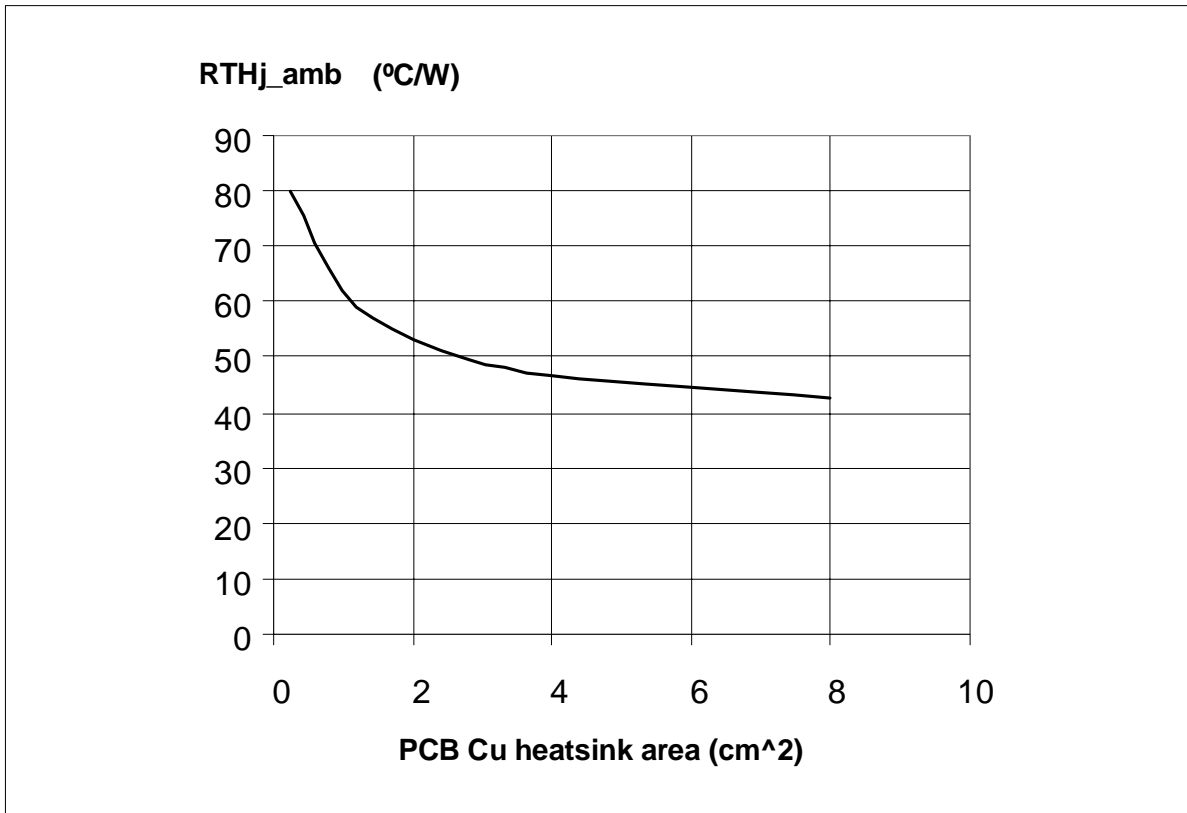
PPAK PC Board

Diagram showing a PPAK package on a PCB with a small copper area (0.44 cm²) for thermal measurement.

Diagram showing a PPAK package on a PCB with a large copper area (8 cm²) for thermal measurement.

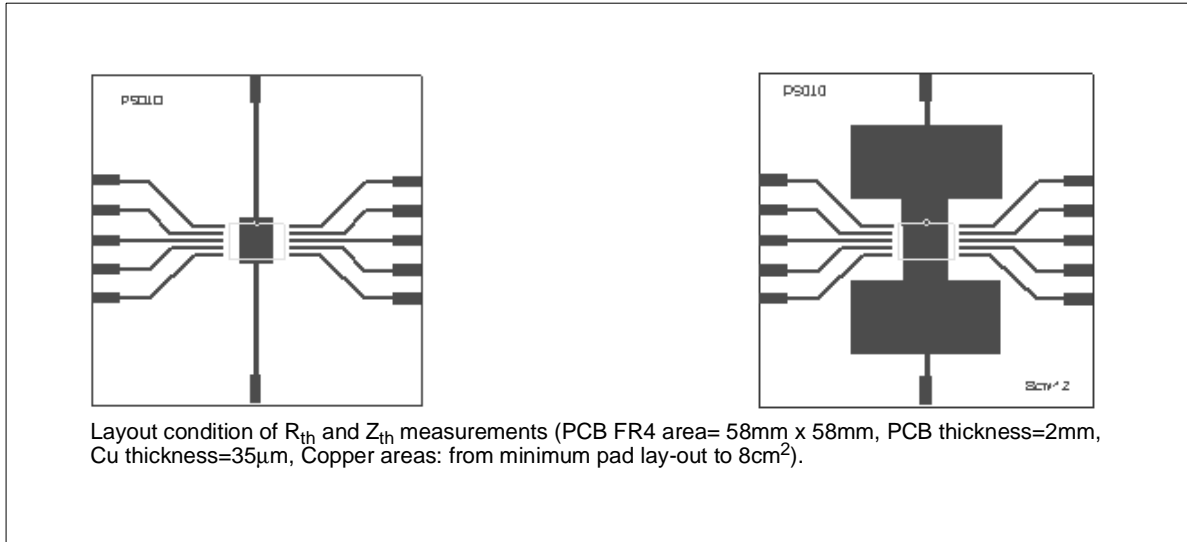
Layout condition of R_{th} and Z_{th} measurements (PCB FR4 area= 60mm x 60mm, PCB thickness=2mm, Cu thickness=35 μ m, Copper areas: 0.44cm², 8cm²).

$R_{thj-amb}$ Vs PCB copper area in open box free air condition

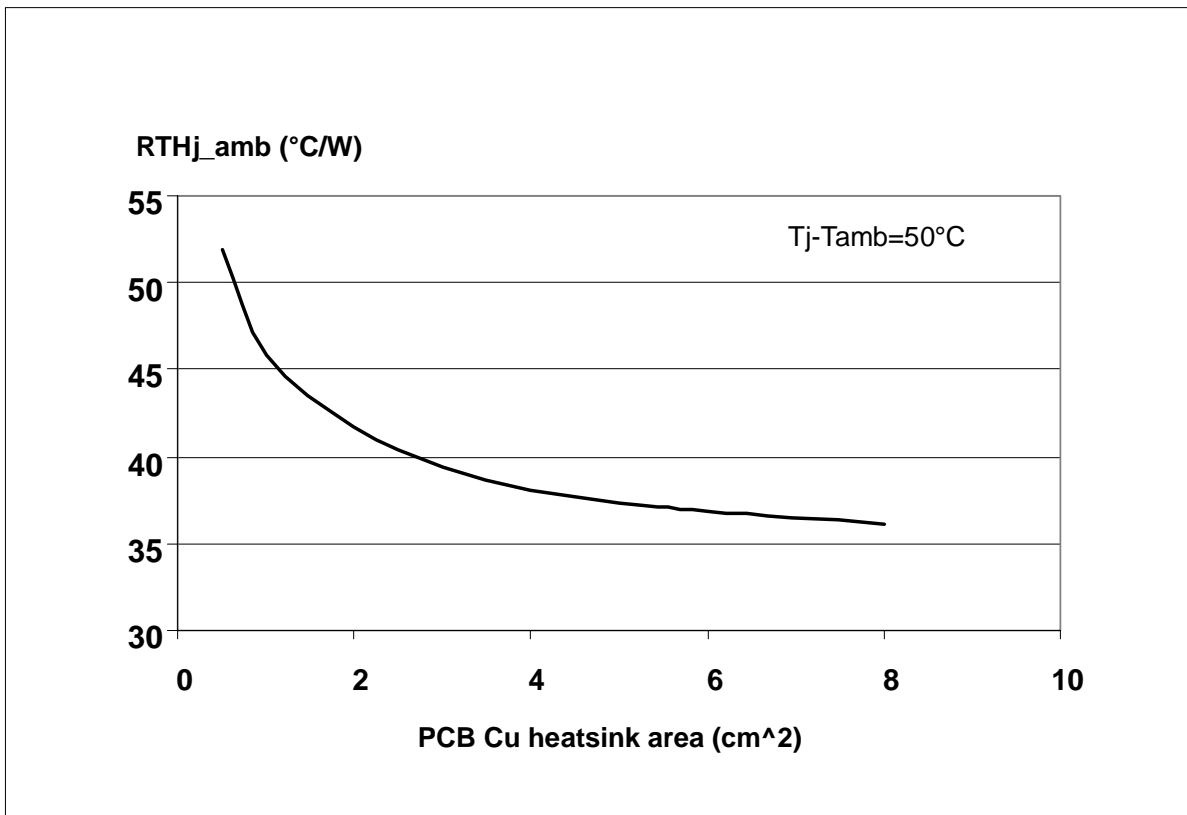


PowerSO-10™ THERMAL DATA

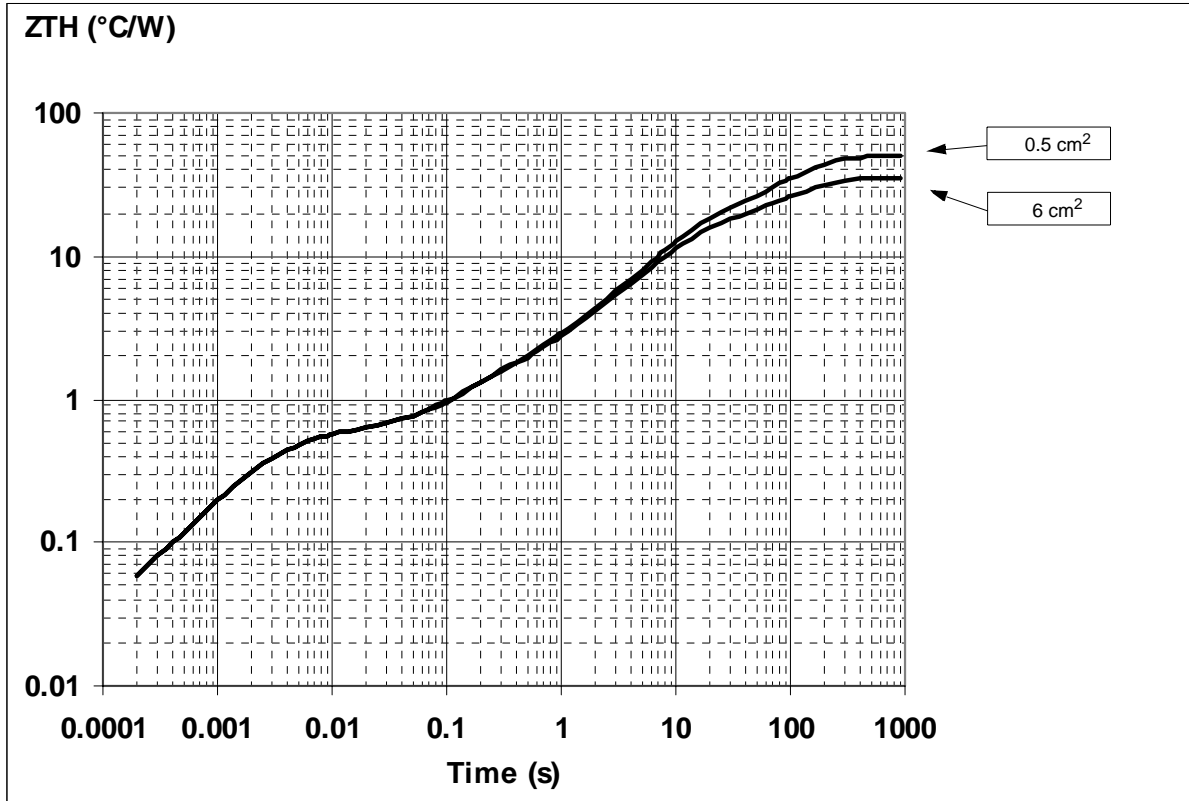
PowerSO-10™ PC Board



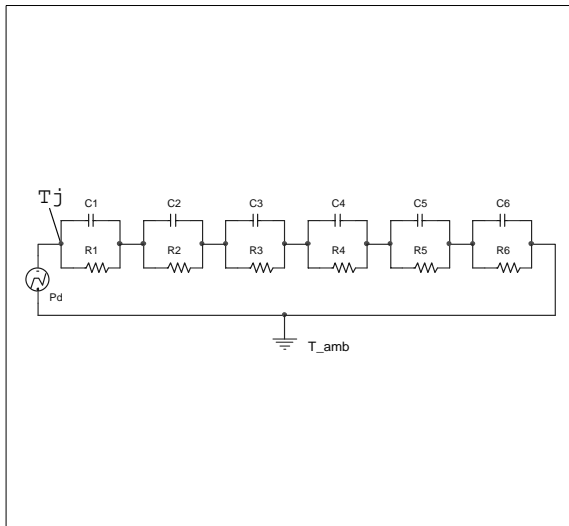
$R_{thj-amb}$ Vs PCB copper area in open box free air condition



PowerSO-10 Thermal Impedance Junction Ambient Single Pulse



Thermal fitting model of a single channel HSD in PowerSO-10



Pulse calculation formula

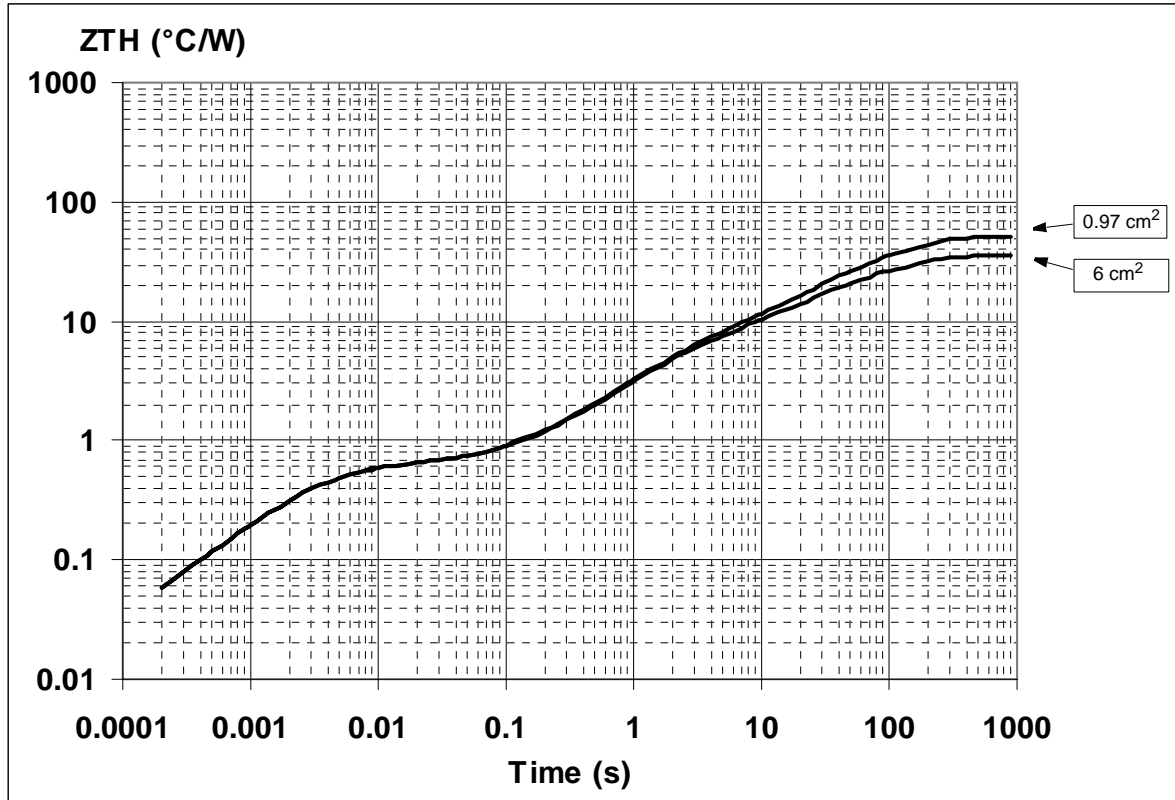
$$Z_{TH\delta} = R_{TH} \cdot \delta + Z_{THtp}(1 - \delta)$$

where $\delta = t_p/T$

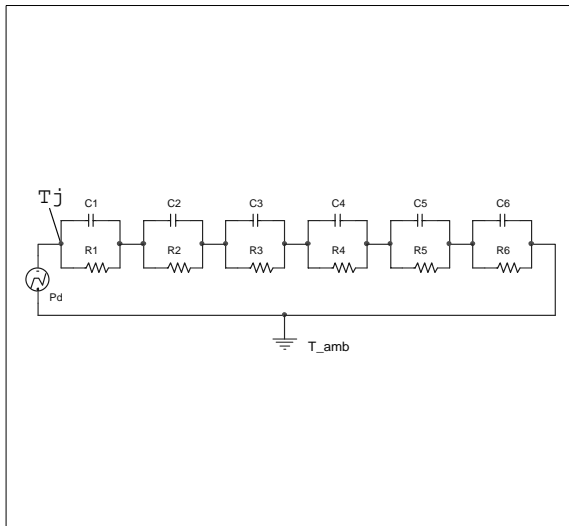
Thermal Parameter

Area/island (cm ²)	0.5	6
R1 (°C/W)	0.04	
R2 (°C/W)	0.25	
R3 (°C/W)	0.25	
R4 (°C/W)	0.8	
R5 (°C/W)	12	
R6 (°C/W)	37	22
C1 (W.s/°C)	0.0008	
C2 (W.s/°C)	7.00E-03	
C3 (W.s/°C)	0.015	
C4 (W.s/°C)	0.3	
C5 (W.s/°C)	0.75	
C6 (W.s/°C)	3	5

P²PAK Thermal Impedance Junction Ambient Single Pulse



Thermal fitting model of a single channel HSD in P²PAK



Pulse calculation formula

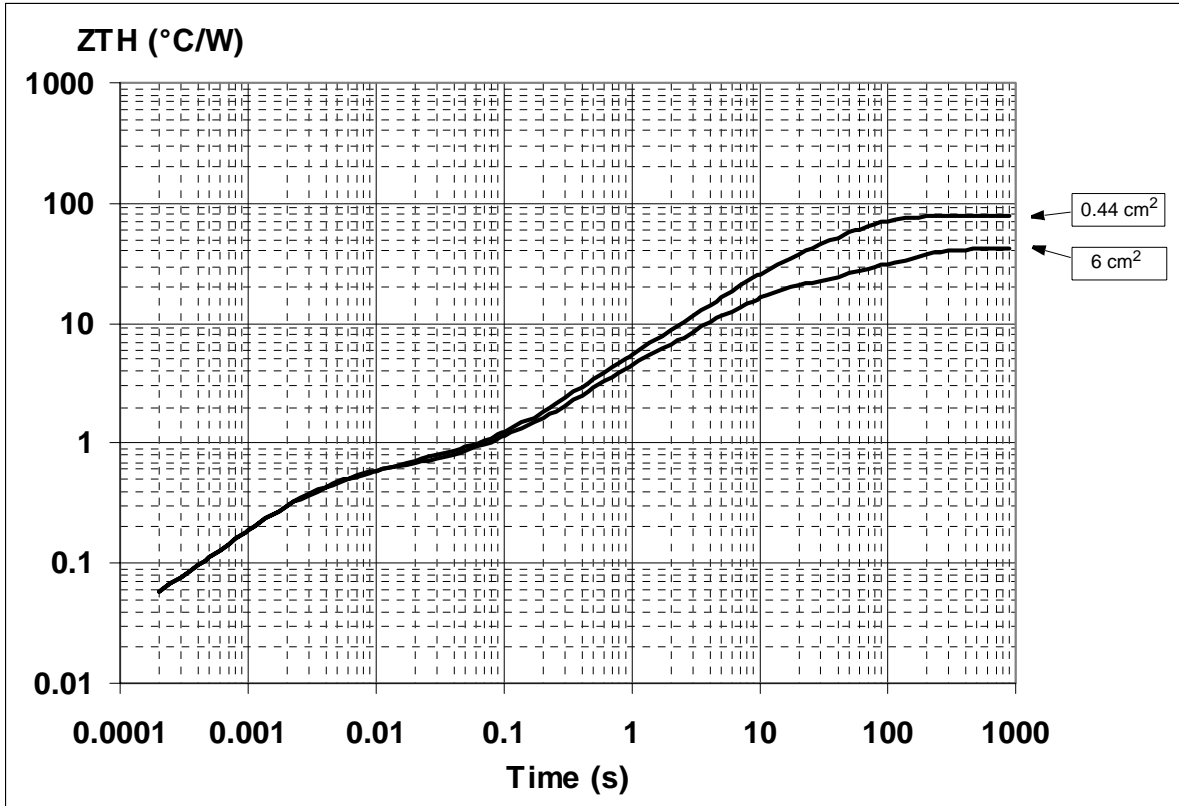
$$Z_{TH\delta} = R_{TH} \cdot \delta + Z_{THtp}(1 - \delta)$$

where $\delta = t_p/T$

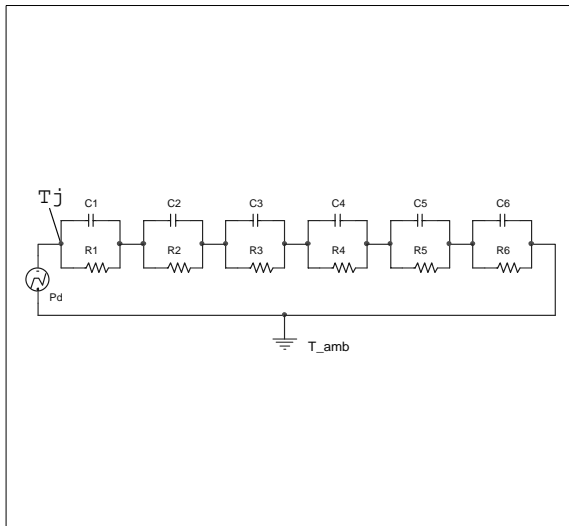
Thermal Parameter

Area/island (cm ²)	0.97	6
R1 (°C/W)	0.04	
R2 (°C/W)	0.25	
R3 (°C/W)	0.3	
R4 (°C/W)	4	
R5 (°C/W)	9	
R6 (°C/W)	37	22
C1 (W.s/°C)	0.0008	
C2 (W.s/°C)	0.007	
C3 (W.s/°C)	0.015	
C4 (W.s/°C)	0.4	
C5 (W.s/°C)	2	
C6 (W.s/°C)	3	5

PPAK Thermal Impedance Junction Ambient Single Pulse



Thermal fitting model of a single channel HSD in PPAK



Pulse calculation formula

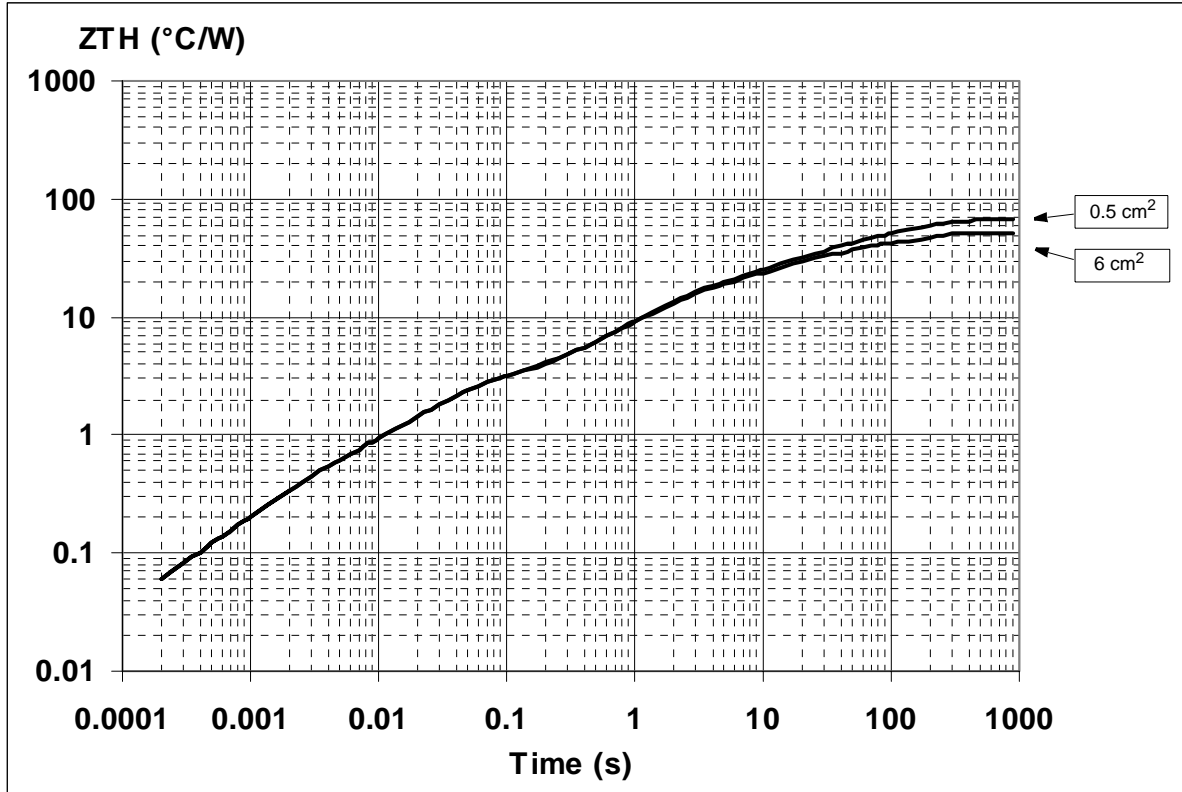
$$Z_{TH\delta} = R_{TH} \cdot \delta + Z_{THtp}(1 - \delta)$$

where $\delta = t_p/T$

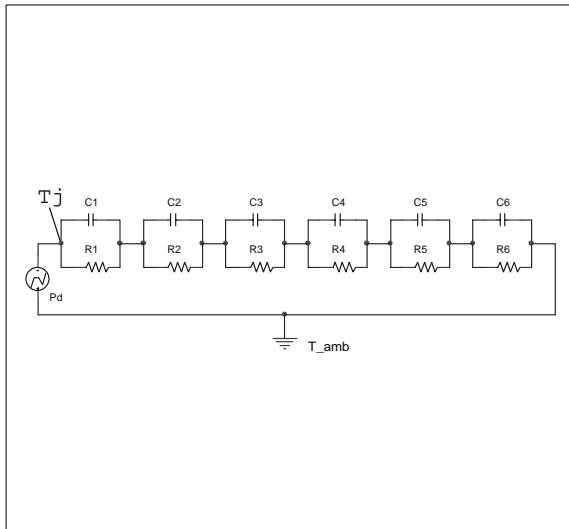
Thermal Parameter

Area/island (cm ²)	0.44	6
R1 (°C/W)	0.04	
R2 (°C/W)	0.25	
R3 (°C/W)	0.3	
R4 (°C/W)	2	
R5 (°C/W)	15	
R6 (°C/W)	61	24
C1 (W.s/°C)	0.0008	
C2 (W.s/°C)	0.007	
C3 (W.s/°C)	0.02	
C4 (W.s/°C)	0.3	
C5 (W.s/°C)	0.45	
C6 (W.s/°C)	0.8	5

SO-16L Thermal Impedance Junction Ambient Single Pulse



Thermal fitting model of a single channel HSD in SO-16L



Pulse calculation formula

$$Z_{TH\delta} = R_{TH} \cdot \delta + Z_{THtp}(1 - \delta)$$

where $\delta = t_p/T$

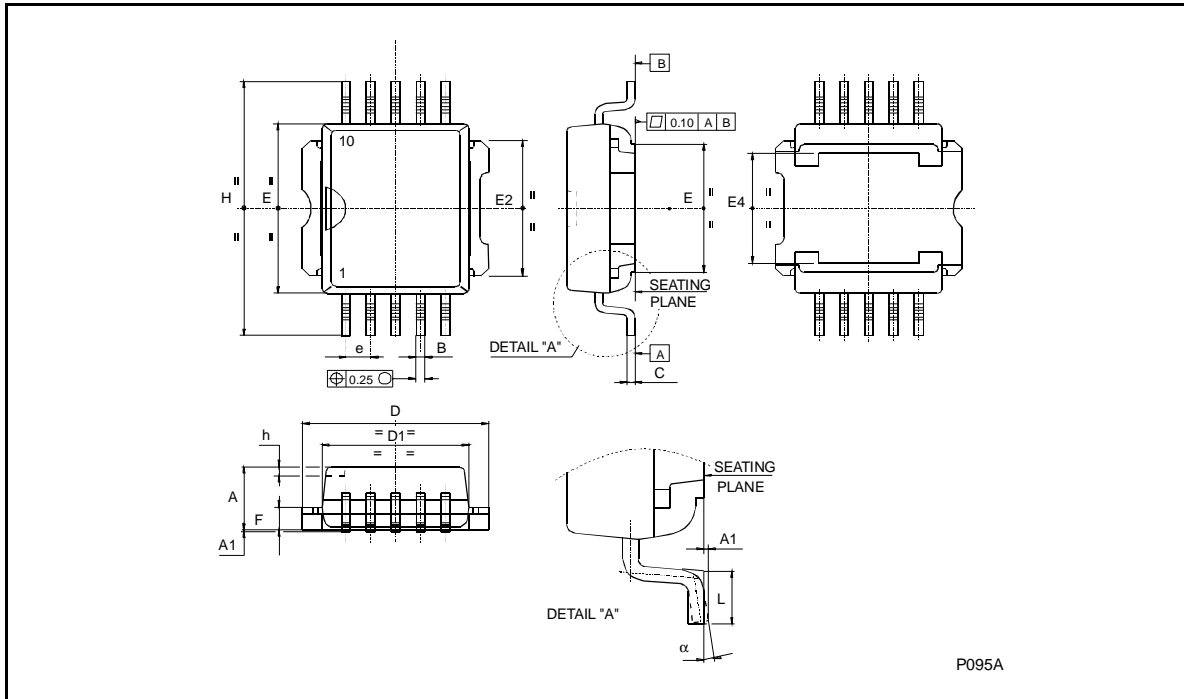
Thermal Parameter

Area/island (cm ²)	0.5	6
R1 (°C/W)	0.04	
R2 (°C/W)	0.25	
R3 (°C/W)	2.2	
R4 (°C/W)	12	
R5 (°C/W)	15	
R6 (°C/W)	37	22
C1 (W.s/°C)	0.0008	
C2 (W.s/°C)	7.00E-03	
C3 (W.s/°C)	1.50E-02	
C4 (W.s/°C)	0.14	
C5 (W.s/°C)	1	
C6 (W.s/°C)	3	5

PowerSO-10™ MECHANICAL DATA

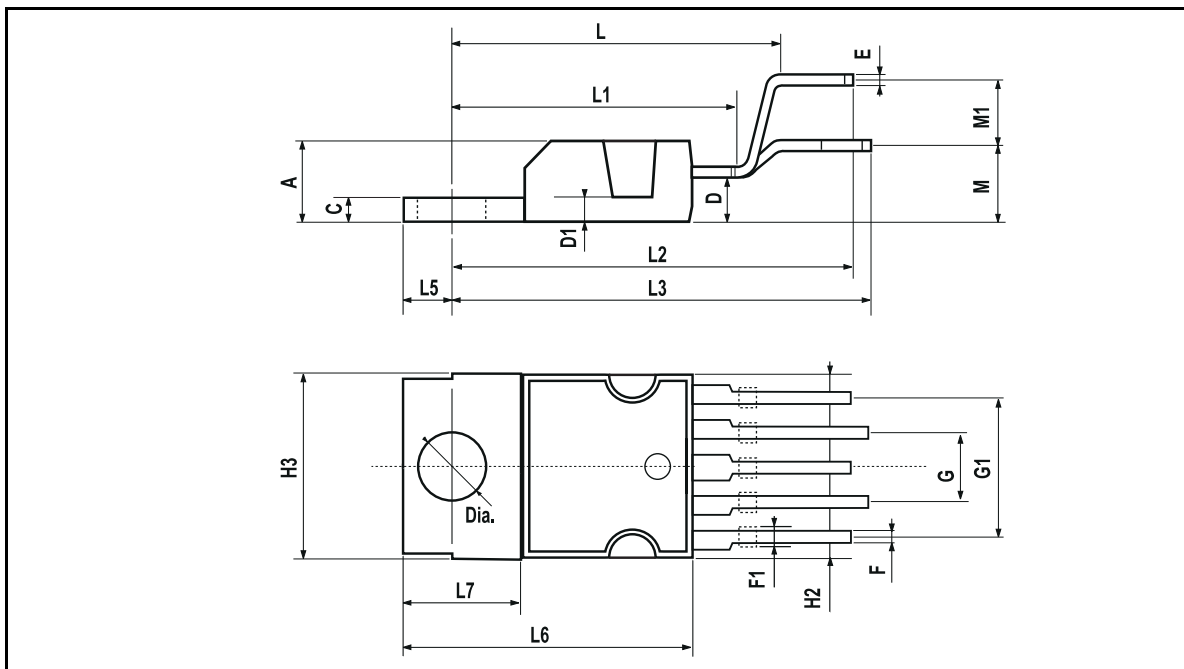
DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	3.35		3.65	0.132		0.144
A (*)	3.4		3.6	0.134		0.142
A1	0.00		0.10	0.000		0.004
B	0.40		0.60	0.016		0.024
B (*)	0.37		0.53	0.014		0.021
C	0.35		0.55	0.013		0.022
C (*)	0.23		0.32	0.009		0.0126
D	9.40		9.60	0.370		0.378
D1	7.40		7.60	0.291		0.300
E	9.30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



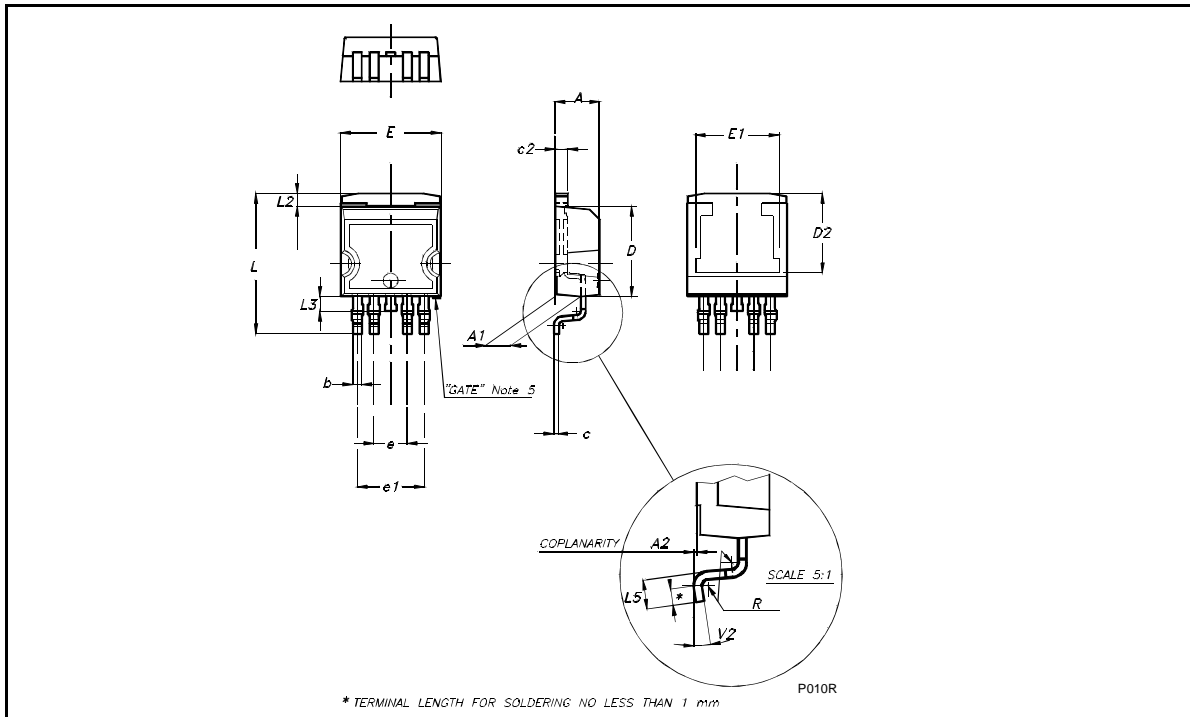
PENTAWATT (VERTICAL) MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			4.8			0.189
C			1.37			0.054
D	2.4		2.8	0.094		0.110
D1	1.2		1.35	0.047		0.053
E	0.35		0.55	0.014		0.022
F	0.8		1.05	0.031		0.041
F1	1		1.4	0.039		0.055
G	3.2	3.4	3.6	0.126	0.134	0.142
G1	6.6	6.8	7	0.260	0.268	0.276
H2			10.4			0.409
H3	10.05		10.4	0.396		0.409
L		17.85			0.703	
L1		15.75			0.620	
L2		21.4			0.843	
L3		22.5			0.886	
L5	2.6		3	0.102		0.118
L6	15.1		15.8	0.594		0.622
L7	6		6.6	0.236		0.260
M		4.5			0.177	
M1		4			0.157	
Diam.	3.65		3.85	0.144		0.152



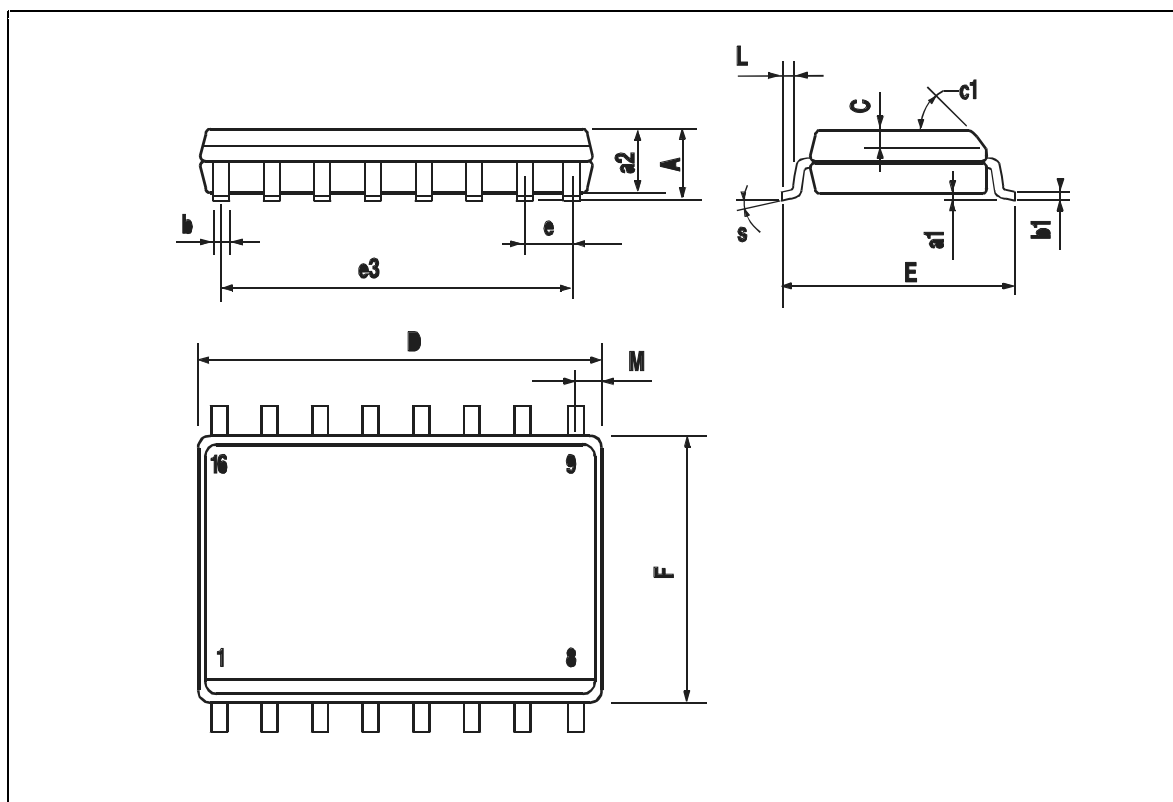
P²PAK MECHANICAL DATA

DIM.	mm.		
	MIN.	TYP	MAX.
A	4.30		4.80
A1	2.40		2.80
A2	0.03		0.23
b	0.80		1.05
c	0.45		0.60
c2	1.17		1.37
D	8.95		9.35
D2		8.00	
E	10.00		10.40
E1		8.50	
e	3.20		3.60
e1	6.60		7.00
L	13.70		14.50
L2	1.25		1.40
L3	0.90		1.70
L5	1.55		2.40
R		0.40	
V2	0°		8°
Package Weight	1.40 Gr (typ)		



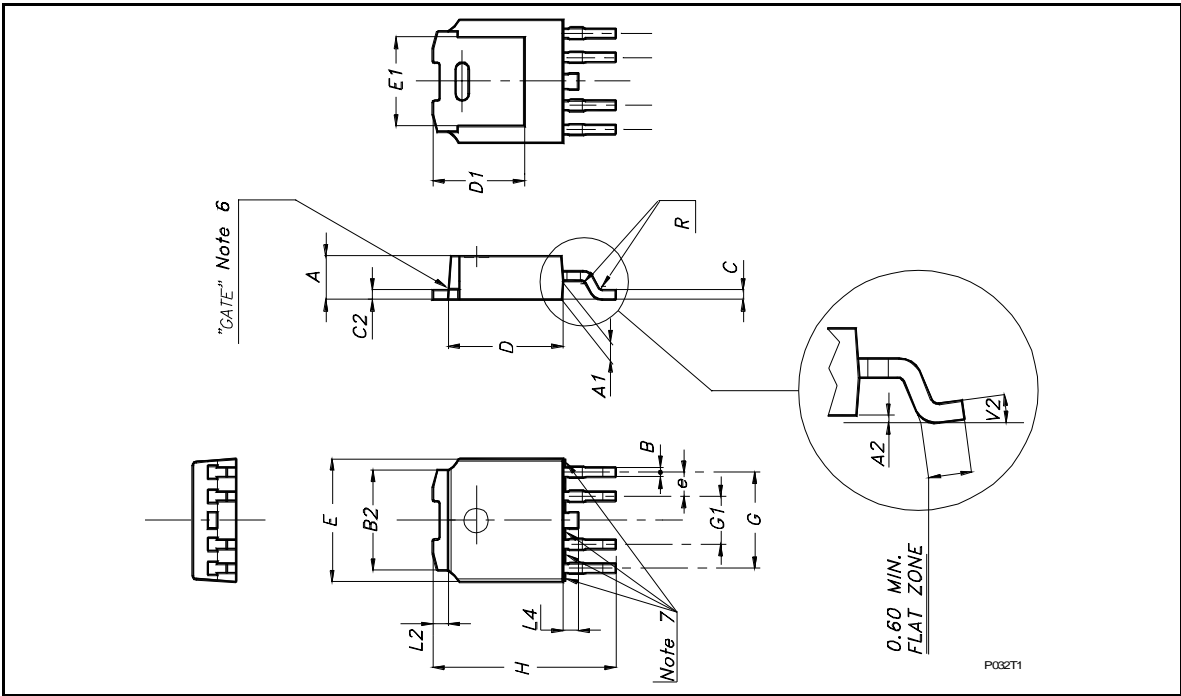
SO-16L MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			2.65			0.104
a1	0.1		0.2	0.004		0.008
a2			2.45			0.096
b	0.35		0.49	0.014		0.019
b1	0.23		0.32	0.009		0.012
C		0.5			0.020	
c1	45° (typ.)					
D	10.1		10.5	0.397		0.413
E	10.0		10.65	0.393		0.419
e		1.27			0.050	
e3		8.89			0.350	
F	7.4		7.6	0.291		0.300
L	0.5		1.27	0.020		0.050
M			0.75			0.029
S	8° (max.)					

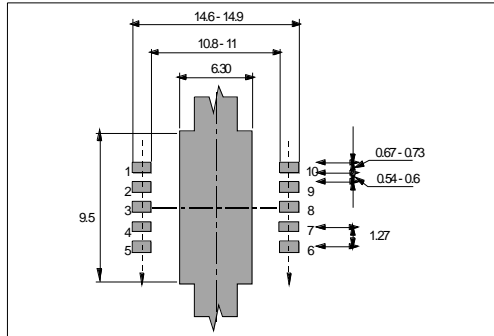


PPAK MECHANICAL DATA

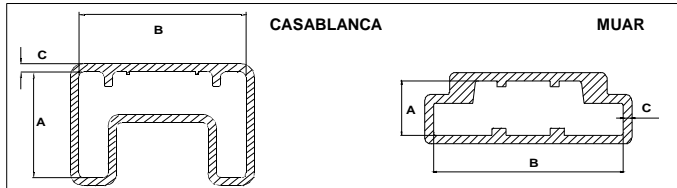
DIM.	MIN.	TYP	MAX.
A	2.20		2.40
A1	0.90		1.10
A2	0.03		0.23
B	0.40		0.60
B2	5.20		5.40
C	0.45		0.60
C2	0.48		0.60
D1		5.1	
D	6.00		6.20
E	6.40		6.60
E1		4.7	
e		1.27	
G	4.90		5.25
G1	2.38		2.70
H	9.35		10.10
L2		0.8	1.00
L4	0.60		1.00
R		0.2	
V2	0°		8°
Package Weight	Gr. 0.3		



PowerSO-10™ SUGGESTED PAD LAYOUT



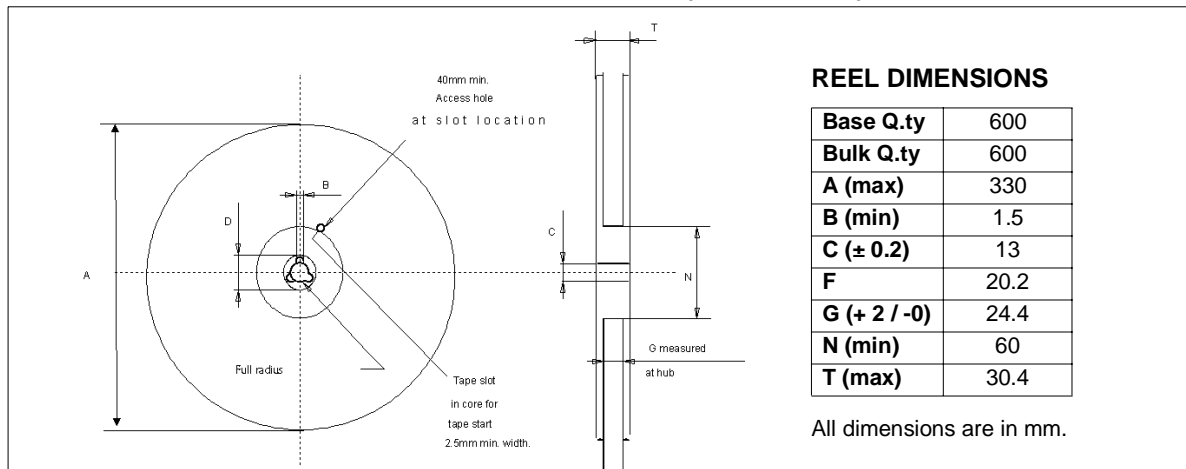
TUBE SHIPMENT (no suffix)



All dimensions are in mm.

	Base Q.ty	Bulk Q.ty	Tube length (± 0.5)	A	B	C (± 0.1)
Casablanca	50	1000	532	10.4	16.4	0.8
Muar	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

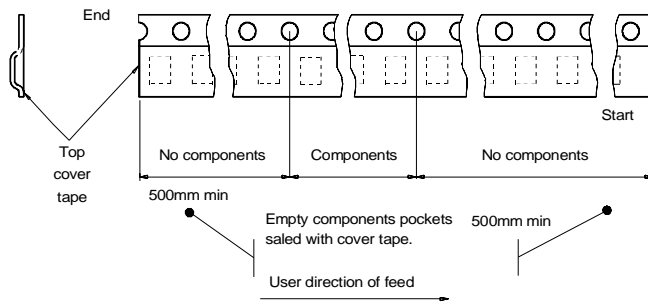
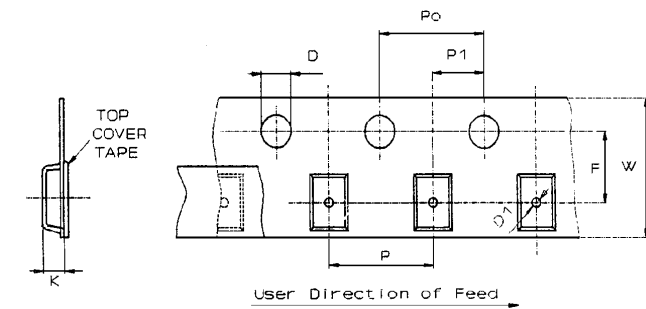
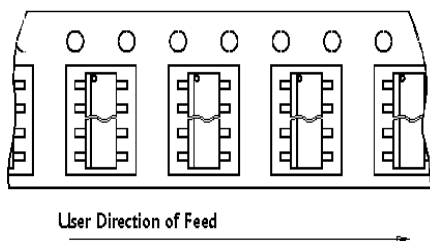
All dimensions are in mm.

TAPE DIMENSIONS

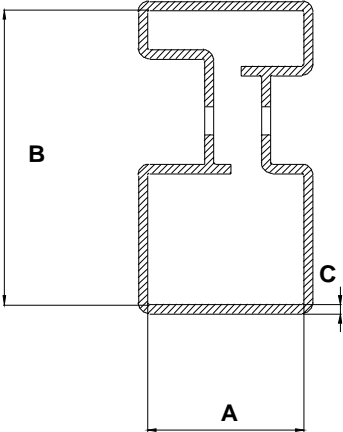
According to Electronic Industries Association (EIA) Standard 481 rev. A, Feb 1986

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.



PENTAWATT TUBE SHIPMENT (no suffix)

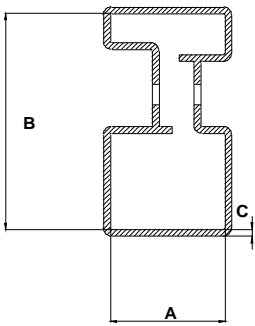


Base Q.ty	50
Bulk Q.ty	1000
Tube length (± 0.5)	532
A	18
B	33.1
C (± 0.1)	1

All dimensions are in mm.

VN820 / VN820SO / VN820SP / VN820-B5 / VN820PT

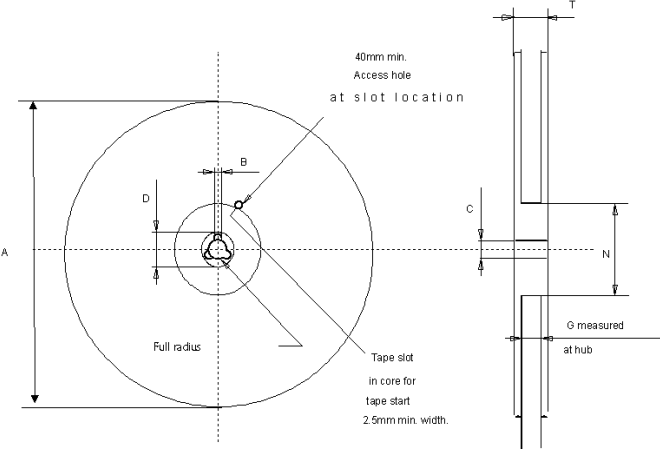
P²PAK TUBE SHIPMENT (no suffix)



Base Q.ty	50
Bulk Q.ty	1000
Tube length (± 0.5)	532
A	18
B	33.1
C (± 0.1)	1

All dimensions are in mm.

TAPE AND REEL SHIPMENT (suffix "13TR")



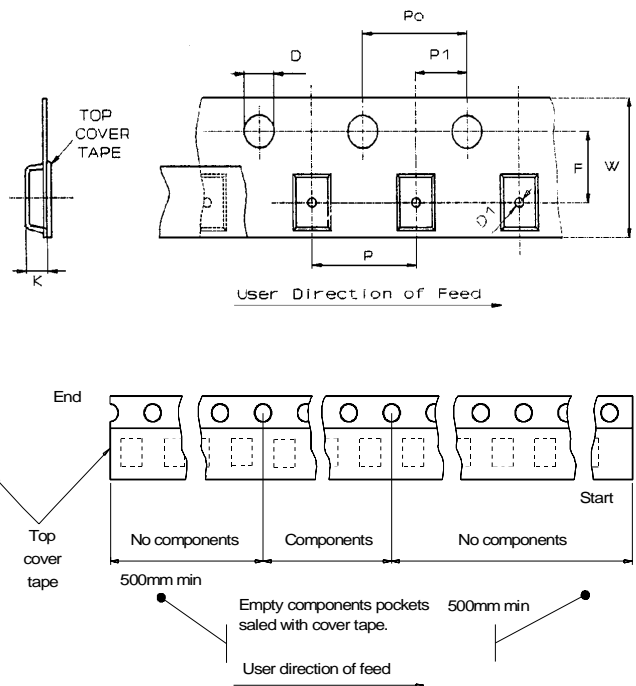
Base Q.ty	1000
Bulk Q.ty	1000
A (max)	330
B (min)	1.5
C (± 0.2)	13
F	20.2
G (+ 2 / -0)	24.4
N (min)	60
T (max)	30.4

All dimensions are in mm.

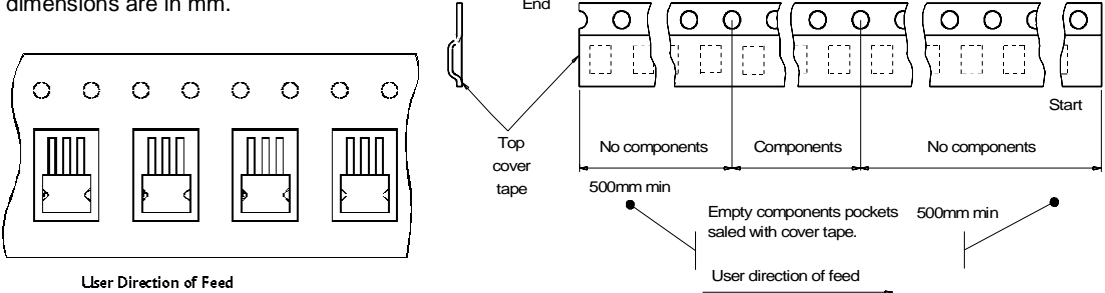
TAPE DIMENSIONS

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	16
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

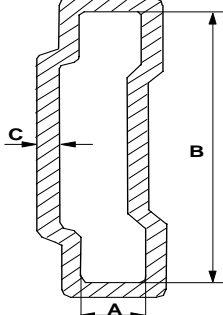


All dimensions are in mm.



ST

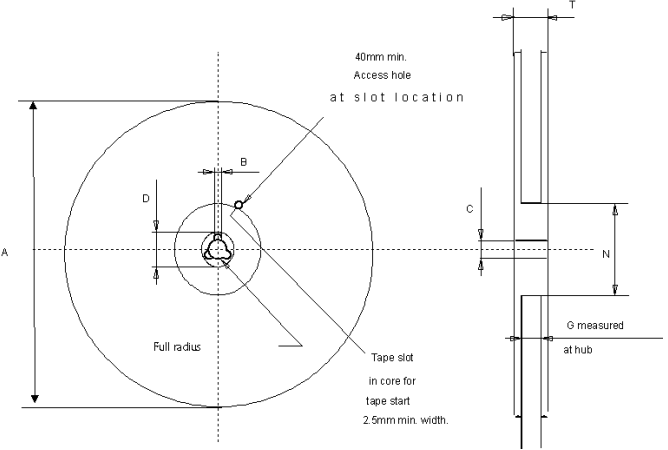
SO-16L TUBE SHIPMENT (no suffix)



Base Q.ty	50
Bulk Q.ty	1000
Tube length (± 0.5)	532
A	3.5
B	13.8
C (± 0.1)	0.6

All dimensions are in mm.

TAPE AND REEL SHIPMENT (suffix "13TR")

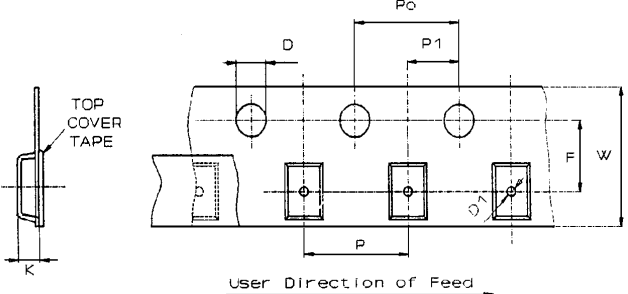


Base Q.ty	1000
Bulk Q.ty	1000
A (max)	330
B (min)	1.5
C (± 0.2)	13
F	20.2
G (+ 2 / - 0)	16.4
N (min)	60
T (max)	22.4

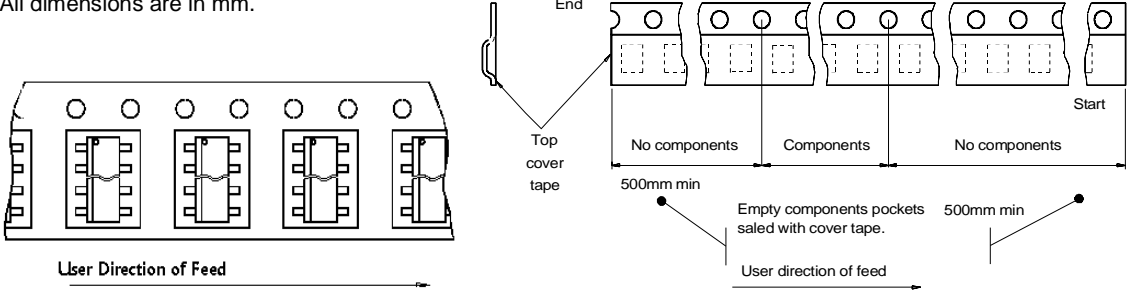
TAPE DIMENSIONS

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

Tape width	W	16
Tape Hole Spacing	P0 (± 0.1)	4
Component Spacing	P	12
Hole Diameter	D ($\pm 0.1/-0$)	1.5
Hole Diameter	D1 (min)	1.5
Hole Position	F (± 0.05)	7.5
Compartment Depth	K (max)	6.5
Hole Spacing	P1 (± 0.1)	2

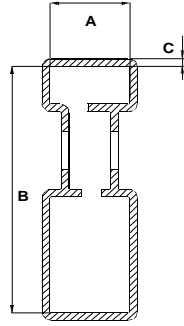


All dimensions are in mm.



VN820 / VN820SO / VN820SP / VN820-B5 / VN820PT

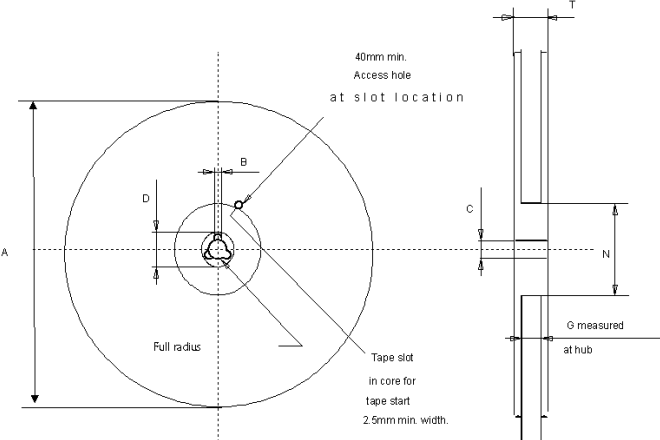
PPAK TUBE SHIPMENT (no suffix)



Base Q.ty	75
Bulk Q.ty	3000
Tube length (± 0.5)	532
A	6
B	21.3
C (± 0.1)	0.6

All dimensions are in mm.

TAPE AND REEL SHIPMENT (suffix "13TR")



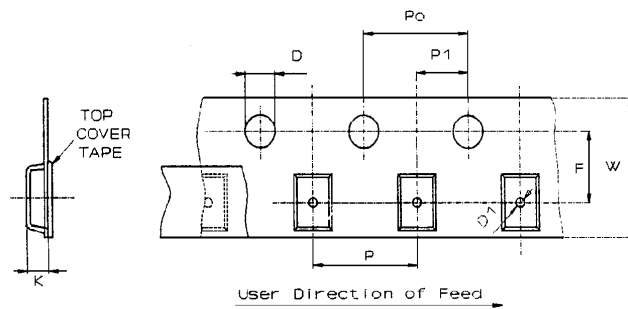
Base Q.ty	2500
Bulk Q.ty	2500
A (max)	330
B (min)	1.5
C (± 0.2)	13
F	20.2
G (+ 2 / -0)	16.4
N (min)	60
T (max)	22.4

All dimensions are in mm.

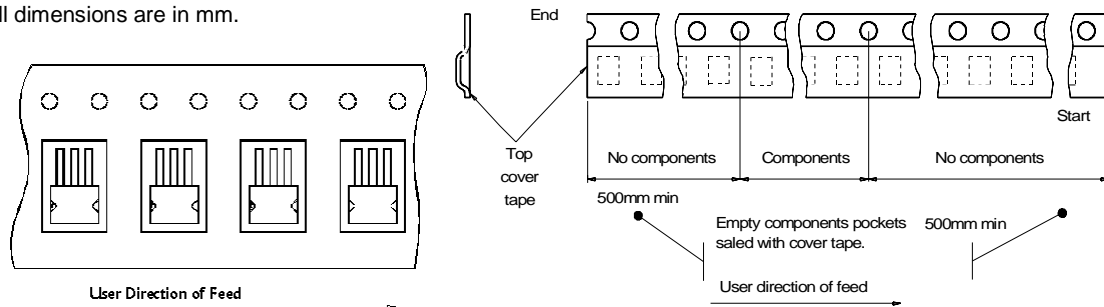
TAPE DIMENSIONS

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

Tape width	W	16
Tape Hole Spacing	P0 (± 0.1)	4
Component Spacing	P	8
Hole Diameter	D ($\pm 0.1/-0$)	1.5
Hole Diameter	D1 (min)	1.5
Hole Position	F (± 0.05)	7.5
Compartment Depth	K (max)	6.5
Hole Spacing	P1 (± 0.1)	2



All dimensions are in mm.



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