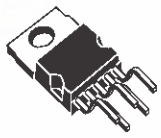
VN750
VN750S / VN750-B5

HIGH SIDE DRIVER

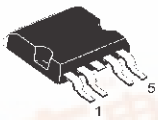
TYPE	$R_{DS(on)}$	I_{OUT}	V_{CC}
VN750 VN750S VN750-B5	60 mΩ	6 A	36 V

- 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 (*)

SO-8



PENTAWATT



P2PAK

ORDER CODES :

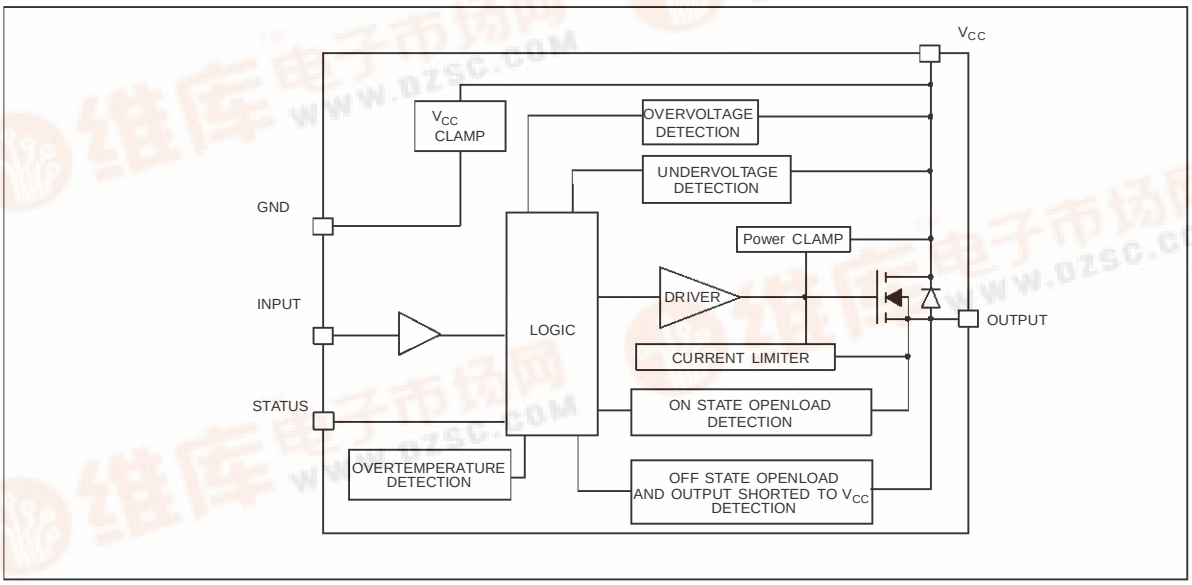
PENTAWATT	VN750
SO-8	VN750S
P2PAK	VN750-B5

DESCRIPTION

The VN750, VN750S, VN750-B5 are a monolithic device designed in STMicroelectronics VIPower 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 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.

BLOCK DIAGRAM

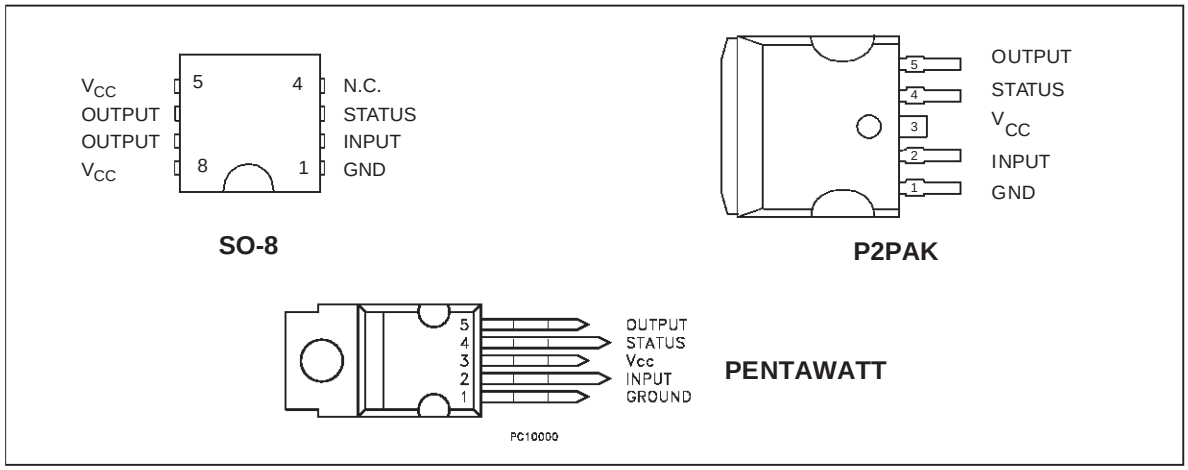


(*) See application schematic at page 8

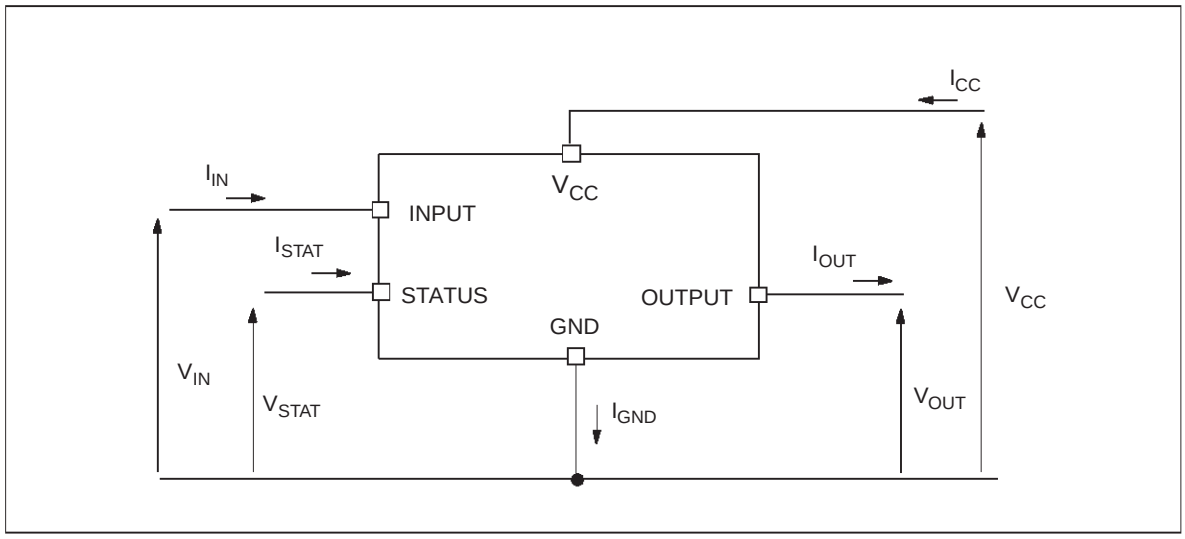
ABSOLUTE MAXIMUM RATING

Symbol	Parameter	Value			Unit
		SO-8	PENTAWATT	P2PAK	
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	- 6			A
I_{IN}	DC Input Current	+/- 10			mA
I_{STAT}	DC Status Current	+/- 10			mA
V_{ESD}	Electrostatic Discharge (R=1.5KΩ; C=100pF)	2000			V
P_{tot}	Power Dissipation T_C=25°C	3.1	42	42	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
			S0-8	PENTAWATT	P2PAK	
$R_{thj\text{-}pins}$	Thermal Resistance Junction-pins	Max	40	-	-	°C/W
$R_{thj\text{-}amb}$	Thermal Resistance Junction-ambient	Max	120	60	60	°C/W
$R_{thj\text{-}case}$	Thermal Resistance Junction-case	Max	-	3	3	°C/W

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}	Under Voltage Shut-down		3	4	5.5	V
$V_{USDhyst}$	Under Voltage Shut-down Hysteresis			0.5		V
V_{OV}	Overvoltage Shut-down		36	(*)	48	V
R_{ON}	On State Resistance	I_{OUT}=2A; T_j=25°C; V_{CC}>8V I_{OUT}=2A; V_{CC}>8V		(*)	60 120	mΩ mΩ
I_S	Supply Current	Off State; V_{CC}=13V On State; V_{CC}=13V		10 2	25 3.5	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

SWITCHING (V_{CC}=13V)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$t_{d(on)}$	Turn-on Delay Time	R_L=6.5Ω from V_{IN} rising edge to V_{OUT}=1.3V		40		µs
$t_{d(off)}$	Turn-off Delay Time	R_L=6.5Ω from V_{IN} falling edge to V_{OUT}=11.7V		30		µs
$dV_{OUT}/dt_{(on)}$	Turn-on Voltage Slope	R_L=6.5Ω from V_{OUT}=1.3V to V_{OUT}=10.4V		(*)		V/µs
$dV_{OUT}/dt_{(off)}$	Turn-off Voltage Slope	R_L=6.5Ω from V_{OUT}=11.7V to V_{OUT}=1.3V		(*)		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_{hyst}	Input Hysteresis Voltage		0.5	(*)		V
V_{ICL}	Input Clamp Voltage	I_{IN}=1mA I_{IN}=-1mA	6.5	(*) -0.7	8.5	V V

(*) See curves at pages 9, 10, 11

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 I_{STAT}=-1mA	6.5	(*) -0.7	8.5	V V

PROTECTIONS

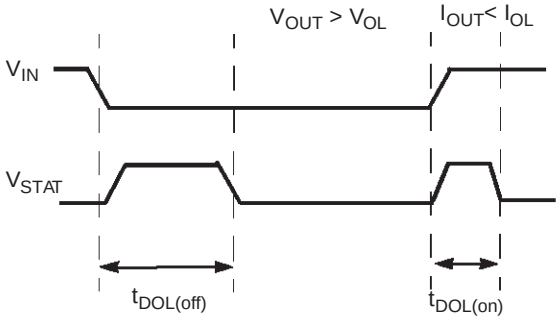
Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
T_{TSD}	Shut-down Temperature		150	175	200	°C
T_R	Reset Temperature		135			°C
T_{hyst}	Thermal Hysteresis		7	15		°C
t_{SDL}	Status delay in overload condition	T_j>T_{jsh}			20	µs
I_{lim}	Current limitation	9V<V_{CC}<36V 5V<V_{CC}<36V	6	9	15 15	A A
V_{demag}	Turn-off Output Clamp Voltage	I_{OUT}=2A; V_{IN}=0V; L=6mH	VCC-41	VCC-48	VCC-55	V

OPENLOAD DETECTION

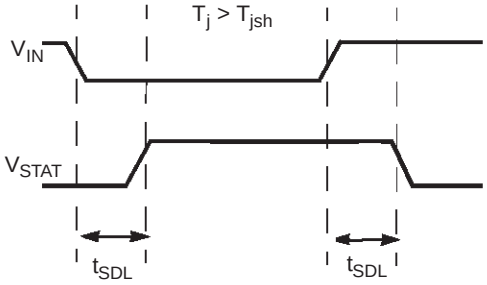
Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
I_{OL}	Openload ON State Detection Threshold	V_{IN}=5V	50	(*)	200	mA
$t_{DOL(on)}$	Openload ON State Detection Delay	I_{OUT}=0A			200	µs
V_{OL}	Openload OFF State Voltage Detection Threshold	V_{IN}=0V	1.5	(*)	3.5	V
$t_{DOL(off)}$	Openload Detection Delay at Turn Off				1000	µs

(*) See curves at pages 9, 10, 11

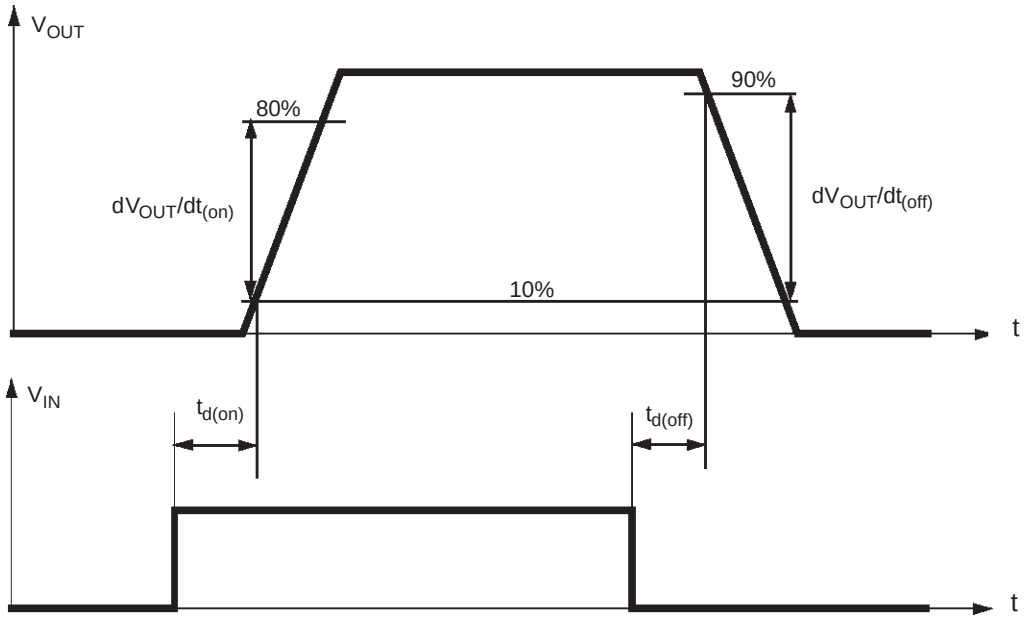
OPEN LOAD STATUS TIMING (with external pull-up)



OVER TEMP STATUS TIMING



Switching time Waveforms



TRUTH TABLE

CONDITIONS	INPUT	OUTPUT	STATUS
Normal Operation	L H	L H	H H
Current Limitation	L H	L X	H H
Overtemperature	L H	L L	H L
Undervoltage	L H	L L	X X
Overvoltage	L H	L L	H H
Output Voltage > V_{OL}	L H	H H	L H
Output Current < I_{OL}	L H	L H	H L

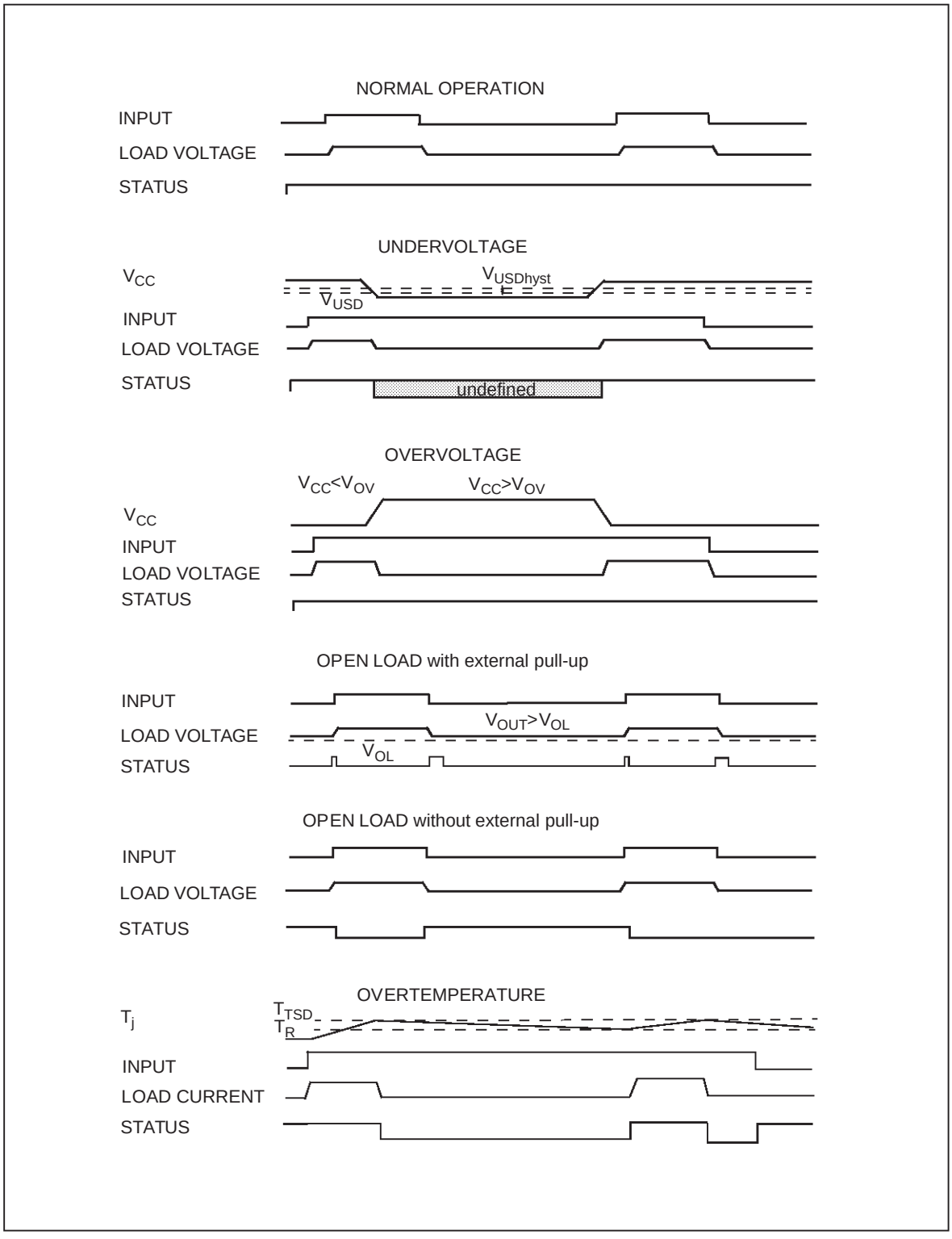
ELECTRICAL TRANSIENT REQUIREMENTS ON V_{CC} PIN

ISO T/R 7637/1 Test Pulse	TEST LEVELS				
	I	II	III	IV	Delays and Impedance
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

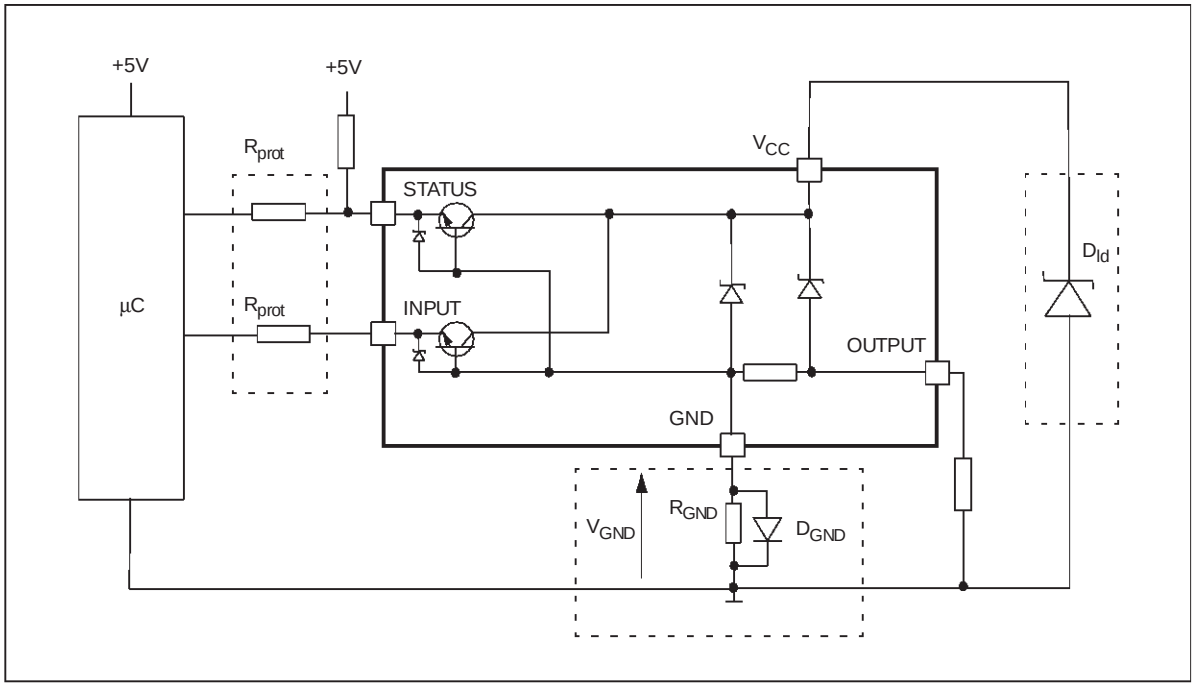
ISO T/R 7637/1 Test Pulse	TEST LEVELS RESULTS			
	I	II	III	IV
1	C	C	C	C
2	C	C	C	C
3a	C	C	C	C
3b	C	C	C	C
4	C	C	C	C
5	C	E	E	E

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.

Figure1: 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) $R_{GND} \leq 600mV / (I_{S(on)max})$.

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 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 suggests to utilize Solution 2 (see below).

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

A resistor (R_{GND}=1kΩ) 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 (j 600mV) 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_{ld} is necessary (Transil or MOV) 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 transients 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.

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

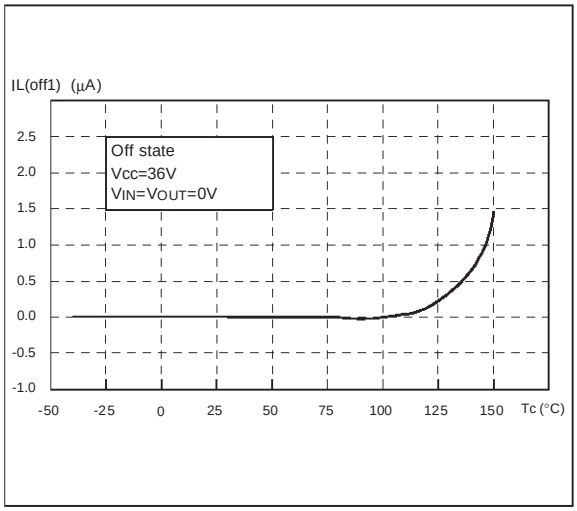
Calculation example:

For V_{CCpeak}= - 100V and $I_{latchup} \geq$ 20mA; $V_{OH\mu C} \geq$ 4.5V

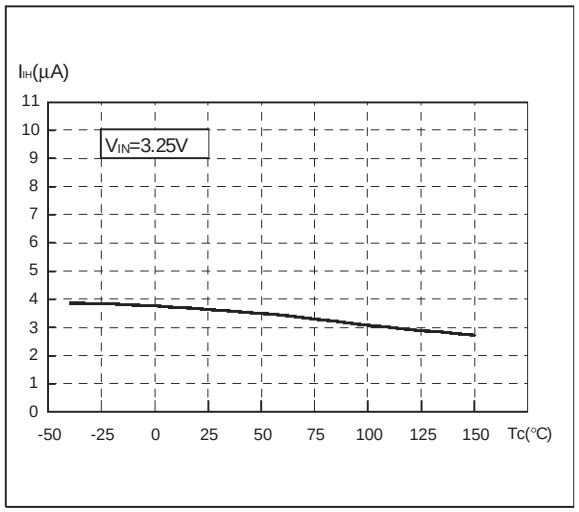
5kΩ ≤ R_{prot} ≤ 65kΩ.

Recommended R_{prot} value is 10kΩ.

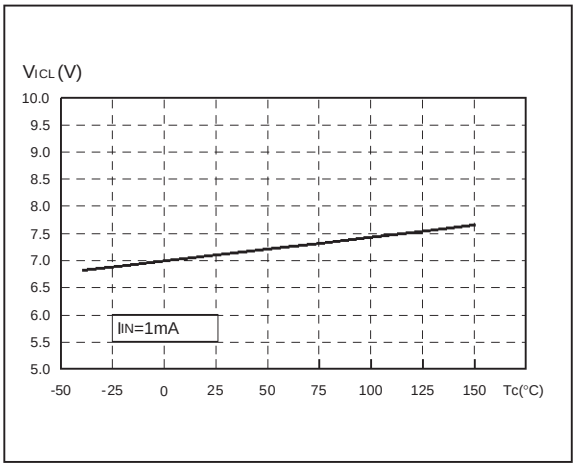
Off State Output Current



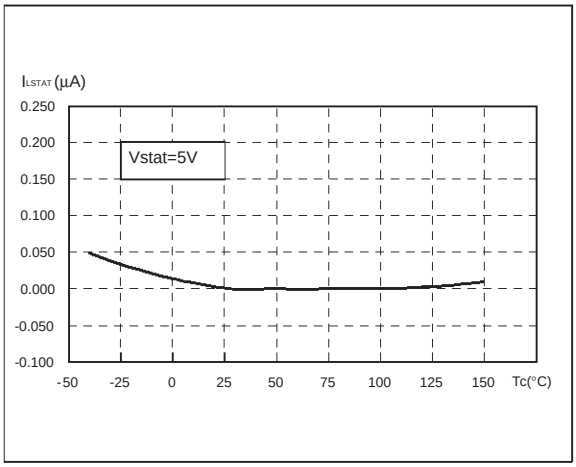
High Level Input Current



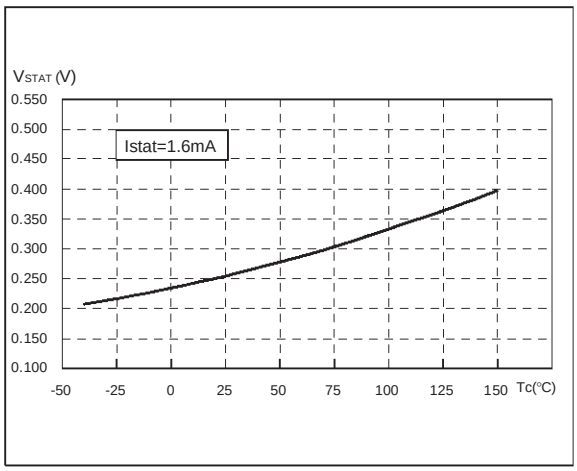
Input Clamp Voltage



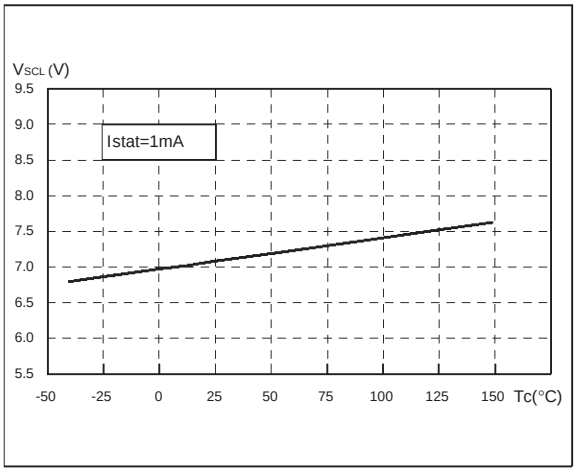
Status Leakage Current



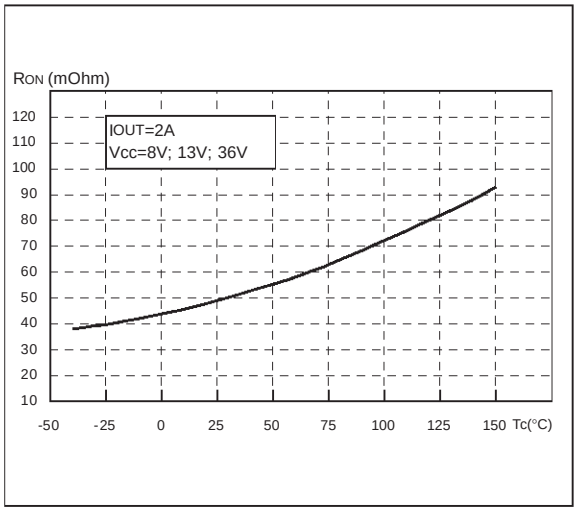
Status Low Output Voltage



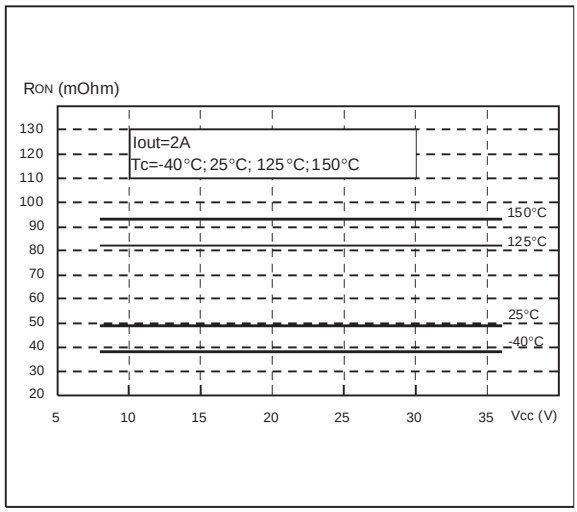
Status Clamp Voltage



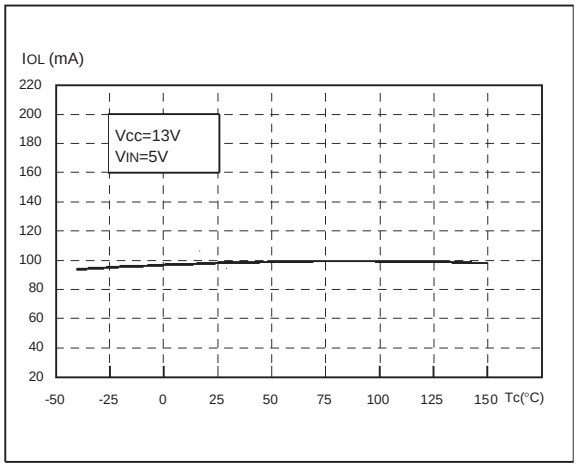
On State Resistance Vs T_{case}



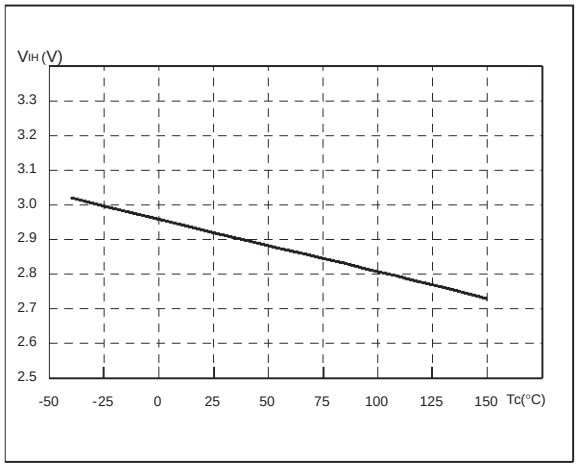
On State Resistance Vs V_{CC}



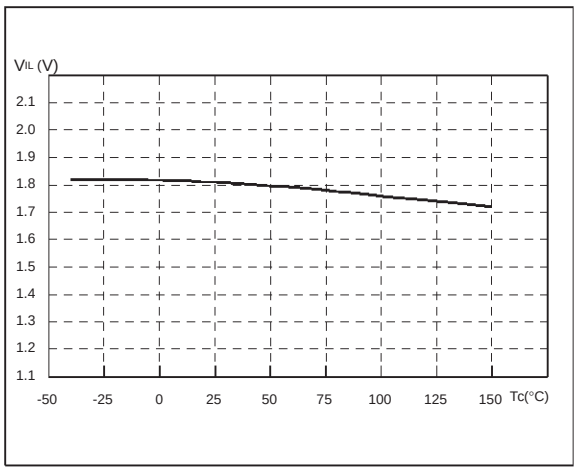
Openload On State Detection Threshold



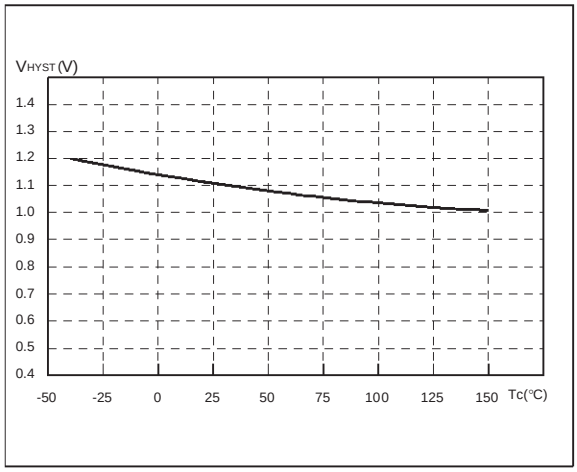
Input High Level



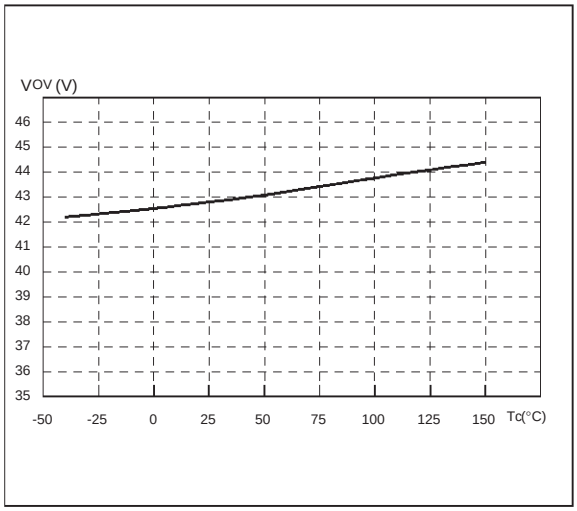
Input Low Level



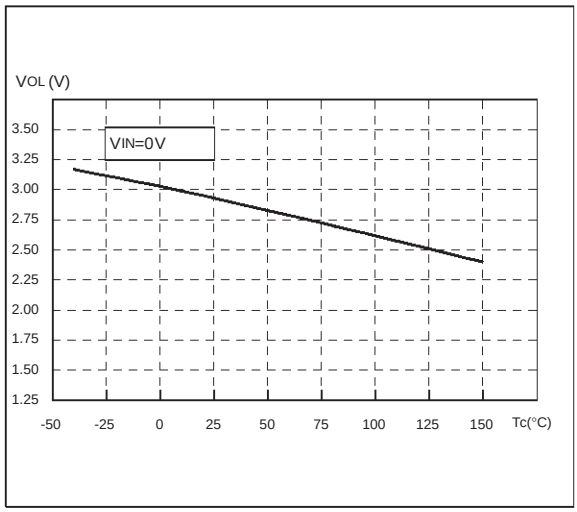
Input Hysteresis Voltage



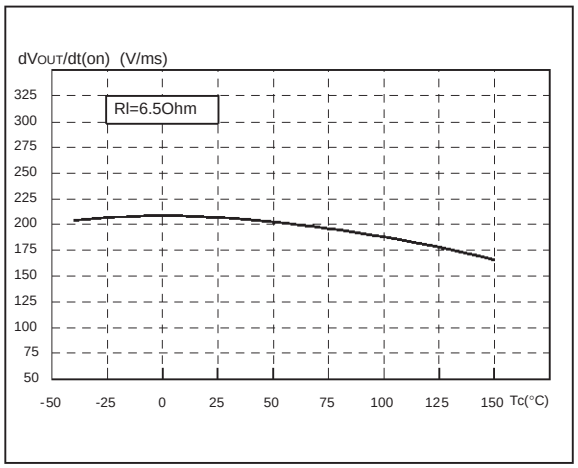
Overvoltage Shutdown



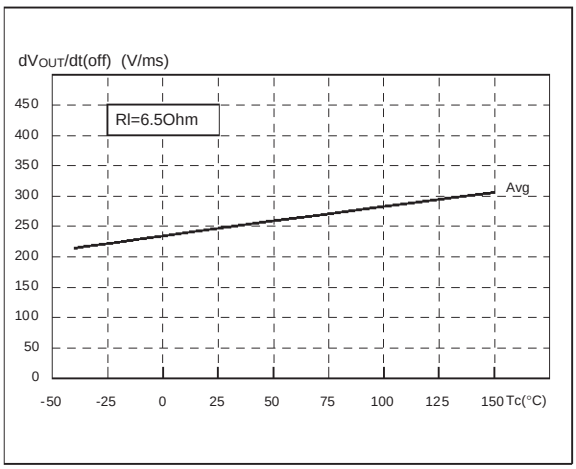
Openload Off State Voltage Detection Threshold



Turn-on Voltage Slope

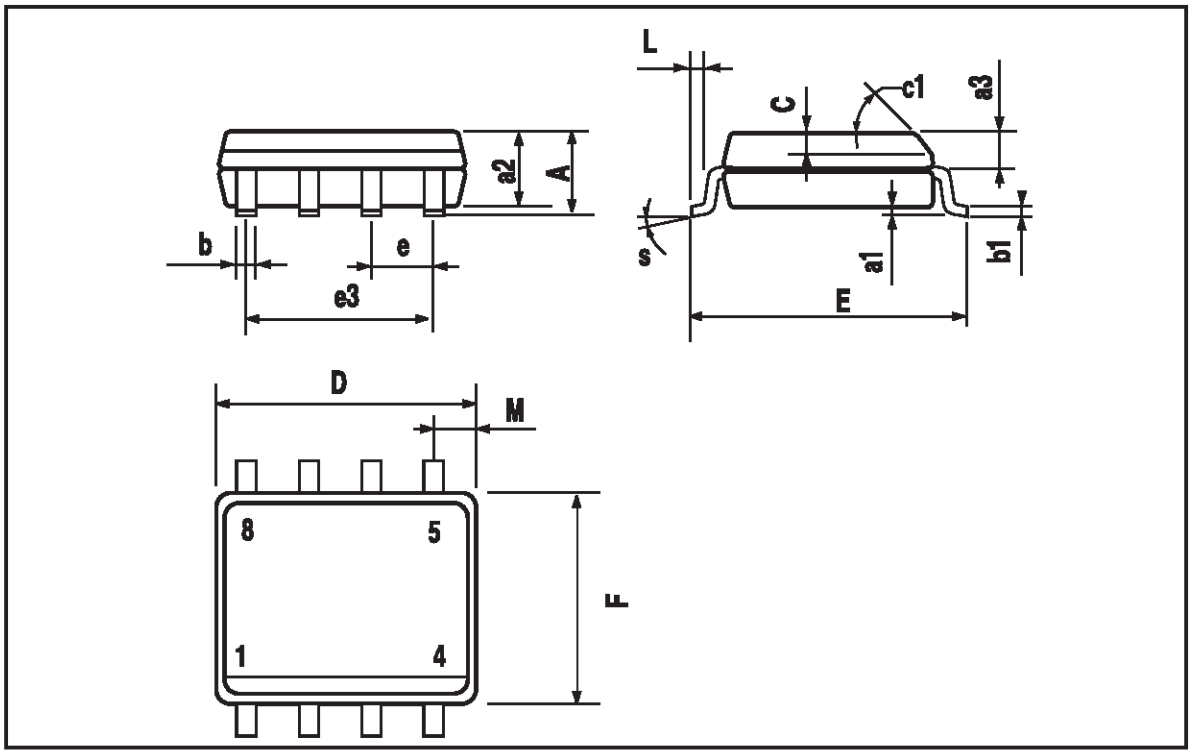


Turn-off Voltage Slope



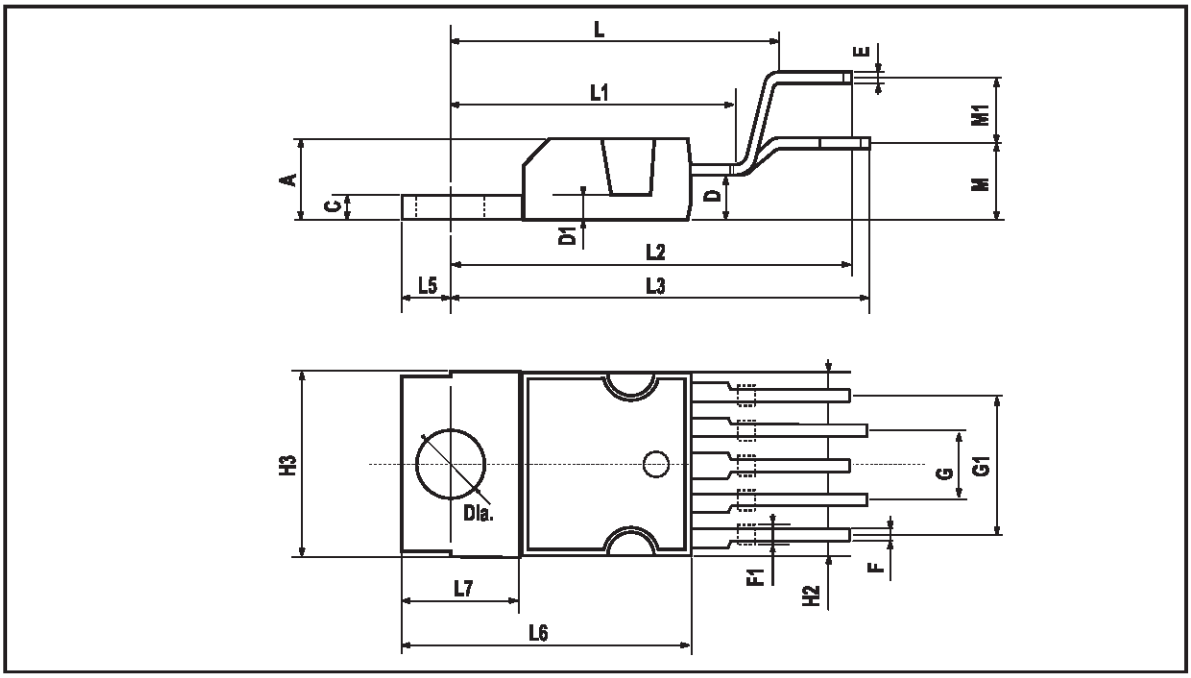
SO-8 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.75			0.068
a1	0.1		0.25	0.003		0.009
a2			1.65			0.064
a3	0.65		0.85	0.025		0.033
b	0.35		0.48	0.013		0.018
b1	0.19		0.25	0.007		0.010
C	0.25		0.5	0.010		0.019
c1	45 (typ.)					
D	4.8		5	0.188		0.196
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		3.81			0.150	
F	3.8		4	0.14		0.157
L	0.4		1.27	0.015		0.050
M			0.6			0.023
S	8 (max.)					
L1	0.8		1.2	0.031		0.047



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.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.30		4.80			
A2	0.03		0.23			
C	1.17		1.37			
D	2.40		2.80			
D1	8.95		9.35			
E	0.35		0.55			
F	0.80		1.05			
G	3.20		3.60			
G1	6.60		7.00			
H2			10.40			
L	13.59		14.39			
L2	1.27		1.40			
L3	1.30		1.70			
R		0.30				
V2	0 d		8 d