Assembly Instructions

General

Optoelectronic semiconductor devices can be mounted in any position.

Connecting wires of less than 0.5 mm diameter may be bent, provided the bend is not less than 1.5 mm from the bottom of the case and no mechanical stress has an affect on it. Connection wires of larger diameters, should not be bent.

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

Soldering Instructions

Protection against overheating is essential when a device is being soldered. Therefore, the connection wires should be left as long as possible. The time during which the specified maximum permissible device junction temperature is exceeded at the soldering process should be as short as possible (one minute maximum). In the case of plastic encapsulated devices, the maximum permissible soldering temperature is governed by the maximum permissible heat that may be applied to the encapsulant rather than by the maximum permissible junction temperature.

The maximum soldering iron (or solder bath) temperatures are given in the individual data sheets. During soldering, no forces must be transmitted from the pins to the case (e.g. by spreading the pins).

Table 5. Maximum Soldering Temperatures

Iron soldering				Wave soldering		
	Iron temperature	Distance of the soldering position from the lower edge of the case	Maximum allowable soldering time	Soldering temperature see temperature-time profiles	Distance of the soldering position from the lower edge of the case	Maximum allowable soldering time
Devices in plastic case ≥ 3 mm	≦260°C	≧2.0 mm	5 s	235°C	≧2.0 mm	8 s

Soldering Methods

There are several methods for soldering devices onto the substrate. The following list is not complete.

- **Soldering in the vapor phase**

Soldering in saturated vapor is also known as condensation soldering. This soldering process is used as a batch system (dual vapor system) or as a continuous single vapor system. Both systems may also include a pre-heating of the assemblies to prevent high temperature shock and other undesired effects.

- **Infrared soldering**

By using infrared (IR) reflow soldering, the heating is contact-free and the energy for heating the assembly is derived from direct infrared radiation and from convection (Refer to CECC00802).

The heating rate in an IR furnace depends on the absorption coefficients of the material surfaces and on the ratio of component’s mass to an As-irradiated surface.

The temperature of parts in an IR furnace, with a mixture of radiation and convection, cannot be determined in advance. Temperature measurement may be performed by measuring the temperature of a certain component while it is being transported through the furnace.

The temperatures of small components, soldered together with larger ones, may rise up to 280°C.

Influencing parameters on the internal temperature of the component are as follows:

- Time and power
- Mass of the component
- Size of the component
- Size of the printed circuit board
- Absorption coefficient of the surfaces
- Packing density
- Wavelength spectrum of the radiation source
- Ratio of radiated and convected energy

Temperature/time profiles of the entire process and the influencing parameters are given in figure 43.

- **Wave soldering**

In wave soldering one or more continuously replenished waves of molten solder are generated, while the substrates to be soldered are moved in one direction across the crest of the wave.

Temperature/time profiles of the entire process are given in figure 44.

- **Iron soldering**

This process cannot be carried out in a controlled situation. It should therefore not be used in applications where reliability is important. There is no SMD classification for this process.

- **Laser soldering**

This is an excess heating soldering method. The energy absorbed may heat the device to a much higher temperature than desired. There is no SMD classification for this process at the moment.

- **Resistance soldering**

This is a soldering method which uses temperature-controlled tools (thermodes) for making solder joints. There is no SMD classification for this process at the moment.

Temperature–Time Profiles

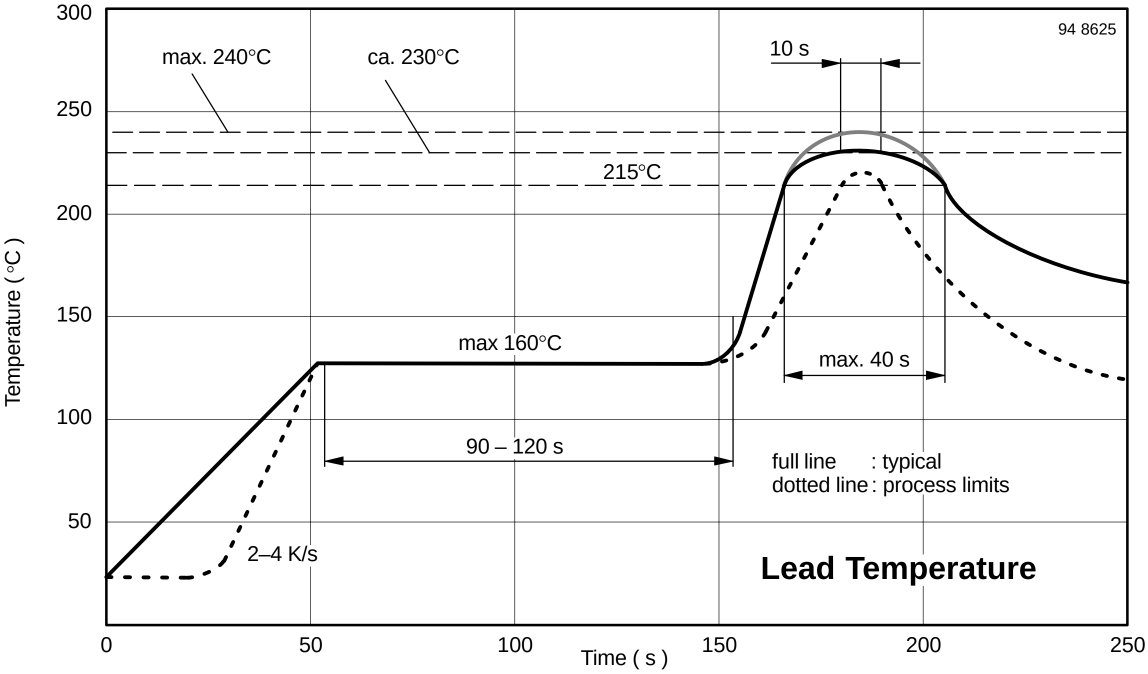

Figure 43. Infrared reflow soldering optodevices (SMD package)

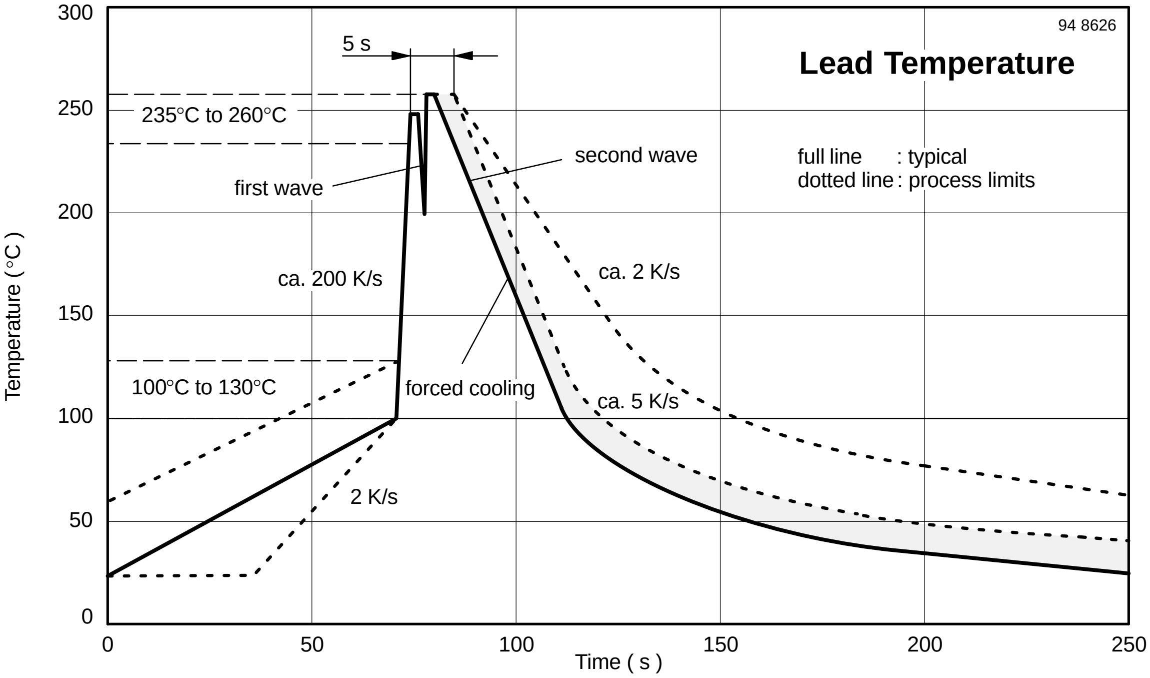

Figure 44. Wave soldering double wave optodevices

Heat Removal

The heat generated in the semiconductor junction(s) must be moved to the ambient. In the case of low-power devices, the natural heat conductive path between case and surrounding air is usually adequate for this purpose.

In the case of medium-power devices, however, heat conduction may have to be improved by the use of star – or flag-shaped heat dissipators which increase the heat radiating surface.

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}, whose value is given 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 being expressed in terms of an R_{thCA} value, i.e. the case ambient thermal resistance. The total thermal resistance, junction ambient is therefore:

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

The total maximum power dissipation, P_{totmax}, of a semiconductor device can be expressed as follows:

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

where:

T_{jmax} the maximum allowable junction temperature

T_{amb} the highest ambient temperature likely to be reached under the most unfavorable conditions

R_{thJC} the thermal resistance, junction case

R_{thJA} the thermal resistance, junction ambient

R_{thCA} the thermal resistance, case ambient, depends on cooling conditions. If a heat dissipator or sink is used, then R_{thCA} depends on the thermal contact between case and heat sink, heat propagation conditions in the sink and the rate at which heat is transferred to the surrounding air.

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

In the case of cooling plates as heat sinks, the approach outlines in figures 45 and 46 can be used as guidelines. The curves shown in both figures 45 and 46 give the thermal resistance R_{thCA} of square plates of aluminium with edge length, a, and with different thicknesses. The case of the device should be mounted directly onto the cooling plate.

The edge length, α, derived from figures 45 and 46 in order to obtain a given R_{thCA} value, must be multiplied with α and β:

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

where

$\alpha = 1.00$ for vertical arrangement

$\alpha = 1.15$ for horizontal arrangement

$\beta = 1.00$ for bright surface

$\beta = 0.85$ for dull black surface

Example

For an IR emitter with $T_{jmax} = 100°C$ and $R_{thJC} = 100$ K/W, calculate the edge length for a 2 mm thick aluminium square sheet having a dull black surface ($\beta = 0.85$) and vertical arrangement ($\alpha = 1$), $T_{amb} = 70°C$ and $P_{tot\ max} = 200$ mW.

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

$$R_{thCA} = \frac{T_{jmax} - T_{amb}}{P_{tot\ max}} - R_{thJC}$$

$$R_{thCA} = \frac{100°C - 70°C}{0.2\ W} - 100\ K/W$$

$$R_{thCA} = \frac{30}{0.2} - 100\ K/W$$

$$R_{thCA} = 50\ K/W$$

$$\Delta T = T_{case} - T_{amb}$$

can be calculated from the relationship :

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

$$\Delta T = T_{case} - T_{amb} = \frac{R_{thCA} \times (T_{jmax} - T_{amb})}{R_{thJC} + R_{thCA}}$$

$$\Delta T = \frac{50\ K/W \times\ (100°C - 70°C)}{100\ K/W + 50\ K/W}$$

$$\Delta T = \frac{50\ K/W \times\ 30°C}{150\ K/W}$$

$$\Delta T = 10°C = 10\ K$$

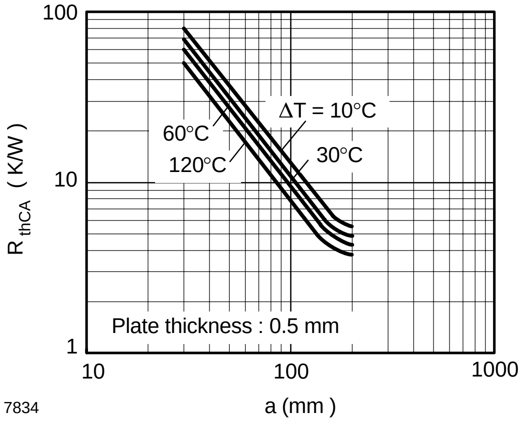

Figure 45.

With R_{thCA} = 50 k/W and ΔT = 10°C, a plate of 2 mm thickness has an edge length α = 28 mm.

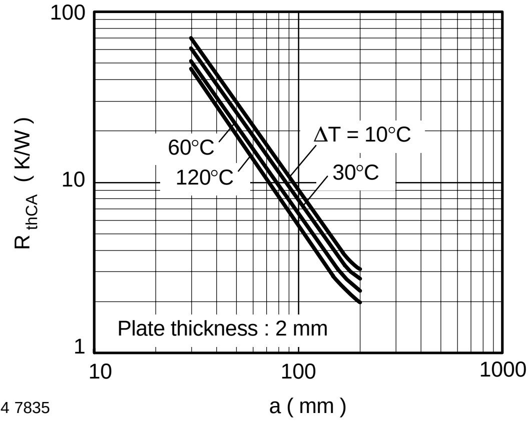

Figure 46.

However, equipment life and reliability have to be taken into consideration and therefore a larger sink would normally be used to avoid operating the devices continuously at their maximum permissible junction temperature.

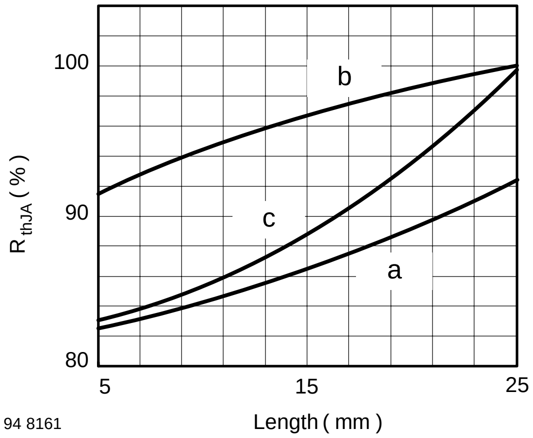

Figure 47. Thermal resistance junction/ambient vs. lead length

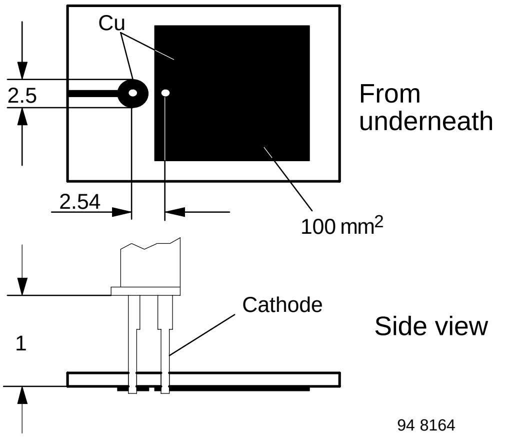

Figure 48. In the case of assembly on PC board with heatsink (curve a, figure 47)

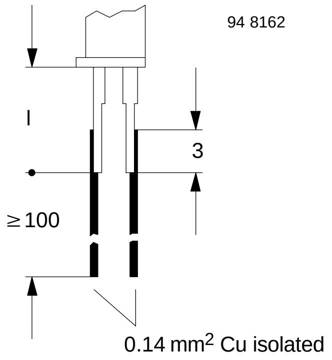

Figure 49. In the case of wire contacts (curve b, figure 47)

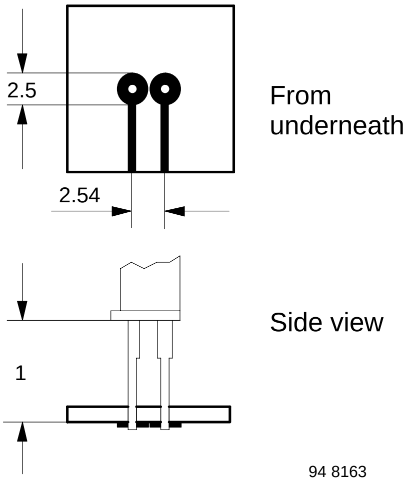

Figure 50. In the case of assembly on PC board, no heatsink (curve c, figure 47)