



# VN380 VN380SP

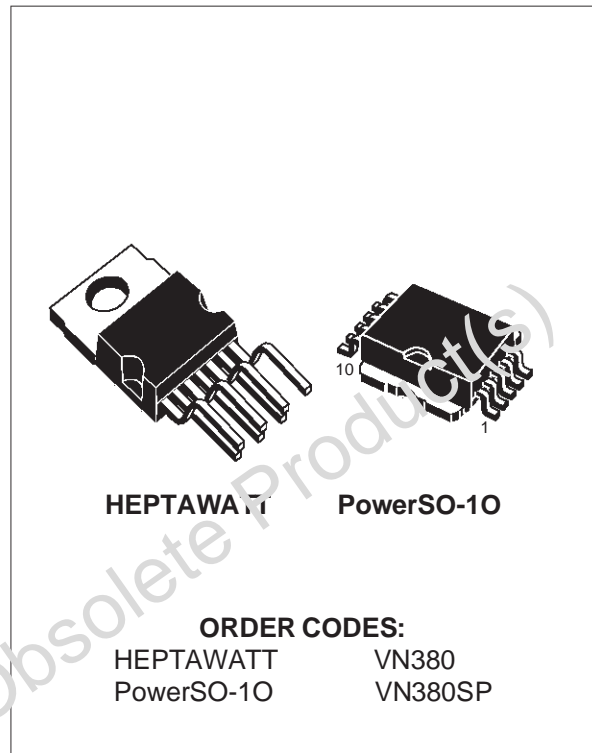
## SMART SOLENOID DRIVER SOLID STATE RELAY

TYPE	$V_{load(cl)}$	$I_n$	$R_{on}$
VN380	60 V	5 A	0.11 $\Omega$
VN380SP	60 V	5 A	0.11 $\Omega$

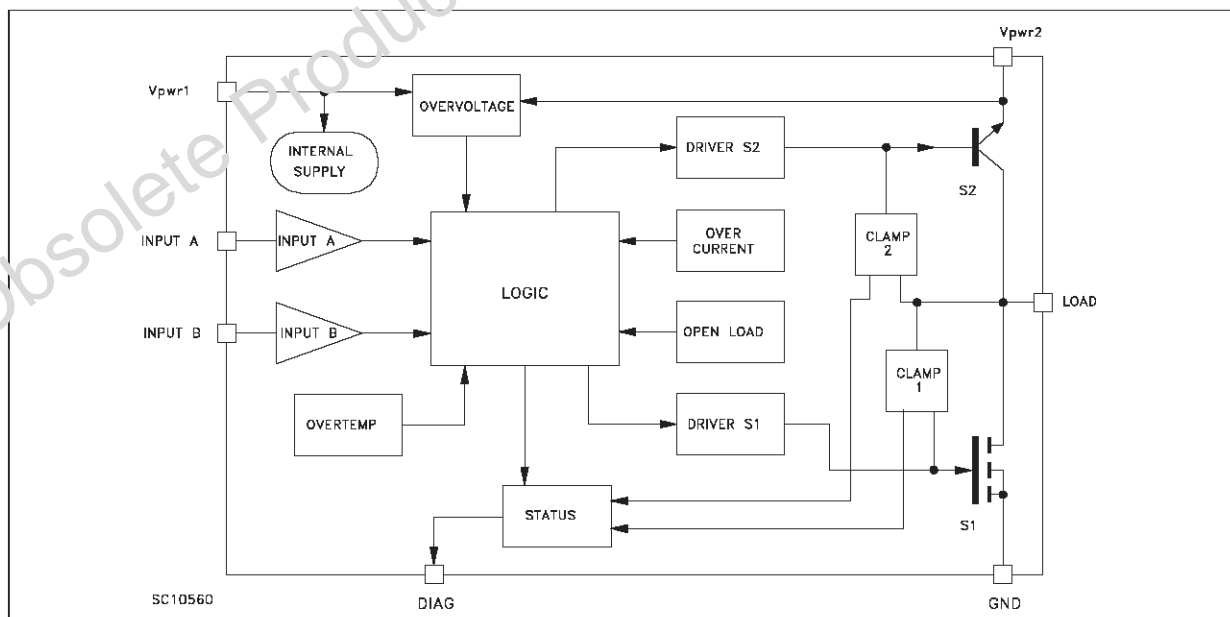
- LOAD CURRENT UP TO 7 A
- CMOS COMPATIBLE
- THERMAL SHUTDOWN
- DIAGNOSTIC OUTPUT
- INTEGRATED CLAMPS
- OVER CURRENT PROTECTION
- OPEN COIL DETECTION
- OVER VOLTAGE DECTION

### DESCRIPTION

The VN380 is a monolithic device made using STM VIPower Technology, intended for driving inductive loads. The inputs are CMOS compatible. The diagnostic output provides an indication of open load and demagnetization mode. Built-in thermal shut-down protects the chip from over-temperature. In case of over-current or over-temperature or over-voltage the product will automatically operate in recirculation mode.



### BLOCK DIAGRAM

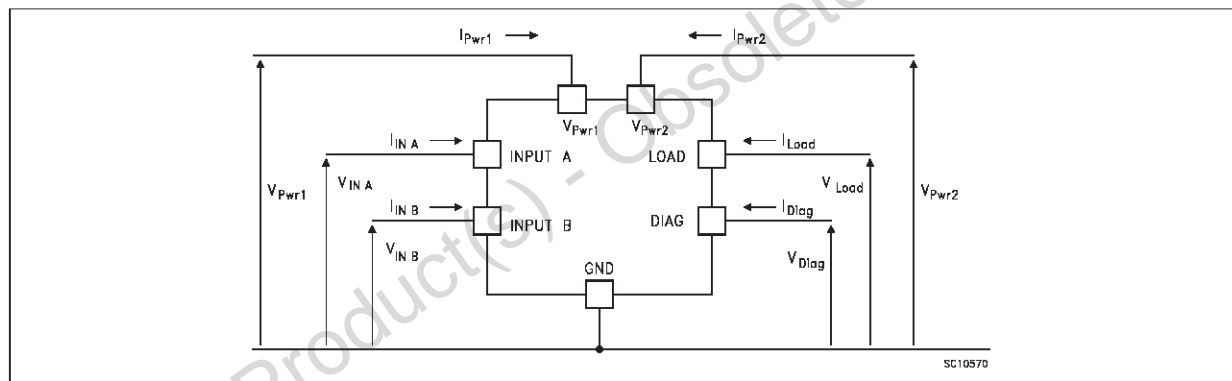


**ABSOLUTE MAXIMUM RATING**

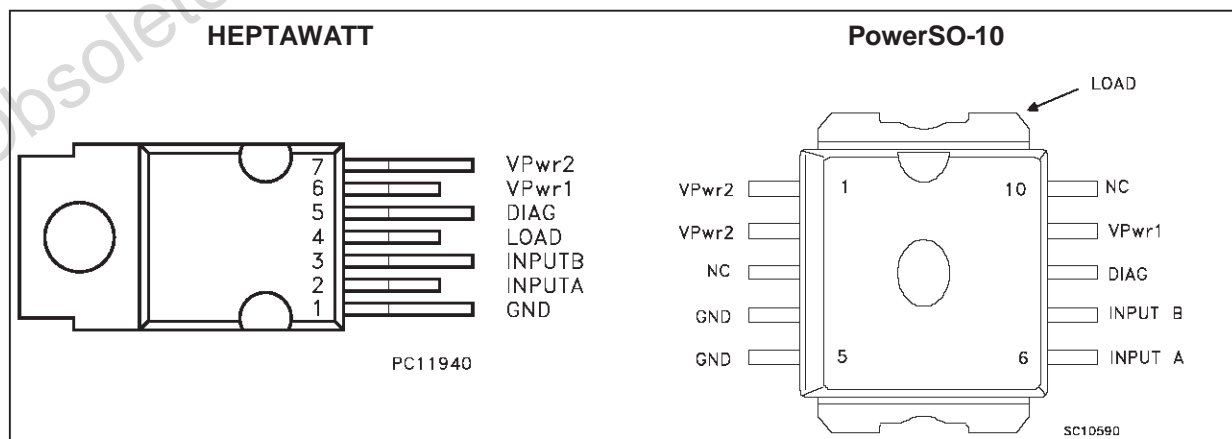
Symbol	Parameter	Value	Unit
$V_{load}$	Maximum DC Load Voltage	(Internally clamped)	V
$I_{load}$	Maximum DC Load Current	(Internally clamped)	A
$I_{rload}$	Reverse Load Current, $T_{case} = 25\text{ }^{\circ}\text{C}$	-10	A
$E_c$	Maximum Clamping Energy, $T_{case} = 150\text{ }^{\circ}\text{C}$ , $f = 40\text{ Hz}$ , 1000 hours ( $f$ : Input A frequency)	100	mJ
$E_c$	Maximum Clamping Energy, $T_{case} = -40\text{ }^{\circ}\text{C}$ , $f = 75\text{ Hz}$ , 5 minutes ( $f$ : Input A frequency)	200	mJ
$I_{in}$	Inputs Current	+/- 10	mA
$I_{diag}$	Diagnostic Output Current	+/- 10	mA
$V_{esd}$	Electrostatic Discharge ( $R = 1.5\text{ k}\Omega$ , $C = 100\text{ pF}$ , all pins)	2000	V
$V_{pwr1}$	Power Voltage 1	60	V
$V_{pwr2}$	Power Voltage 2	60	V
$R_{Vpwr}$	Reverse Power Voltage	-0.3	V
$T_j$	Junction Operating Temperature	-40 to 150 (*)	$^{\circ}\text{C}$
$T_{stg}$	Storage Temperature	-55 to 150	$^{\circ}\text{C}$
$V_{in}$	Input Voltages	8	V
$V_{diag}$	Diagnostic Output Voltage	8	V
$C_{load}$	Load Capacity	1	$\mu\text{F}$

Note (\*): Higher temperature is allowed during a short time before thermal shutdown. Permanent operation above  $^{\circ}\text{C}$  150 is not allowed.

**CURRENT AND VOLTAGE CONVENTIONS**



**CONNECTION DIAGRAM**



## THERMAL DATA

			HEPTAWATT	PowerSO-10	
R <sub>thj-case</sub>	Thermal Resistance Junction-case	Max	1.8	1.67	°C/W
R <sub>thj-amb</sub>	Thermal Resistance Junction-ambient (*)	Max	60	50	°C/W

(\*) When mounted using minimum recommended pad size on FR-4 board.

**ELECTRICAL CHARACTERISTICS** (10V < V<sub>PWR1</sub> < 18 V; - 40 °C < T<sub>J</sub> < 150 °C unless otherwise specified)

## POWER

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V <sub>pwr1</sub>	Operating Voltage		6	13	24	V
R <sub>on1</sub>	On State Resistance (excitation path)	I <sub>load</sub> = I <sub>n</sub> = 5 A V <sub>inA</sub> = V <sub>inB</sub> = 5 V			0.2	Ω
R <sub>on2</sub>	On State Resistance (recirculation path)	V <sub>pwr1</sub> = 13 V      I <sub>load</sub> = I <sub>n</sub> = 5 A V <sub>inA</sub> = 5 V          V <sub>inB</sub> = GND			0.4	Ω
V <sub>ce(sat)</sub>	Saturation Voltage of Bipolar S2	I <sub>load</sub> = I <sub>n</sub> = 5 A V <sub>pwr1</sub> = V <sub>pwr2</sub> = 13 V I <sub>load</sub> = 10 A          T <sub>J</sub> > 125 °C V <sub>pwr1</sub> = V <sub>pwr2</sub> = 13 V			2 2	V V
I <sub>sq</sub>	Supply Quiescent Current	V <sub>pwr1</sub> = 13 V      V <sub>inA</sub> = V <sub>inB</sub> = 5 V			25	mA
I <sub>lk</sub>	Output Leakage Current	V <sub>pwr1</sub> = 18 V      V <sub>inA</sub> = V <sub>inB</sub> = GND			5	mA
I <sub>off</sub>	Off State Supply Current	V <sub>inA</sub> = V <sub>inB</sub> = GND V <sub>pwr1</sub> = Not Connected 10V < V <sub>pwr2</sub> < 24 V T <sub>J</sub> = 25 °C			50	μA

## SWITCHING (EXCITATION PATH)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
t <sub>d(on)</sub>	Turn-on Delay Time	R <sub>load</sub> = 2.5 Ω    V <sub>inA</sub> = 5 V (see fig.1)			50	μs
t <sub>r</sub>	Rise Time of Output Current	R <sub>load</sub> = 2.5 Ω    V <sub>inA</sub> = 5 V (see fig.1)	1		20	μs
t <sub>d(off)</sub>	Turn-off Delay Time	R <sub>load</sub> = 2.5 Ω    V <sub>inA</sub> = 5 V (see fig.1)			50	μs
t <sub>f</sub>	Fall Time of Output Current	R <sub>load</sub> = 2.5 Ω    V <sub>inA</sub> = 5 V (see fig.1)	1		20	μs

## LOGIC INPUT

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V <sub>il</sub>	Input Low Level Voltage				1.5	V
V <sub>ih</sub>	Input High Level Voltage		3.5			V
V <sub>i(hyst)</sub>	Input hysteresis Voltage		0.5	0.8	2	V
V <sub>i(CL)</sub>	Input Clamp Voltage	I <sub>in</sub> = 10 mA	8	9.5	11	V
I <sub>in</sub>	Input Current	V <sub>inA</sub> = V <sub>inB</sub> = 2 V V <sub>inA</sub> = V <sub>inB</sub> = 5 V	20		250	μA μA

**ELECTRICAL CHARACTERISTICS** (continued)  
**PROTECTIONS AND DIAGNOSTICS**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
T <sub>tsd</sub>	Thermal Shut-Down Temperature		160	180	200	°C
I <sub>lim</sub>	Current Cut Off Level		15		30	A
V <sub>ov</sub>	Over Voltage Threshold	V <sub>inA</sub> = V <sub>inB</sub> = 5 V	27			V
V <sub>diag</sub>	Status Output Voltage	Diagnostic Output Active (low) I <sub>diag</sub> = 2 mA			0.5	V
V <sub>diag(CL)</sub>	Status Output Clamp Voltage	I <sub>diag</sub> = 10 mA	8	9.5	11	V
T <sub>d</sub>	Status Propagation Delay	Demagnetization Mode (Fast turn-off) V <sub>diag</sub> = 1 V (see figure 3)			70	μs
V <sub>cl1</sub>	Switch S1 Detection Clamp	I <sub>load</sub> = I <sub>n</sub> = 5 A	60	70	80	V
V <sub>cl2</sub>	Output Inductive Clamp Voltage	I <sub>load</sub> = I <sub>n</sub> = 5 A	24	28.5	33	V
V <sub>fb</sub>	Flyback Diagnostic Threshold	Demagnetization Mode (Fast turn-off) V <sub>cl</sub> = V <sub>cl1</sub> or V <sub>cl2</sub>	V <sub>cl</sub> -5		V <sub>cl</sub>	V
I <sub>ol</sub>	Oper Load Current Level		5		700	mA

**TRUTH TABLE**

Conditions	IN A	IN B	S1	S2
Standby Modes	L	L	OFF	OFF
	L	H	OFF	OFF
Excitation Mode	H	H	ON	OFF
Recirculation Mode	H	L	OFF	ON
Demagnetization Mode (Fast turn off)	V <sub>pwr2</sub> + V <sub>cl2</sub> < V <sub>cl1</sub>	L	OFF	ON
	V <sub>pwr2</sub> + V <sub>cl2</sub> > V <sub>cl1</sub>	L	ON	OFF
Thermal Shutdown	H	H	OFF	ON
Current Cut Off	H	H	OFF	ON
Open Load	See Open Load Waveforms			
Overvoltage	H	H	OFF	ON

## FUNCTIONAL DESCRIPTION

### - CURRENT CUT OFF

When the load current rise above the current cut off level, S1 is automatically switched off and the device operates in recirculation mode (S2 active). S1 is latched off until A goes low and high again.

This default is not displayed by diagnostic flag.

### - OPEN LOAD

If the load current is below the open load current level, the flag of the open load block is activated but this default is displayed by the diagnostic output on the falling edge of input B and the diagnostic output is latched at low level until input A goes low and high again. In case an open load is detected during an active phase of input B, but disappears before a falling edge of input B, this default is not displayed by the diagnostic flag (see open load waveforms).

### - THERMAL SHUTDOWN

The device is internally protected against over temperatures by the thermal circuit protection. When the device junction temperature exceeds the protection limit, S1 is automatically switched off. Therefore the device operates in recirculation mode (S2 active). S1 remain latched off until  $V_{pwr1}$  goes low and high again. This default is not displayed by the diagnostic flag.

### OVERVOLTAGE

During the ON state of S1 switch, if  $V_{pwr1}$  or  $V_{pwr2}$  is rising above the threshold detection S1 is automatically switched off, therefore the device operates in recirculation mode.

FIGURE 1: SWITCHING PARAMETER TEST CONDITIONS

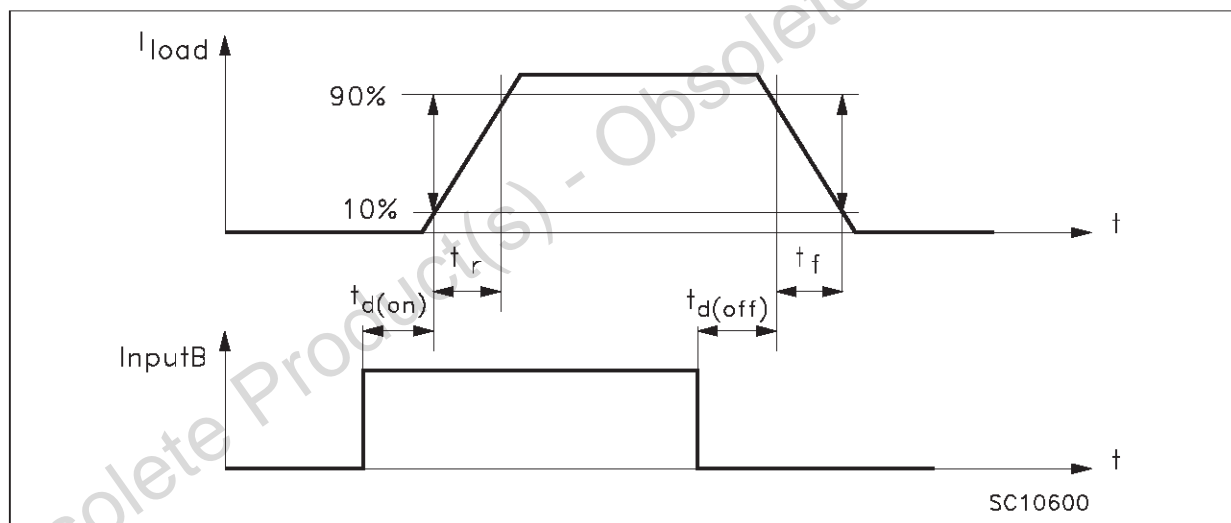


FIGURE 2: Switching Waveforms

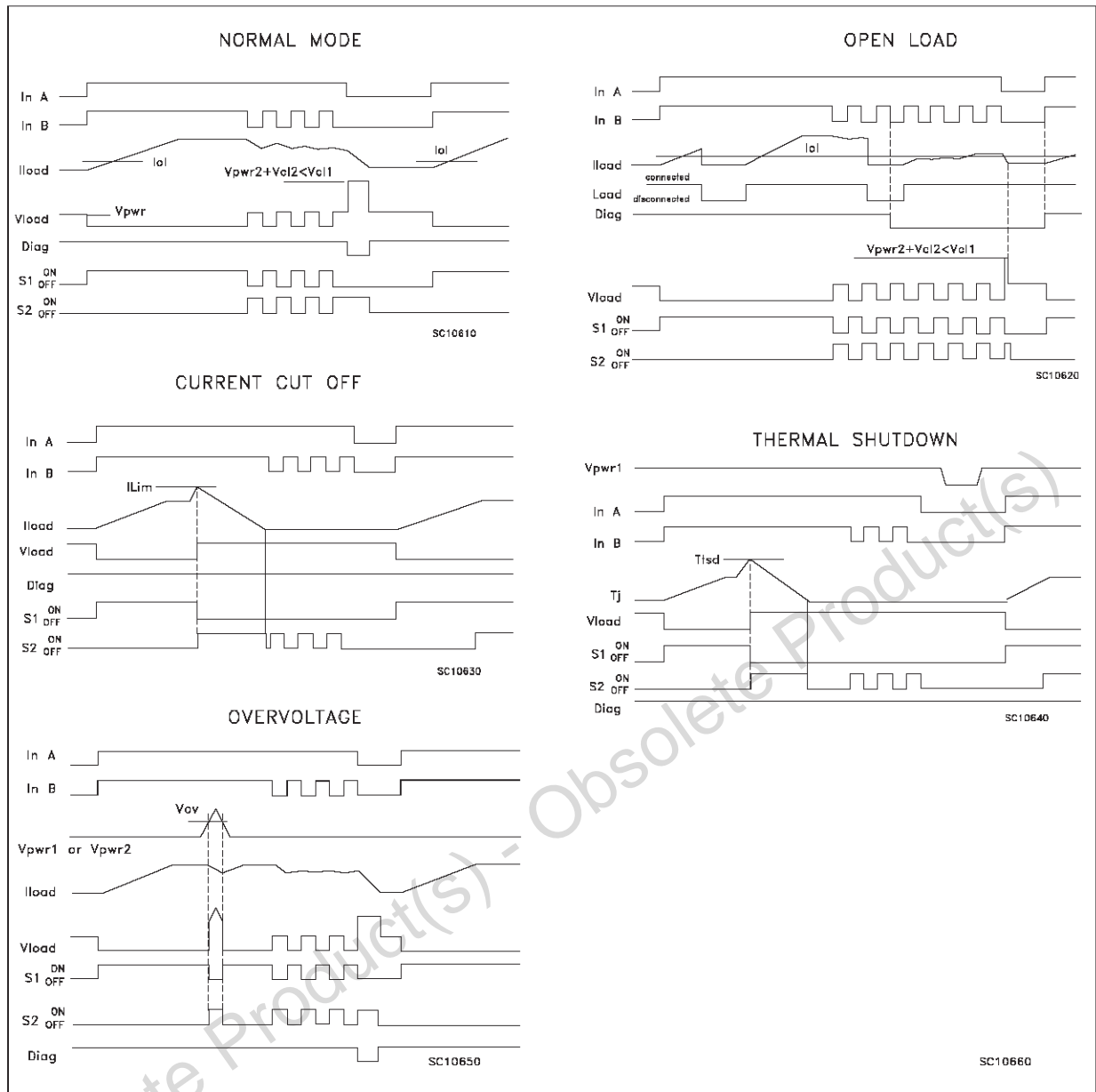
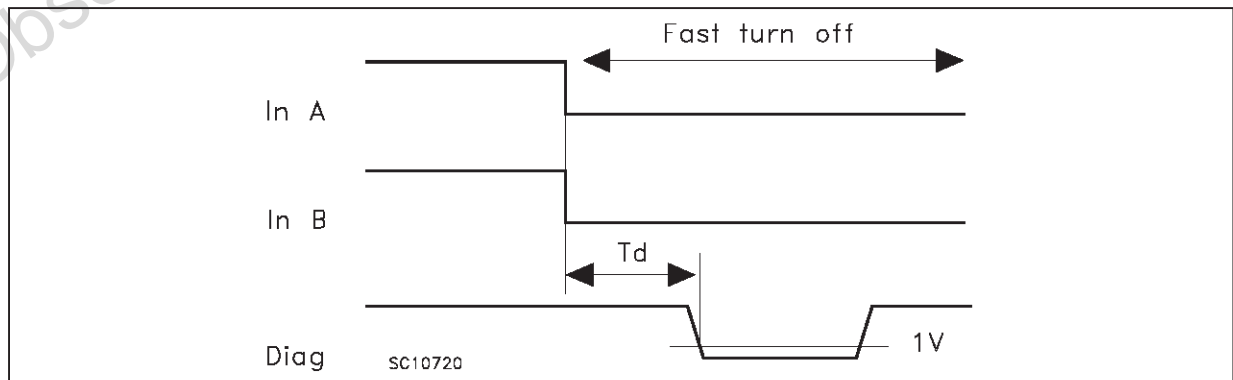
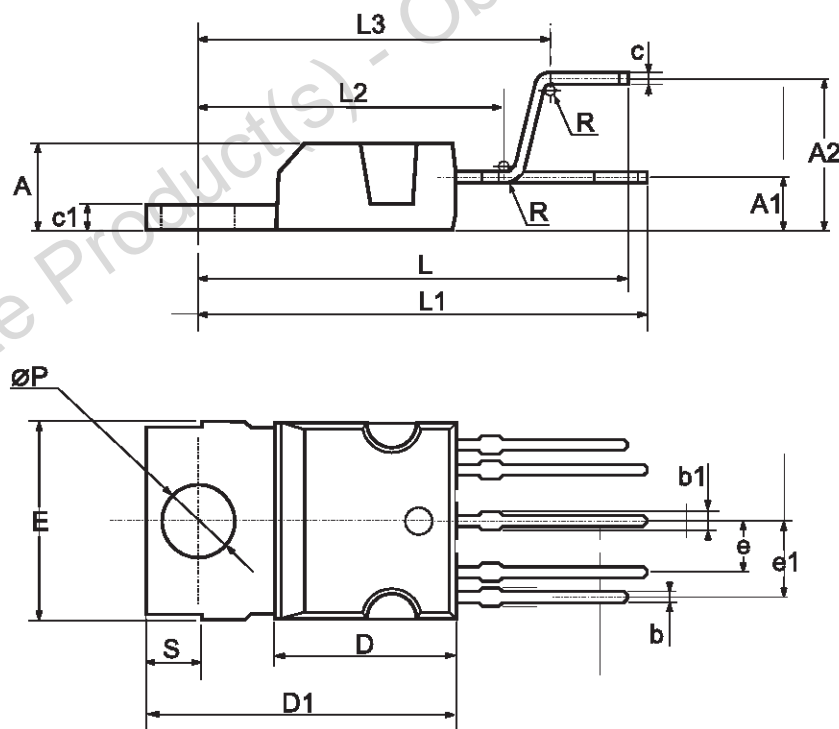


FIGURE 3



## HEPTAWATT (VERTICAL) MECHANICAL DATA

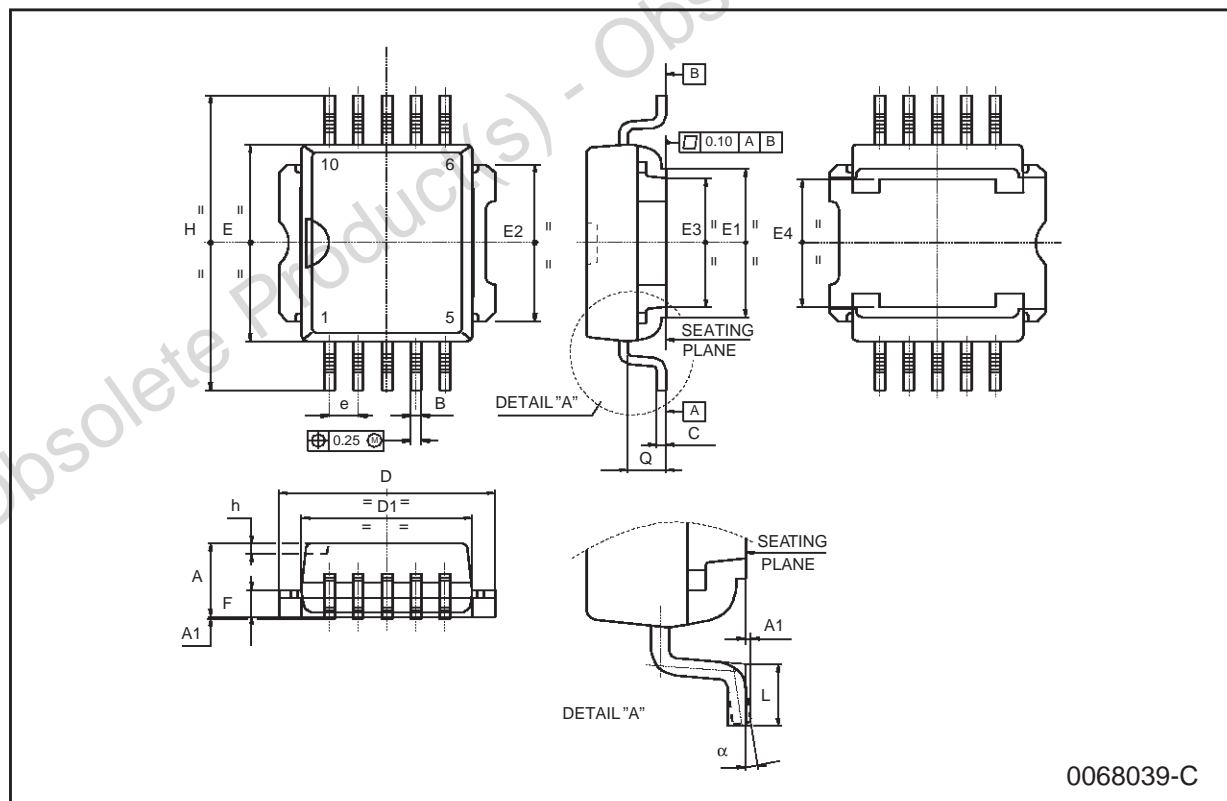
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			4.8			0.189
C			1.37			0.054
D	2.4		2.8	0.094		0.110
D1	1.2		1.35	0.047		0.053
E	0.35		0.55	0.014		0.022
F	0.6		0.8	0.024		0.031
F1			0.9			0.035
G	2.41	2.54	2.67	0.095	0.100	0.105
G1	4.91	5.08	5.21	0.193	0.200	0.205
G2	7.49	7.62	7.8	0.295	0.300	0.307
H2			10.4			0.409
H3	10.05		10.4	0.396		0.409
L		16.97			0.668	
L1		14.92			0.587	
L2		21.54			0.848	
L3		22.62			0.891	
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		2.8			0.110	
M1		5.08			0.200	
Dia	3.65		3.85	0.144		0.152



P023A

**PowerSO-10 MECHANICAL DATA**

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	3.35		3.65	0.132		0.144
A1	0.00		0.10	0.000		0.004
B	0.40		0.60	0.016		0.024
c	0.35		0.55	0.013		0.022
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
E1	7.20		7.40	0.283		0.291
E2	7.20		7.60	0.283		0.300
E3	6.10		6.35	0.240		0.250
E4	5.90		6.10	0.232		0.240
e		1.27			0.050	
F	1.25		1.35	0.049		0.053
H	13.80		14.40	0.543		0.567
h		0.50			0.002	
L	1.20		1.80	0.047		0.071
q		1.70			0.067	
$\alpha$	0°		8°			



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