Soldering of EconoPACK™ , EconoPIM™ , EconoBRIDGE™, EconoPACK™+, EconoDUAL™, EasyPACK and EasyPIM™ - Modules

Soldering with alloys containing lead (SnPb) is the standard connection technology for the general electrical and electronics industry until today.
The soldering processes have been acquired, developed and improved over decades.
This means: All components used, such as devices, circuit boards and aiding materials are tuned for plumbiferous soldering.

Soldering is differentiated between soft and hard soldering. In soft soldering maximum operating temperatures of approximately 450°C are applied. For hard soldering the operating temperature is above this value.
The solder is usually an alloy of two or more metals and it joins metals under the influence of the applied temperature. The temperature melts the solder, however, not the metals to be joined.
A good solder has the following properties: The solder should easily flow onto the metals at the given temperatures, should wet the metal and join with the metal surface to form an alloy with it.
Rigidity should be as great as possible without becoming brittle.

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Solder process

The common soldering is a way to join electrically conducting metals. In the most simple and conventional soldering process one requires a soldering iron, solder and flux. Flux is applied to the metals to be joined, the soldering iron heats up the parts to be soldered, the solder is applied and thus the soldering is achieved.
(Fig a)

In an optimised process the metals to be joined are heated up with the soldering iron. The improved hollow solder with a flux core is applied to the point of contact. The melting point of the solder is around 180°C to 200°C. Resin and colophony are used as flux in these cored solders. The purpose of the flux is to dissolve oxides and to prevent further oxidisation during the solder process.

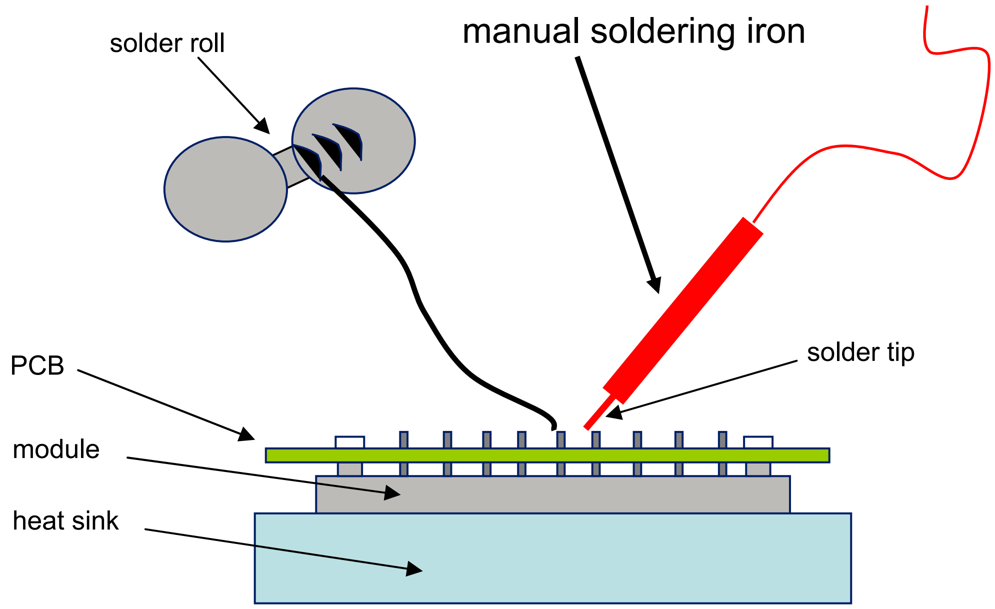

Fig a) manual soldering

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There are different solder processes used in industry.

1. Radiation soldering with the use of infrared heaters (Fig b)
2. Convection soldering using hot gas
3. Condensation soldering in a steam phase

These three concepts are melting processes and are referred to as reflow soldering.
To reflow solder the solder mixed with flux is applied to the points of connection. Once the melting temperature of the solder used is exceeded, the connection points are wetted with the aid of the flux.

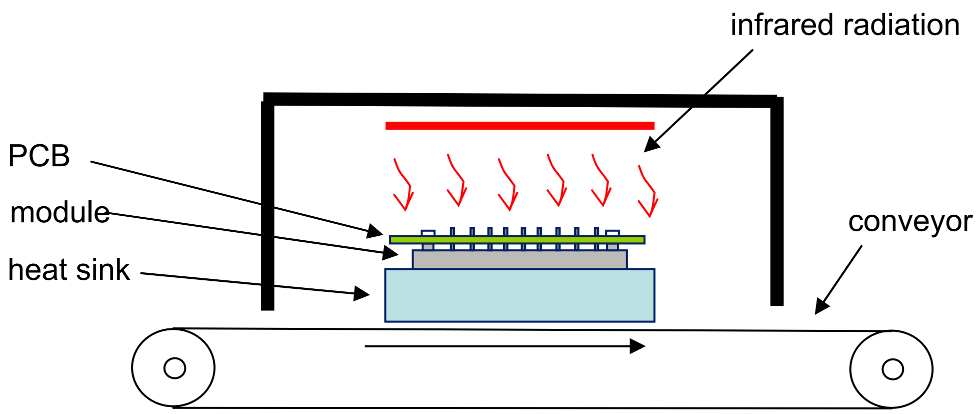

Fig b) radiation soldering using infrared heater

The most common solder process used is the wave soldering
In wave soldering first dissolved flux is applied, then the solvent is evaporated and the preheating started. After this process the points of contact are driven over a pumped up standing wave. (Fig c)

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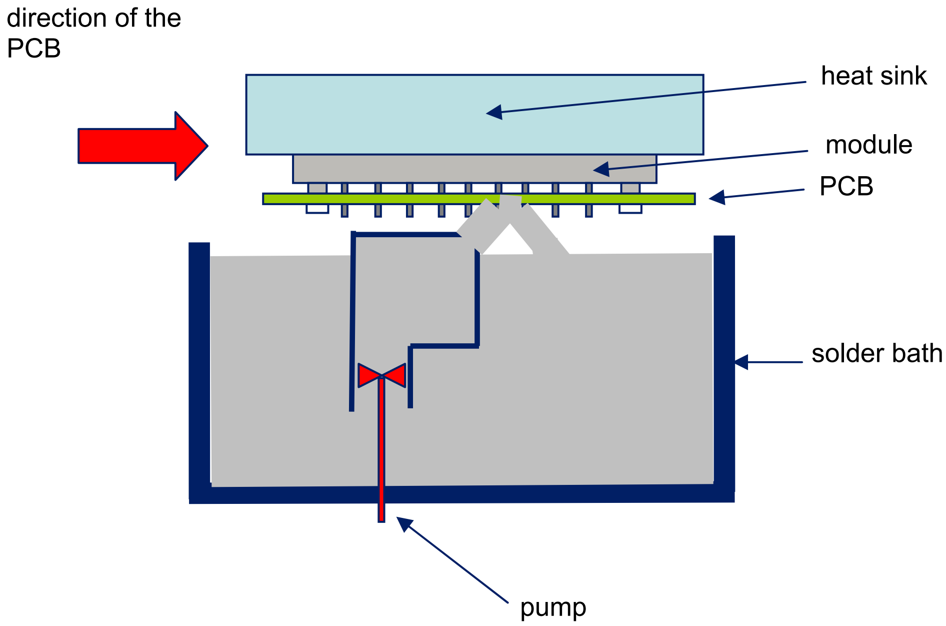

Fig c) concept of wave soldering

Reflow and wave soldering are mass solder processes. The operating temperature for soldering electronic assemblies is approximately between 200°C and 260°C, (depending on the heat sensitivity of the components used).

A further process is selective soldering. In this solder process the connection points are locally brought up to temperature, aided by robotics, without coming into contact with other possibly heat sensitive components.
This selective solder process too is based on melting onto the contact. Here too the operation involves solder paste, solder wire or a solder bath.

Selective soldering is hence separated into:

- automatised soldering iron
  The heat is applied by a solder tip (soldering iron) to the connection point, where solder and flux (flux cored solder wire) is then fed to. (Fig d)
  According to need the contact point can be pre-heated.

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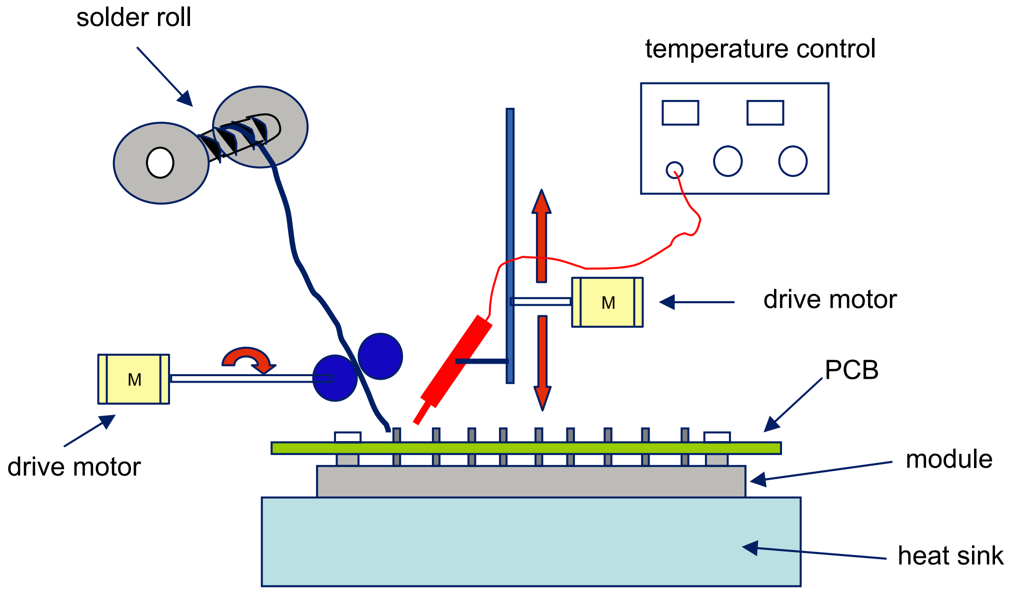

Fig d) concept of automatised iron soldering

- Use of pointed wave
  With this concept the already molten solder is applied to the connection point. Here dedicated points are aimed at, where metallic contacts are still to be bonded. (Fig e)

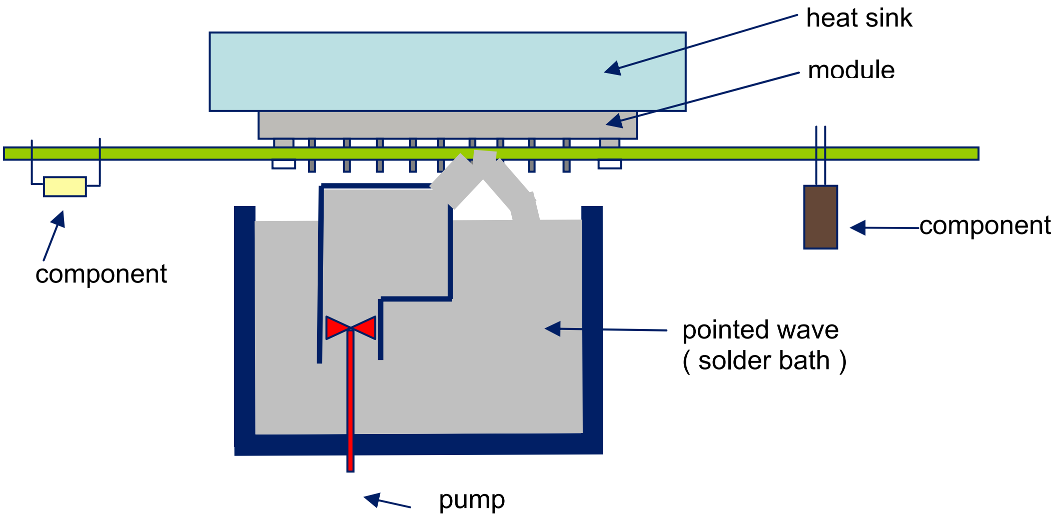

Fig e) concept of a pointed or mini wave

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- Laser soldering
  With this the soldering heat is brought to the contact points using a CO_2 laser or diode laser. Solder and flux can be applied as paste before the solder process. (Fig f)

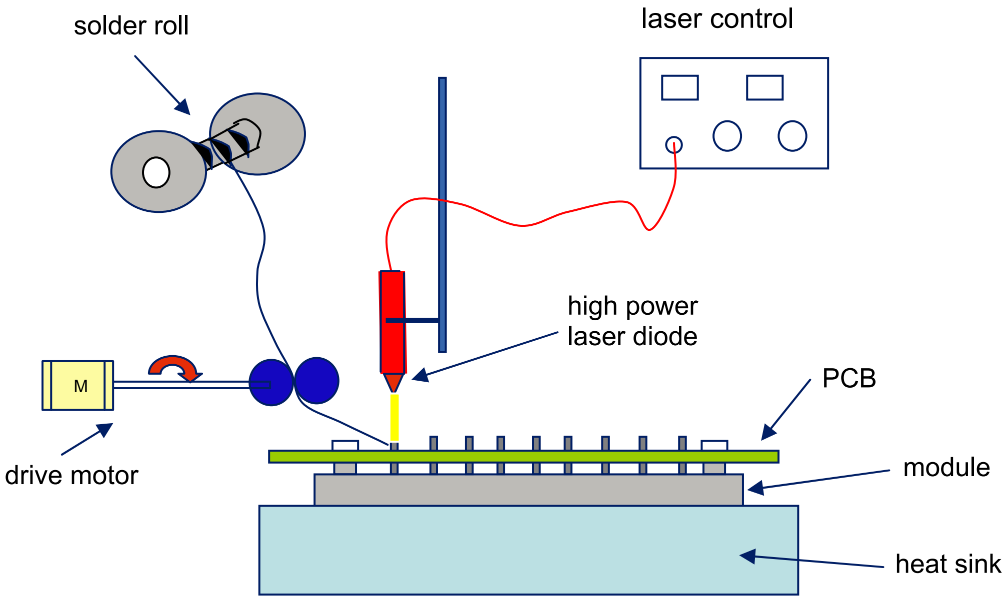

Fig f) concept of a laser soldering set-up with a high power diode

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- Dip soldering

When dip soldering the points of contact are submerged into the molten and temperate solder. Fig g)

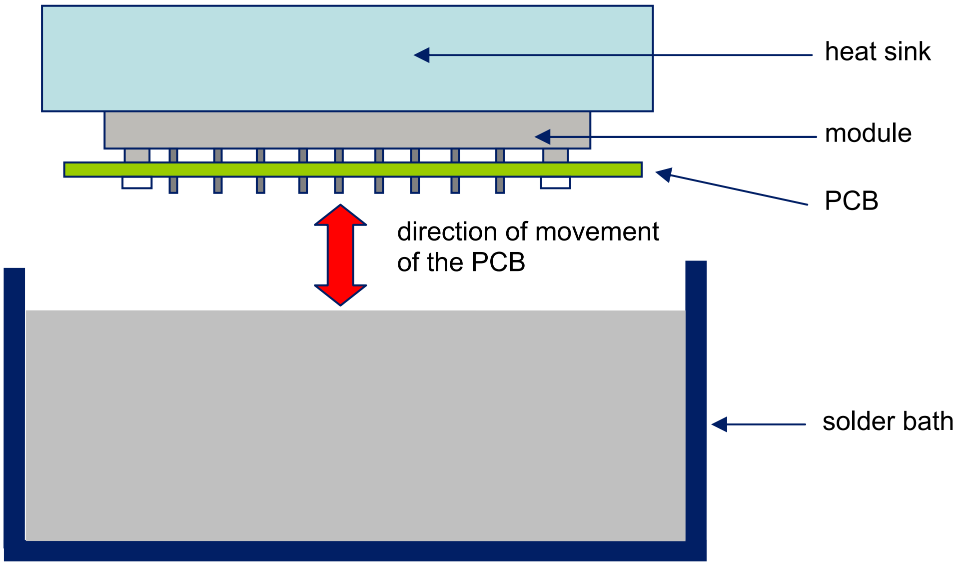

Fig g) concept of dip soldering

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Solder temperature

The international Standard IEC 68 Section 2 (260°C <= 10s) is to be observed with all these soldering examples. This specifies a soldering temperature of 260°C and a solder time of 10s max. for the module. During the described soldering process the maximum permissible case temperature of 223°C must not be exceeded.

To assure and control the quality of the solder joint the following techniques may be used:

- Visual inspection by the operator
- automatic optical inspection by an inspection system which scans images of the assembly and evaluates them.
- X-ray inspection

Evaluation of good or faulty solder joints can only be made through the build-up of the joint (bulge or reflection), with x-ray inspection via the spatial distribution of the solder.
The build-up of the joint and hence its evaluation depends mostly on the properties of the solder on the adjoining surfaces. (Distribution of the solder, wetting and surface oxidisation).

When repairing by manually soldering, de-solder wick, suction pump and de-soldering iron may be used.

When using de-solder wick the solder and the wick are heated. The capillary action of the wick sucks up the solder.
The disadvantage of this process is that de-solder wick can only be used once and is expensive too.

A more cost effective and widely used solution to de-solder is the use of suction pumps. The de-soldering suction pump sucks up the heated and molten solder by means of a vacuum. (Fig h)

Another improved version is the de-soldering iron. This is a combination of soldering iron and suction pump. Here the soldering iron is equipped with a hollow canal in the tip. The hollow tip is placed onto the solder to be removed. Once the

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solder is molten, it is sucked up into a storage compartment by a motorised pump.

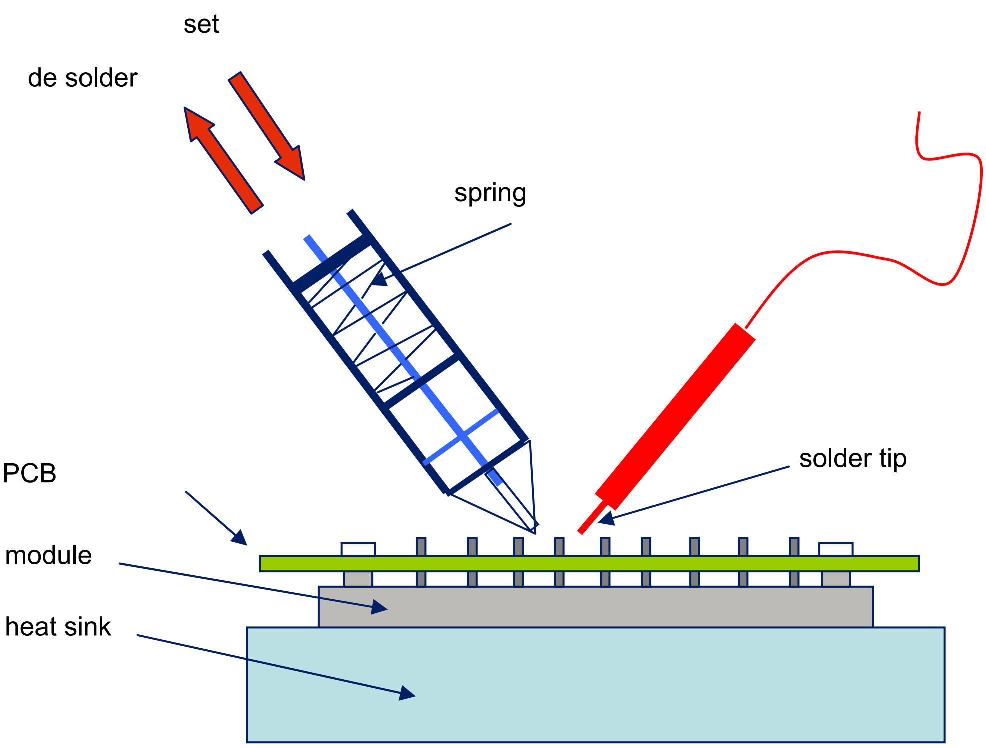

Fig h) concept of a soldering suction pump

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Leadfree soldering

For some time now leadfree soldering gains in importance as a connection technique. The EU-Directive 2002/95/EG requires that from 1 July 2006 onward electric and electronic equipment newly released in the market may not contain lead, mercury, cadmium, hexavalent chromium, polybromide biphenyl (PBB) or polybromide diphenyl ether (PBDE).
At this time there is no total substitute for plumbiferous soft solder. No known alternative alloy fulfils all requirements with regard to melting point, cost, processability and reliability.
Leadfree alternatives to special solders, as they are used for example inside components to mount the chips, are not known.
It demonstrates that the process windows are becoming much narrower and exact consistency is the parameter to the key factor in successfully introducing leadfree solder techniques.
As far as technically possible existing plants can be adapted or reconstructed. Inquiries regarding this should be made to the manufacturer of the soldering machine.
Another important step is that the circuit board manufacturers produce epoxy FR4 PCBs with halogen-free base materials suitable to the process (with the necessary Tg-values)
As mentioned, there is no substitution alloy for plumbiferous solders which fulfils all technical requirements given the same peripheral conditions.
In the USA the committees involved recommend for reflow soldering SnAg3.9Cu0.6 alloys and for wave soldering SnCu0.7 alloys. The European committee advocates the use of SnAg3.8Cu0.7 for reflow soldering and SnAg3.8Cu0.7Sb0.25 for wave soldering. In Japan it is recommended to use of SnAg alloys such as SnAg3.0Cu0.5 for reflow soldering and SnCu alloys such as SnAg3.0Cu0.5 for wave soldering.
This listing shows that currently alloys of the SnAgCu family are considered the best option worldwide.

Generally the soldering temperature impacts on the selection of the flux, the setting of the pre-heat profile, oxidisation behaviour and of course the selection of suitable SMD components. When increasing the process temperature note has to be taken of the specification of the components regarding the maximum permissible heat gradients and the maximum temperature. The maximum temperature limit of the flux should not be exceeded either. The aim should therefore

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be to keep the solder temperature as low as possible. In leadfree solder processes, however, one will usually encounter higher solder temperatures.

Plumbiferous solders had been used at temperatures around 210°C in the past, lead free solders have to be processed with a minimal temperature of 245°C to achieve decent soldering results.

During the course of 2005 eupec will realise pins with leadfree surfaces for all modules with solder contacts.

The modules with these leadfree tinned pins (base nickel-plated) were tested according to the specification IEC 68-2-20 with a positive result. As mentioned this specification defines test conditions with a solder temperature of 260°C and process time of 10s. Further, tests have shown that alternatively solder temperatures up to 280°C and a process time of 5s are also permissible. Given these maximum conditions the case temperature of 223°C may not be exceeded.

Repair

To repair a leadfree solder joint a greater use of energy is required when compared to a plumbiferous joint given the same conditions.
This applies to all solder processes regardless if solder wire or solder paste is used.
The heat transfer to the solder joint is always the critical factor when de-soldering. Most important is to create an optimal contact region for the heat transfer by using a tip appropriate to a solder job.
The energy requirement for heating up is difficult to estimate as the energy flow from the tip to the solder joint is hard to determine.
The required heat to be supplied is influenced by the joint itself which dissipated heat to its surround. The gauge and the number of the circuit board tracks as well as the metallisation especially for multi-layer boards are important factors of influence.

Once the solder is molten is may be removed from the joint with a pump.
This procedure has to be carried out on all pins.

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Once the module is no longer mechanically connected to the PCB, it may easily be removed from the contact holes.
When a new module is inserted into the same PCB it is quite logical to use the same solder for the process with which the previous module was soldered in before.

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