Assembly Instructions

General

Semiconductor devices can be mounted in any position. The terminal length may be bent at a distance greater than 1.5 mm from the case provided no mechanical force has an effect on the case.

If the device is to be mounted near heat generating components, consideration must be given to the resultant increase in ambient temperature.

Soldering Instructions

Leaded Devices

Protection against overheating is essential when a device is being soldered. It is recommended, therefore, that connection terminals are left as long as possible, are soldered at the tip only, and that any heat generated is quickly conducted away. The time during which the specified maximum permissible device junction temperature is exceeded during the soldering operation should be as short as possible, (i.e. for silicon, 260°C for 5 seconds.

Avoid any force on the body or leads during or just after soldering.

Do not correct the position of an already soldered device by pushing, pulling or twisting the body. Prevent fast cooling after soldering.

The maximum soldering temperatures are shown in table 1.

Iron Soldering				Dip or Flow Soldering			
	Iron Temperature	Soldering Distance from the Case	Maximum Allowable Soldering Time	Soldering Temperature	Soldering Distance from the Case		Maximum Allowable Soldering Time
					Vertical	Horizontal	
Glass case	≤ 260 °C ≤ 260 °C 260 to 400 °C	1.5 to 5 mm > 5 mm > 5 mm	5 s 10 s 5 s	≤ 260 °C	> 1.5 mm	> 5 mm	5 s

Table 1 : Maximum soldering temperatures

Important layout notes

If components are to be arranged in rows, then separate soldering surfaces must be provided for each component. If this is not carried out, a block of solder forms between the components during soldering, and a rigid connection results. This can cause breakage or cracks in the component as the result of the slightest bending of the board, and thus lead to failure. If it is necessary to solder a wire (standard conductor, etc.) to the board, a separate soldering surface must be provided in order to avoid excessive heating of the components during soldering with a soldering iron.

Heat Removal

To keep the thermal equilibrium, the heat generated in the semiconductor junction(s) must be removed.

In the case of low-power devices, the natural heat-conductive path between the case and surrounding air is usually adequate for this purpose. However, in the case of medium-power devices, heat radiation may have to be improved by the use of star or flag-shaped heat dissipators, which increase the heat radiating surface.

Finally, in the case of high-power devices, special heat sinks must be provided, the cooling effect of which can be increased further by the use of special coolants or air blowers.

The heat generated in the junction is conveyed to the case or header by conduction rather than convection. A measure of the effectiveness of heat conduction is the inner thermal resistance or thermal resistance junction case, R_{thJC}, the value of which is governed by the construction of the device.

Any heat transfer from the case to the surrounding air involves radiation convection and conduction. The effectiveness of transfer is expressed in terms of an R_{thCA}-value, i.e. the external or case-ambient thermal resistance. The total thermal resistance between junction and ambient is consequently

$R_{thJA} = R_{thJC} + R_{thCA}$.

The total maximum power, $P_{tot\ max}$, of a semiconductor device can be expressed as follows

$$P_{totmax} = \frac{T_{jamb} - T_{amb}}{R_{thJA}} = \frac{T_{max} - T_{amb}}{R_{thJC} + R_{thCA}}$$

where

T_{jmax}

is the maximum junction temperature,

T_{amb}

is the highest ambient temperature likely to be reached under the most unfavorable conditions,

R_{thJA}
is the thermal resistance between junction and ambient. For diodes with axial leads, it is measured with a heat sink at a specified distance from the case,

R_{thJC}
is the thermal resistance between junction and case,

R_{thCA}
is the thermal resistance between case and ambient. Its value is cooling dependent. When using a heat sink, it can be influenced through thermal contact between the case and heat sink, thermal distribution in the heat sink and heat transfer to the surroundings.

Therefore, the maximum permissible total power dissipation for a given semiconductor device can be influenced only by changing T_{amb} and R_{thCA}. The value of R_{thCA} can be obtained either from the data of heat sink suppliers or through direct measurements.

Heat due to energy losses is mainly conducted with power diodes without cooling pins through the connecting leads and hence the pc board.

Figure 1. shows the thermal resistance plotted as a function of edge length. The values are valid with a heat source in the middle of the plate, resting air and vertical position. In a horizontal position, thermal resistance increases approximately by 15 to 20%.

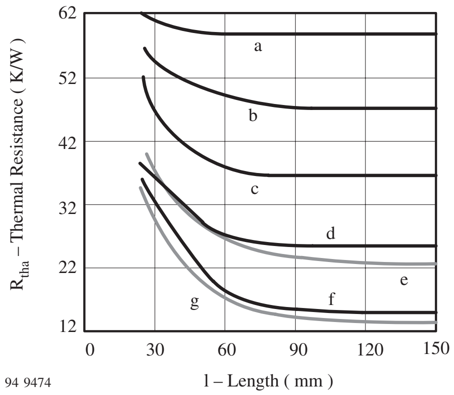

Figure 1.

Pertinax boards 1.5 mm thick

a: Pertinax non-metallized

b: Pertinax with 35 mm copper metallization on one side; heat source fitted to non-metallized side

c: Pertinax with 70 mm copper metallization on one side; heat source fitted to non-metallized side

d: Pertinax with 35 mm copper metallization on one side; heat source fitted to metallized side

e: Pertinax with 35 mm copper metallization on both sides

f: Pertinax with 70 mm copper metallization on one side; heat source fitted to metallized side

g: Pertinax with 70 mm copper metallization on both sides

R_{tha}: Thermal resistance of boards

l: Edge length

When using cooling plates as heat sink without optimum performance, the following approach is acceptable.

The curves shown in Figure 2. and Figure 3. are given for thermal resistance, R_{thCA}, by using square plates of aluminium with edge length **a** but with different thick- nesses. The device case should be mounted directly on the cooling plate.

The edge length **a** derived from Figure 2. and Figure 3. for a given R_{thCA} value must be multiplied with α and β :

$a' = a \times \beta \times \alpha$

where

α= 1.00 for vertical arrangement

α= 1.15 for horizontal arrangement

β= 1.00 for bright surface

β= 0.85 for dull black surface

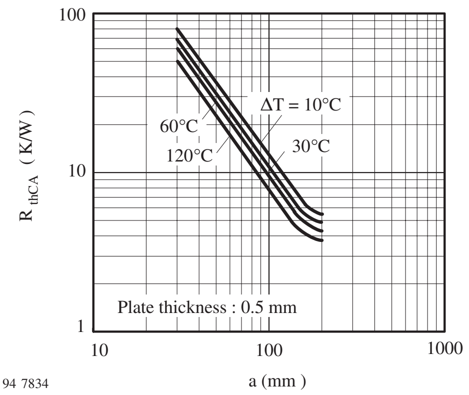

Figure 2.

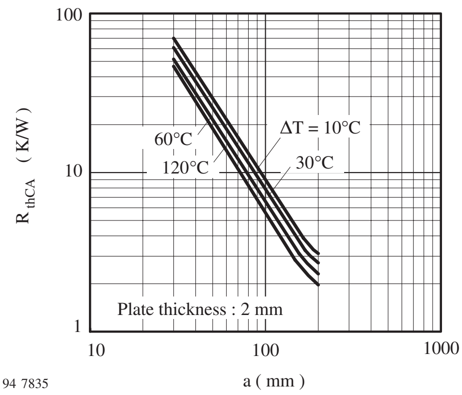

Figure 3.

Example

For a silicon power rectifier with T_{jmax} = 150 °C and R_{thJC} = 5 K/W, a 2-mm aluminium square sheet is used in a horizontal arrangement. The maximum ambient temperature is 50°C and the maximum power dissipation is $P_{tot\ max}$ = 8 W.

With R_{thCA} = 7.5 K/W and DT = 60 °C, plate thickness = 2 mm. Therefore, the edge length a = 90 mm. This value should be multiplied with a = 1.15 due to the horizontal arrangement. Hence, the actual edge length = 105 mm.

For a given plate sheet length, the allowable power dissipation should be first calculated with a supposed ΔT. The result should be corrected then with the actual ΔT.

$$P_{totmax} = \frac{T_{jmax} - T_{amb}}{R_{thJC} + R_{thCA}}$$

$$R_{thCA} = \frac{T_{jmax} - T_{amb}}{P_{tot}} - R_{thJC} = \frac{150°C - 50°C}{8W} - 5°K/W = 7.5K/W$$

$\Delta T = T_{case} - T_{amb}$ can be calculated from

$$P_{totmax} = \frac{T_{jmax} - T_{amb}}{R_{thJC} + R_{thCA}} = \frac{T_{case} - T_{amb}}{R_{thCA}}$$

$$T_{case} - T_{amb} = \frac{R_{thCA}(T_{jmax} - T_{amb})}{R_{thJC} + R_{thCA}} = \frac{7.5°C/W \cdot (150°C - 50°C)}{5K/W + 7.5K/W} = 60°C$$

Boards for RthJA Definition

Epoxy glass hard tissue, board thickness 1.5 mm, copper overlay 35 mm

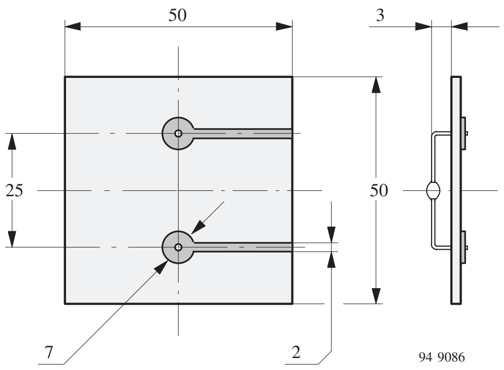

Figure 4. Leaded Diodes