LPS Power Thick Film Resistors Mounting Instructions and Thermal Considerations

1. HEATSINK SPECIFICATION

The mounting area on the heatsink and the bottom of the LPS must be free of particles. Surfaces in contact must be carefully cleaned in order to obtain the maximum thermal conductivity between the component and the heatsink.

The heatsink must have an acceptable flatness: From 0.05 mm to 0.1 mm/100 mm. Roughness of the heatsink must be around 6.3 µm.

2. CHOICE OF THE THERMAL INTERFACE

In order to improve thermal conductivity, surfaces in contact should be coated with a silicone grease or a thermal film. The function of this element is to minimize the thermal interface resistance by filling the potential air voids. Since the thermal resistance of air is very high, these voids will substantially degrade performance. Therefore, it is important to use a thermal interface material to fill these air voids. Several materials are available to reduce thermal resistance between the resistor and heatsink surface.

Thermal grease is an addition of thermally conductive particles with a fluid typically, a silicone oil. The final consistency is like a grease.

We recommend to use for the thermal grease Bluesil Past 340 from BlueStar Silicones (thermal conductivity at 25 °C = 0.41 W/mK - dielectric strength = 15 kV/mm.

Thermal interface can be applied either to the base area of the component or the area of the heatsink. We recommend to have a constant thickness of grease, to screen print or to use a rubber roller to deposit this element.

Thermal film, an alternative to thermal grease, but with a lower efficiency for the thermal dissipation, is easier and faster to install than the grease. Moreover, you can use different times the same thermal films and this element allows to have uniform thickness. These thermally conductive pads are available in sheet form or in pre-cut shapes. These pads use silicone rubber binder combined with a variety of materials such as aluminum oxide, boron nitride or magnesium oxide to provide good thermal conductivity. For the thermal interface, we recommend to use Q-PAD II from Berquist (thermal conductivity = 2.5 W/mK; non-insulated). The Q-Pad II film is not electrically insulated.

3. MOUNTING THE RESISTOR

Avoid any movement of the resistor once positioned on the heatsink. The fixing screws are inserted and evenly tightened by hand (around 0.5 Nm) or by electric or pneumatic screwdrivers with a torque of 0.5 Nm. After, the screws are tightened again to the final torque (2 Nm). The use of torque wrenches with automatic release is recommended. The two step procedure must be strictly followed to allow the component base-plate to relax and conform to the heatsink. The bus-bars must be mounted onto the connections of the power resistor with the recommended torque. The cross sections of the bus-bars must be sufficiently large to avoid heating of the module by bus-bar resistive losses. Stress to the power resistor from bus-bar forces must be minimized during assembly, transportation and operation.

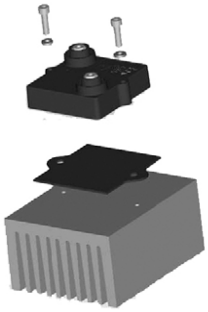

Fig. 1 - Mounting assembly for LPS

MOUNTING INFORMATION

MOUNTING	SCREW	TORQUE VALUES RECOMMENDED (Nm)
Resistor on heatsink	M4	2
Connexions	M4	2

Note

- Maximum torque: 2.5 mm

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4. THERMAL CONSIDERATIONS

For reliable operation it is crucial not to exceed the maximum specified temperature for the resistive element

THERMAL INFORMATION ON LPS RESISTORS

	MAXIMAL TEMPERATURE FOR RESISTIVE ELEMENT	THERMAL RESISTIVITY BETWEEN RESISTIVE ELEMENT AND CASE $R_{th\ (j - c)}$
LPS300	120 °C	0.112 °C/W
LPS600	155 °C	0.112 °C/W
LPS800	175 °C	0.112 °C/W
LPS1100	200 °C	0.039 °C/W

Excessive resistive temperatures will cause a drift of the resistance value or reduced component life. Proper thermal design followed by temperature measurements to verify the design, and consistent mounting procedures will avoid these problems. The film temperature (T_j) is related to the case temperature (T_C) by the parameter "Thermal resistance" $R_{th\ (j - c)}$. Thermal resistance is expressed in °C/W. In other words, the thermal resistance $R_{th(j-c)}$ is the temperature rise (°C) between the film and the case per W applied.

5. CHOICE OF THE HEATSINK

The user must choose the heatsink according to the working conditions of the component (power, room temperature).
Maximum working temperature must be not exceeded. The dissipated power is simply calculated by the following ratio:

$$P = \frac{\Delta T}{R_{TH\ (j - c)} + R_{TH\ (c - h)} + R_{TH\ (h - a)}}$$

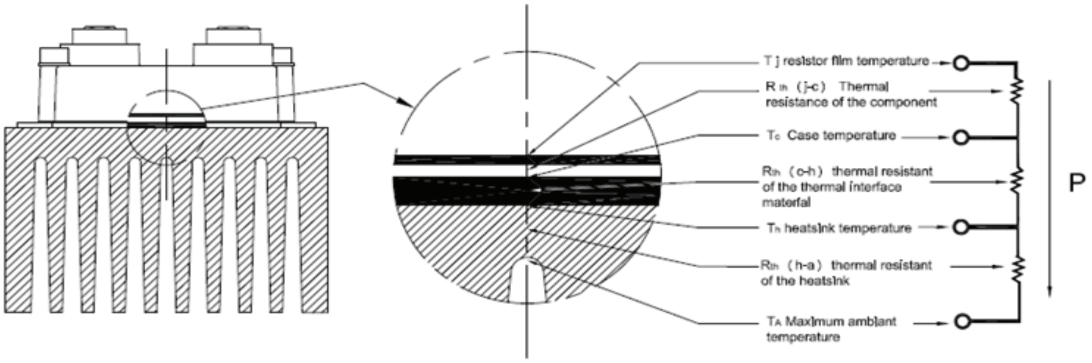
P: Expressed in W

ΔT: Difference between maximum working temperature and room temperature or fluid cooling temperature.

$R_{th\ (j - c)}$: Thermal resistance value measured between resistive layer and outer side of the resistor. It is the thermal resistance of the component: (See §4 for the thermal resistivity of each LPS model).

$R_{th\ (c - h)}$: Thermal resistance value measured between outer side of the resistor and upper side of the heatsink. This is the thermal resistance of the interface (grease, thermal pad), and the quality of the fastening device.

$R_{th\ (h - a)}$: Thermal resistance of the heatsink.



Example:

$R_{th\ (c - h)} + R_{th\ (h - a)}$ for LPS 1100 power dissipation 850 W at + 18 °C fluid temperature.

$\Delta T \leq 200\ °C - 18\ °C = 182\ °C$

$R_{th\ (j - c)} + R_{th\ (c - h)} + R_{th\ (h - a)} = \frac{\Delta T}{P} = \frac{182}{850} = 0.214\ °C/W$

$R_{th\ (j - c)} = 0.039\ °C/W$

$R_{th\ (c - h)} + R_{th\ (h - a)} = 0.214\ °C/W - 0.039\ °C/W = 0.175\ °C/W$

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6. MECHANICAL PROPERTIES (for all LPS models)

The clearance distance in air is defined as the shortest direct path between the terminals and the base and between terminals.

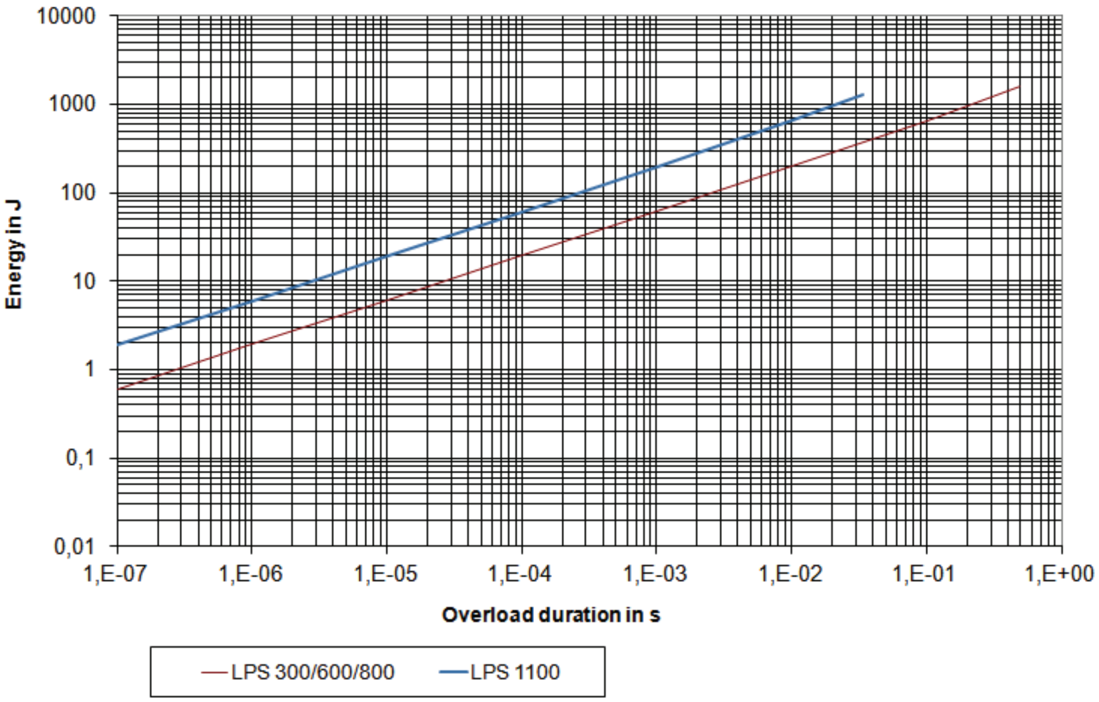
The surface creepage distance is the shortest path along the plastic housing between the terminals and the base and between the terminals.

PARAMETER		VALUE	UNIT
Dimensions		65.2 x 60 x 25.8	mm
Clearance distance in air	Termination to base	14.7 min.	mm
	Termination to term	40 min.	mm
Surface creepage distance	Termination to base	30 min.	mm
	Termination to term	83 min.	mm

7. OVERLOAD

In any case the applied voltage must be lower than U_L = 6600 V for LPS 1100 and U_L = 5000 V for LPS 300, LPS600, LPS 800.

Accidental overload: The values indicated on the following graph are applicable to resistors in air or mounted onto a heatsink.



For more information about the calculations from this energy curve, see the Application Note “Pulse Capabilities for Thick Film Power Resistors” (www.vishay.com/doc?50060).

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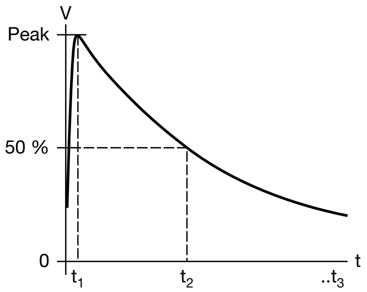
8. LIGHTING PULSES

Typical calculations are for the lightning pulses. The lightning is an atmospheric discharge of electricity resulting from an accumulation of static charges. The pulses are defined in the IEC 61000-4-5:



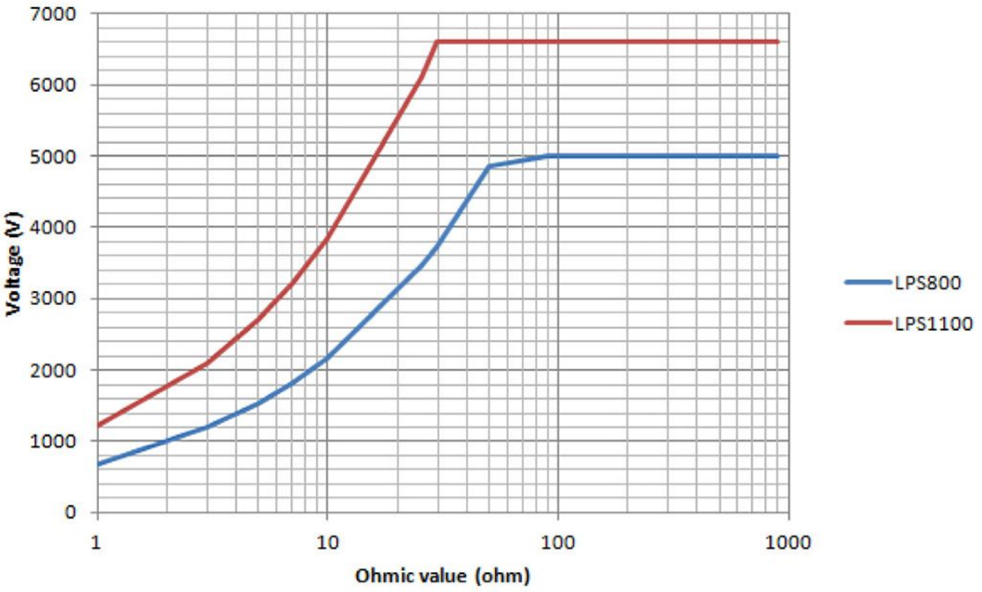
$$E = \left(\frac{1}{3} \times \frac{V^2}{R} \times t_1\right) + \left(\left(\frac{V^2 \times \tau}{-2 \times R}\right) \times \left(e^{-\frac{2 \times t_3}{\tau}} - e^{-\frac{2 \times t_1}{\tau}}\right)\right)$$

Lightning pulse

With:
E = Energy (J)
V = Peak Voltage (V)
R = Resistance (Ω)
t_1 =Time to peak voltage (s)
t_2 =Time to 50 % of peak voltage (s)
t_3 = Time to negligible voltage (s) (minimum 20 x t_2)
τ = Exponential rate of decay = - $(t_2 - t_1)/\ln(0.50)$

Using the energy curve and with the limitations for LPS300, LPS600, LPS800 at 5000 V and for LPS1100 at 6600 V, you can apply the following voltages according the ohmic values:

For pulse 1.2/50 (1.2 µs for the increase time and 50 µs for the half-height):



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For pulse 10/700 (10 μs for the increase time and 700 μs for the half-height):