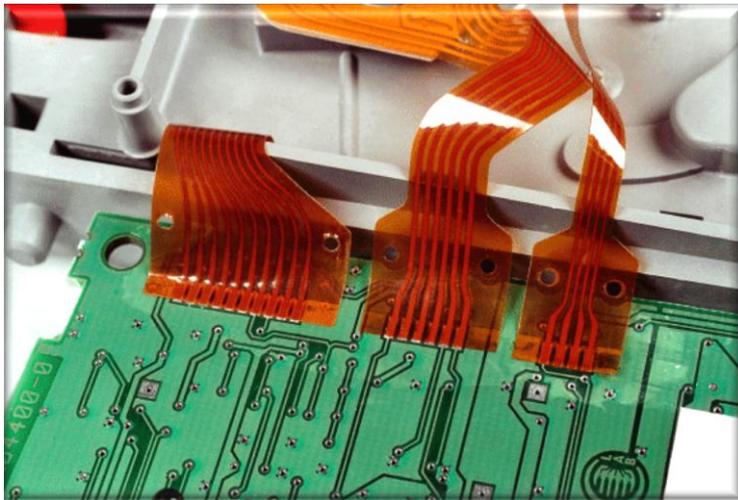


Hot Bar Reflow Soldering Fundamentals

Comprehensive Manufacturer of Metalworking Machinery

A high quality Selective Soldering Technology



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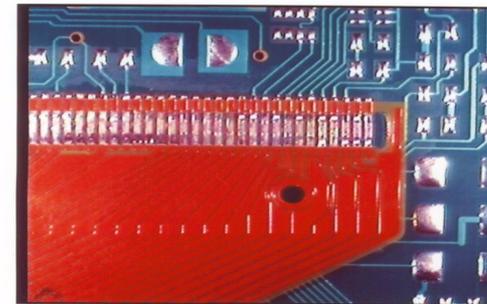
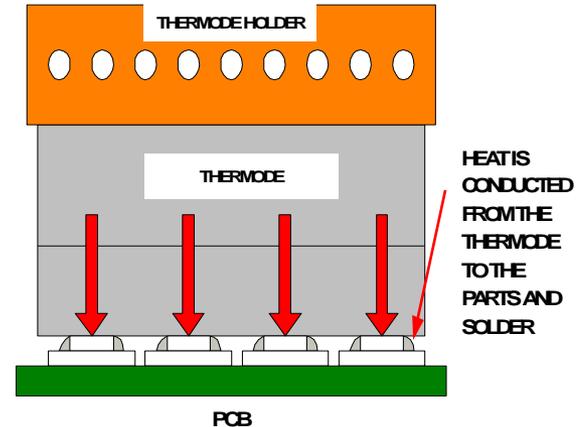
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What is Hot Bar Reflow Soldering?

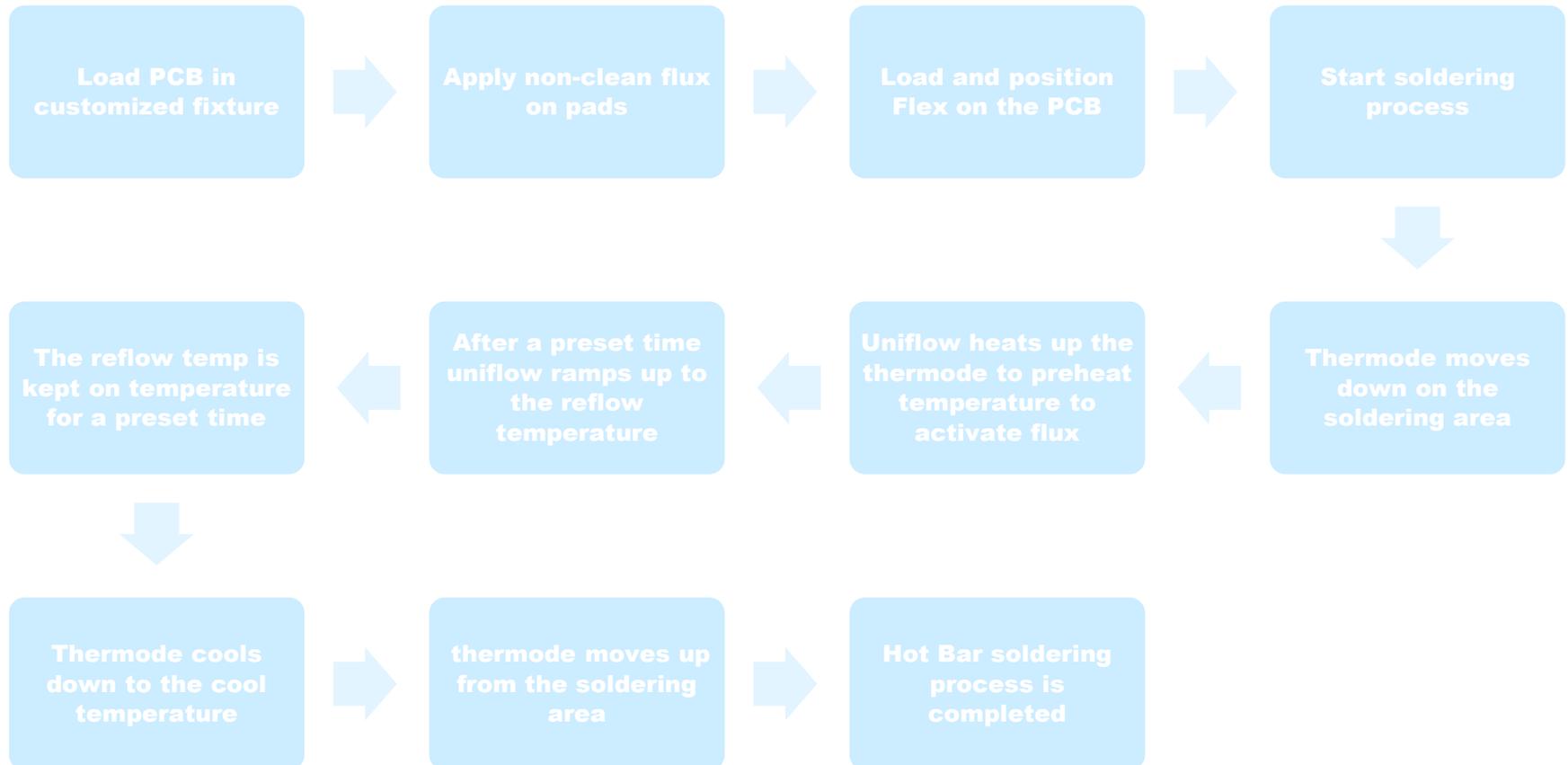
Pulsed heat Thermode (Hot Bar) soldering, is a joining technology where two pre-tinned parts are heated to the melting point of the tin. The joining technology results in a permanent electro mechanical joint.

The required process energy is supplied by a thermode, also know as a Hot Bar. This thermode is pressed on the upper part to transfer the thermal energy to both parts.

Closed loop process control is used to control the time-temperature profile .



How does it work?



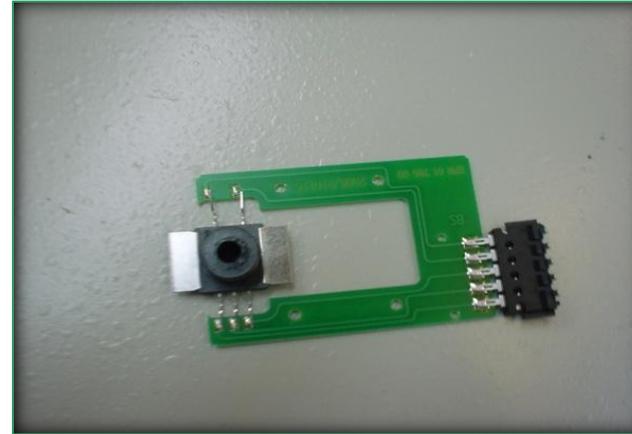
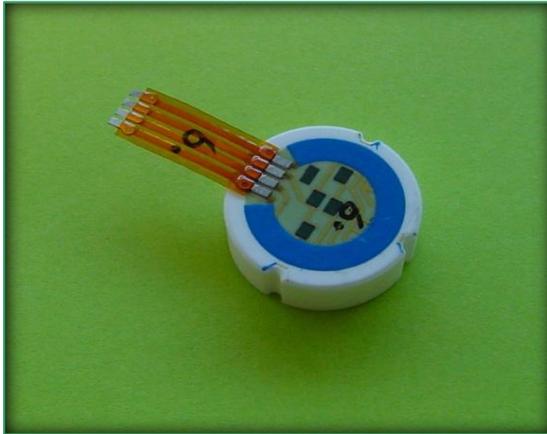
The benefits of Hot Bar Reflow Soldering

HBR Introduction

- Suitable for mass production
- Reliable processing, always equal process conditions
- Cost effective due to the fact that no third component is needed to connect flex/wire to the PCB/substrate (connector or ACA can be avoided)
- Multiple connections to be made simultaneously. Number of leads depend on product, pitch, design.
- Fast temperature ramp-up and cool-down
- Closed loop temperature and process control.
- Very accurate positioning of the parts

Hot Bar Reflow Soldering Applications

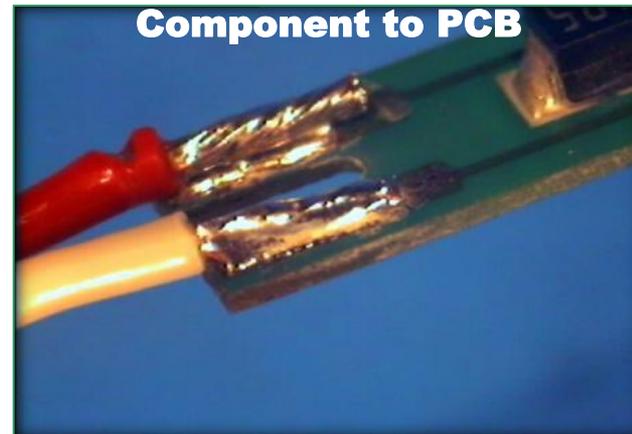
Application Range



Flex to Ceramic

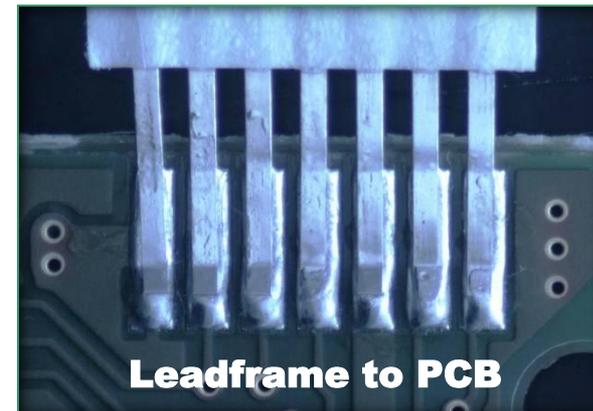
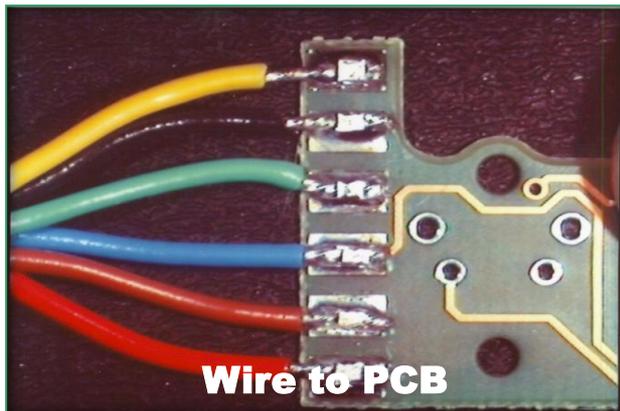
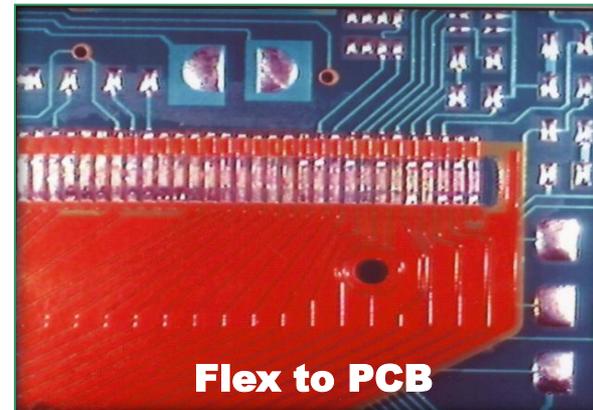
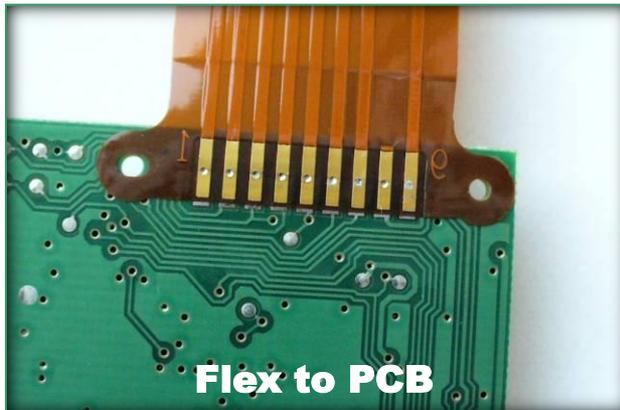


Component to PCB



Hot Bar Reflow Soldering Applications

Application Range

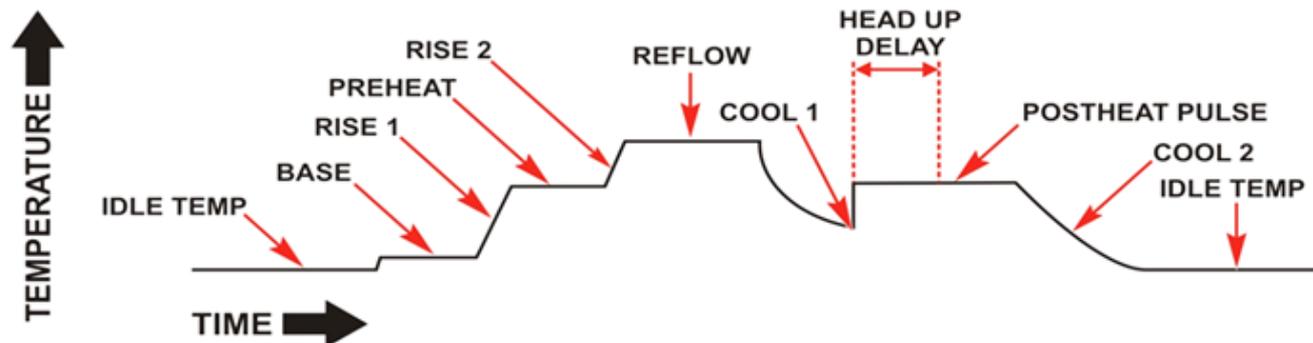


Process Description: Preparation

In preparation for the Hot Bar Reflow soldering process, the following preparation steps need to be taken:

1. The base substrate is located in a fixture, and flux is applied to the pads.
2. The flex is positioned in the parts fixture, ensuring alignment of both sets of pads.
3. A process start signal is given to the soldering control unit.

More info about the parts, the fixtures and the fluxing can be found further in this article. The Hot Bar Reflow Soldering process itself consists of the following process steps: heating up, reflow and cooling down. These process steps are described in the next sheets.



Process Description: Contacting

The Hot Bar or thermode is mounted to a bonding head by means of a quick connect block. The bonding head has an accurate and stable linear guidance for the thermode. Movement is done with a pneumatic cylinder or an electrical motor. An internal spring system generated an accurate force. Most reflow joints of this nature require fewer than 100 Newton pressure. Force should be calibrated and set to the correct level to achieve the right transfer of thermal energy to the solder joint. The bonding head should have an accurate coplanarity adjustment to set the flatness of the thermode to the product accurately. These heads are modular in construction and therefore versatile for integration.

After the start signal is given, the thermode is gently lowered until it seats on the product. The head senses this. Force is build up until the preset force is reached. When the right force is reached, a signal is passed to the power supply, which starts heating up the Hot Bar.

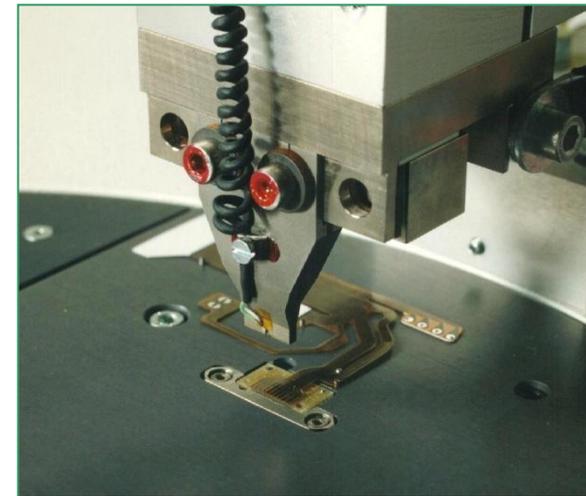


Process Description: Heating up

By now, the Hot Bar holds down the product with the preset force. The Hot Bar is at “room temperature”. The solder control unit, also called “SCU” or “power supply” has received the start signal for the soldering process.

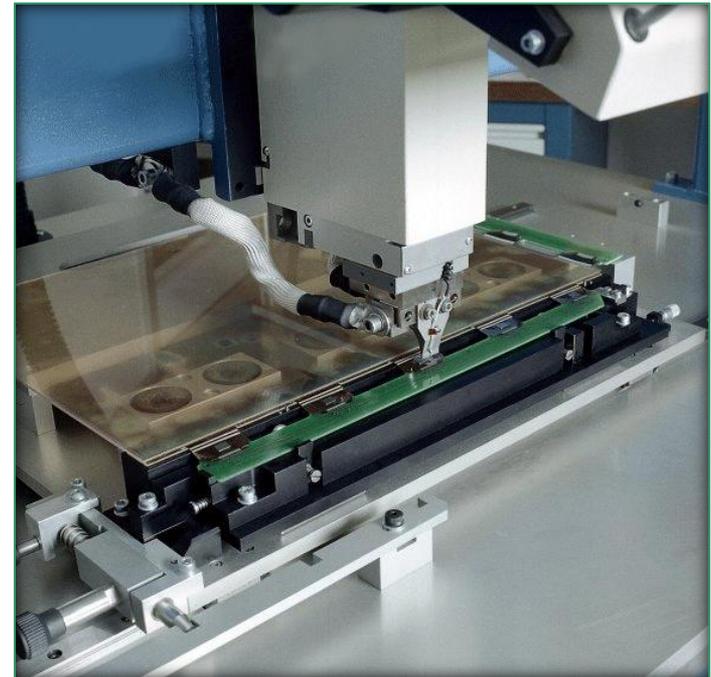
The SCU sends current through the Hot Bar. The Hot Bar is designed so that the electrical resistance is highest at the bottom (where it touches the product). Heat is generated because of the combination of current and electrical resistance. A small thermocouple is welded on the front of the Hot Bar. This thermocouple feeds back the actual Hot Bar temperature to the SCU. This makes a complete closed-loop regulation for the temperature-time cycle.

Normal rise time for most thermodes is 1.5 to 2 seconds, equaling a heating rate of about 200 degrees Celsius a second. The newest generation of solder control unit is controlling the temperature all the way through the heating up phase. When the “REFLOW temperature” is nearly reached the solder control unit needs to slow down the heating rate to prevent a temperature overshoot. A good solder control unit and Hot Bar combination will compensate for all differences in heat-loads that can occur during normal production circumstances.



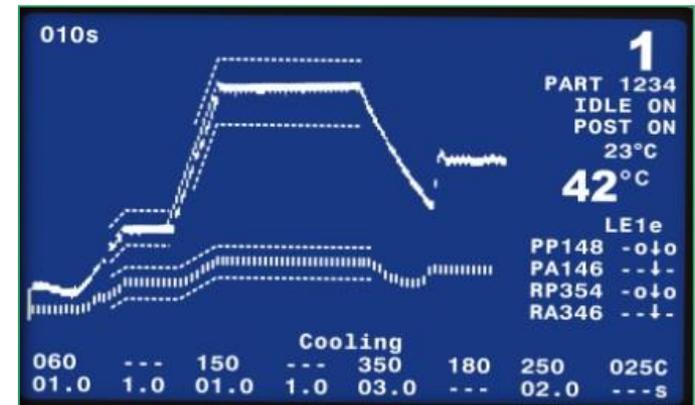
Process Description: Reflow

During the reflow period the flux is activated, the flux cleans the surfaces and the solder is heated until it starts melting on all pads. This normally takes 3-8 seconds, at Hot Bar temperatures around 300° C (Hot Bar touches the leads), 400° C (Hot Bar touches kapton) or 500° C (ceramics and MC-PCB soldering). Although normal solder will melt at 180° C, ideal solder temperature is above 220° C to get a good flowing and wetting behavior but below 280° C to prevent burning of the solder. The Hot Bar must be set higher due to the thermal transfer losses. Ideally, time can be programmed on the SCU in 0.1-sec. increments and temperature in one-degree increments. Use the minimum time and temperature to achieve the desired joint to minimize the parts exposure to heat and chance of damage.



Process Description: Cooling

When the solder is connected on all pads, the energy delivery to the Hot Bar can be stopped. The Hot Bar will start cooling down. The cooling process can be shortened by the use of forced air-cooling. The SCU can switch a relay that controls the flow of air at the end of the reflow period and cool the joint and Hot Bar rapidly. For optimum process control, cooling is done to a specific temperature. This temperature is set below the solder solidification temperature. Therefore, as soon as the solder becomes solid, the process is ended and a joint is formed. Because most connections have a relatively high heat sink, the temperature in the solder is lower than the measured Hot Bar temperature, even when using forced air-cooling. Therefore, the release temperature can be set to 180°C in most cases without the chance of releasing the parts before solidification has taken place.



Process Description: Quality Control

Quality control before starting the process is done by:

- The Amada Miyachi Europe force measurement kit, which contains a precision load-cell with a large contact area to support the Thermo-plane Thermode and a control panel including a readout display.
- The Amada Miyachi Europe pressure sensitive paper, especially designed to optimize the planarity of the Thermo-plane Thermode in combination with the product. Putting it in between thermode and product support will result in an accurate readout of planarity.
- Knowing and understanding the temperature during all the different Hot Bar processes inside the materials is essential for optimal results. The easy-to-use handheld temperature meter can be used in combination with ultra flat thermocouples. The thermocouple can be sandwiched between the parts, and the actual process temperature can be measured inside the connection. The thermocouple is re-usable.



Quality control during the entire process cycle

The new Premium Hot Bar Monitoring system combines MIYACHI EAPRO Hot Bar know-how with MIYACHI PECO technical expertise all in one unit. The MG3 Hot Bar measures force, temperature, time and displacement, allowing for continuous control throughout the **entire process cycle**. The compact and flexible system features high quality Hot Bar connections and high throughput, all within an easily adjustable frame construction.



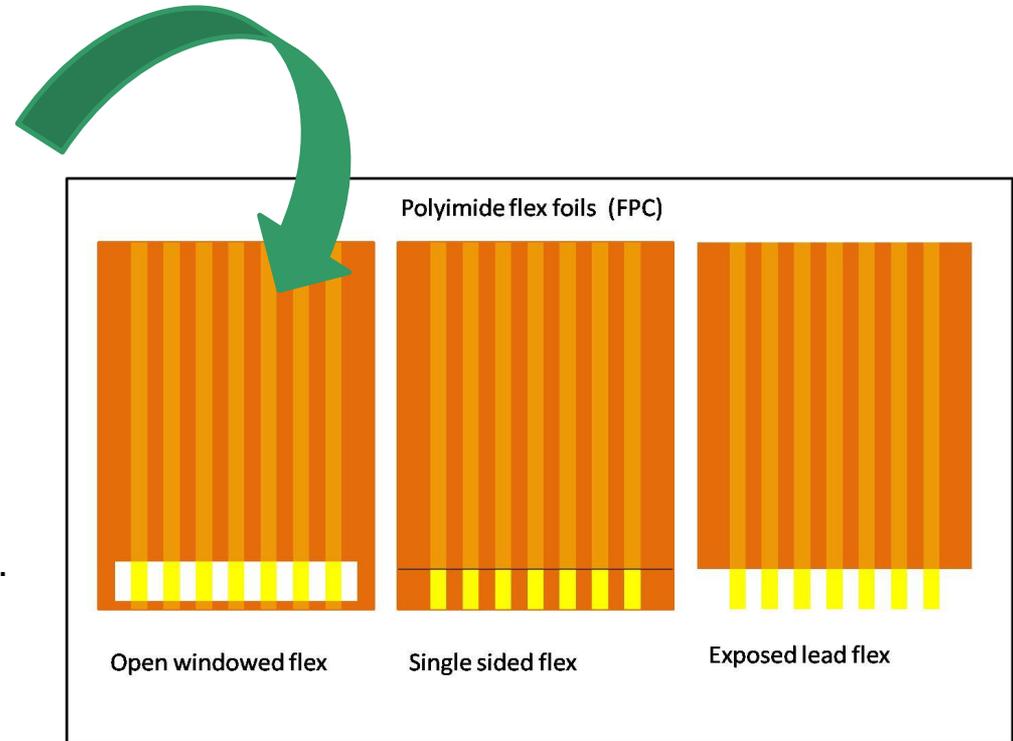
Quality control after the bonding cycle

Using the MG3 for Hot Bar, featuring full on screen (SPC) statistic process control.

Open windowed flex design:

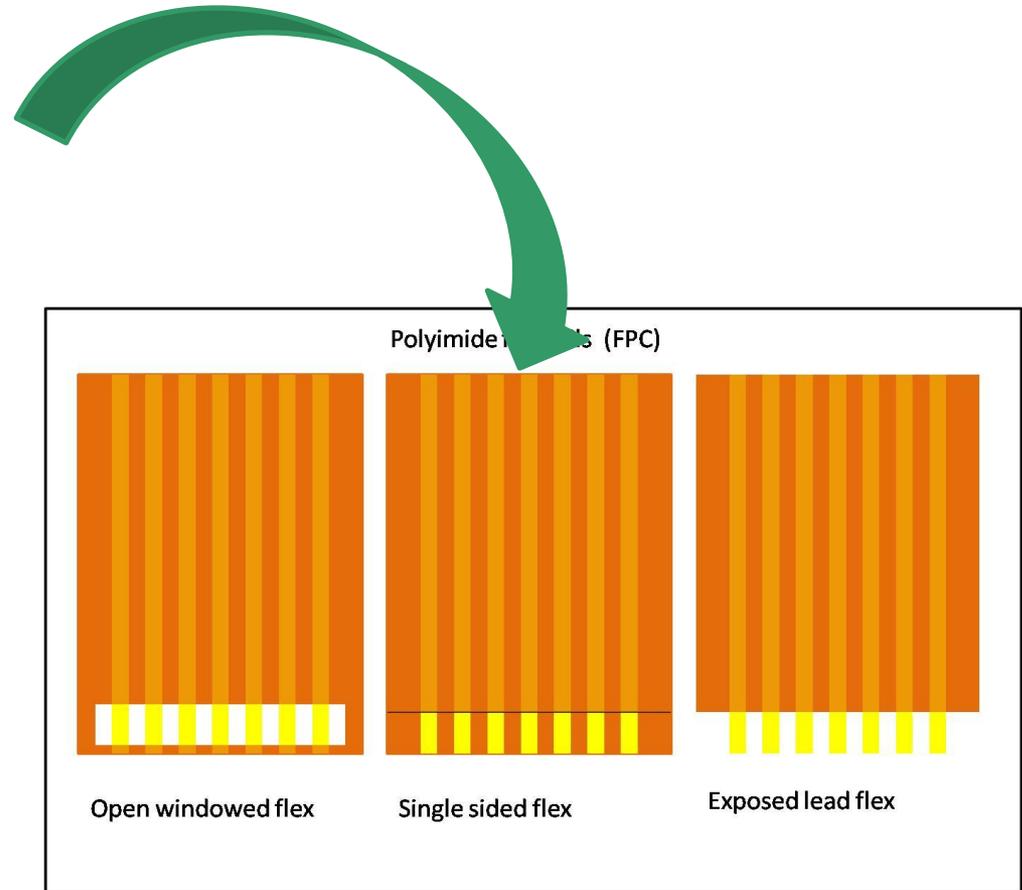
This design has both sides of the polyimide material removed from the joint area but has support from the remaining polyimide material on the sides and also along the end of the traces. This design gives some strength to the assembly and is resilient to harsher handling.

As the traces are exposed, the thermal transfer to the parts is good and excess solder has extra space to flow. Thermode sizing is critical as it must fit into the window and allow space for the molten solder to flow. This design behaves similar to the exposed lead design.



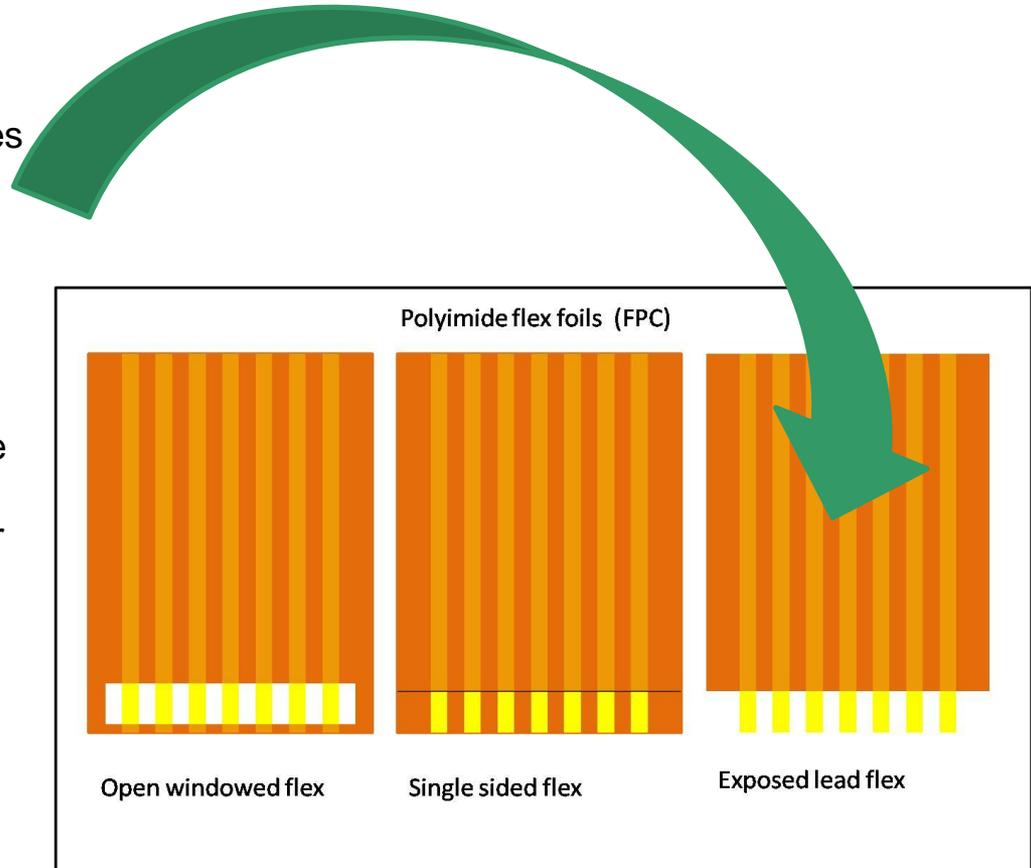
Single sided flex design:

This design has the polyimide removed on one side only. Heat is conducted from the Hot Bar through the solid polyimide surface to the exposed traces underneath. The polyimide conducts heat through the insulation to the exposed traces and pads on the PCB. The polyimide thickness in the joint area is limited to about 50 microns, enabling conduction. If the polyimide has to be heated past 400 - 425° C, burning of polyimide and Hot Bar contamination can result. This design is less tolerant of excess solder on the PCB pads because little room exists for excess to flow. The single-sided flex is most suitable for small pitches. Pitches as small as 200 micron, arranged in one or two rows, are possible.



Exposed lead flex design:

This design has both sides of the polyimide (kapton) material removed, leaving the traces free of insulation. The Hot Bar contacts the traces directly and conducts heat to the parts. If the PCB pads and Hot Bar footprint are sized correctly, this design will be most tolerant to excess solder on the pads, as solder may flow into open areas. During the process, solder will also wet to the top of the trace. Caution must be exercised in part handling as the traces may be easily bent or damaged. Because of the direct Hot Bar to lead contact, this design will have low Hot Bar temperatures and short process times. The Hot Bar will pollute with flux residues, and will require cleaning. A kapton feeder module (see the section on equipment) will solve these objections.

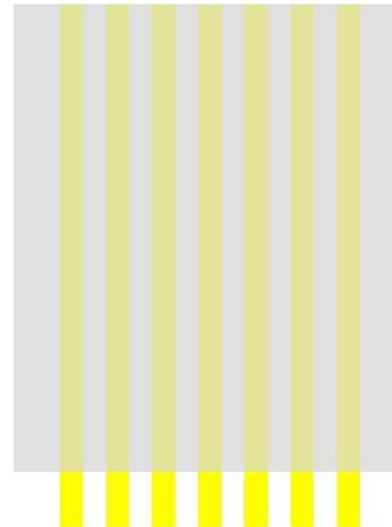


Polyimide flex types

Polyester based flex foils (FFC)



Flex with polyimide stiffener



Exposed lead flex

Wire and PCB design: Connection Type

For Wire-PCB soldering up to thermode length of 40 mm

PCB track design recommendations:

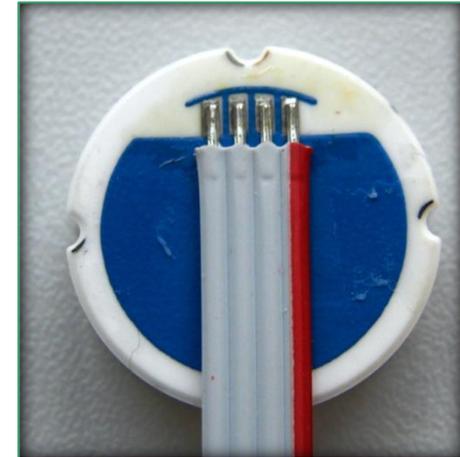
- PCB track width: > 150% of wire-diameter
- PCB track length:>3mm
- Minimum pitch (centre-centre track): 0.8mm
- Minimum spacing between tracks: 0.4mm

Wire recommendations

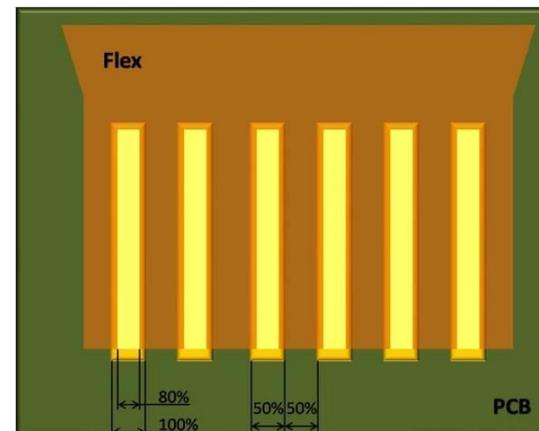
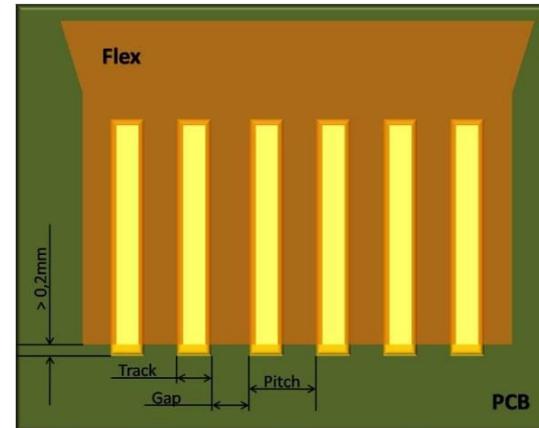
- Wire stripped length minimum: PCB track length

Pre-tinning of parts

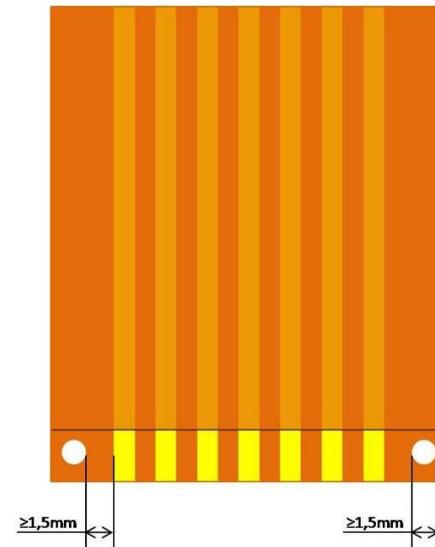
- Estimated pre-tinning height on the PCB tracks: 50-80 micron (each reflow of solder paste)
- Each individual wire in the cable must be pre-tinned to enable a solid wire prior to the solder process



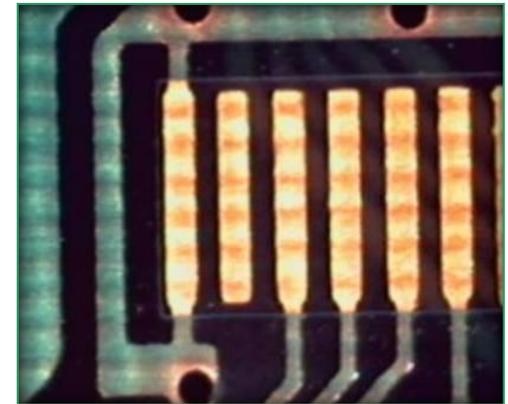
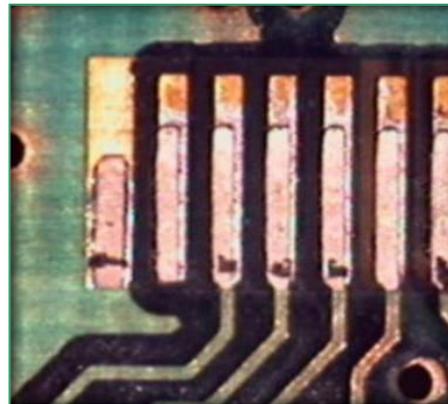
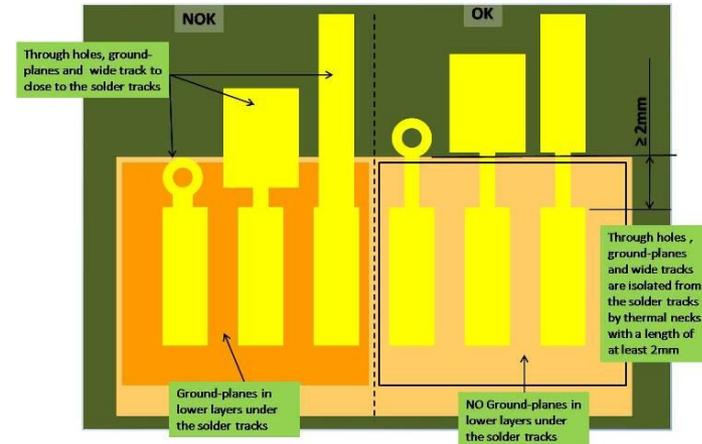
- Track and gap of PCB should be both 50% of the pitch
- Track of the flex should be 80% of the track of the PCB
 - this allows excessive solder to flow
- Flex tracks should be approx. 0,2 mm shorter than PCB tracks
 - Visual inspection possible
 - Easy alignment check
 - Allow excessive solder to flow



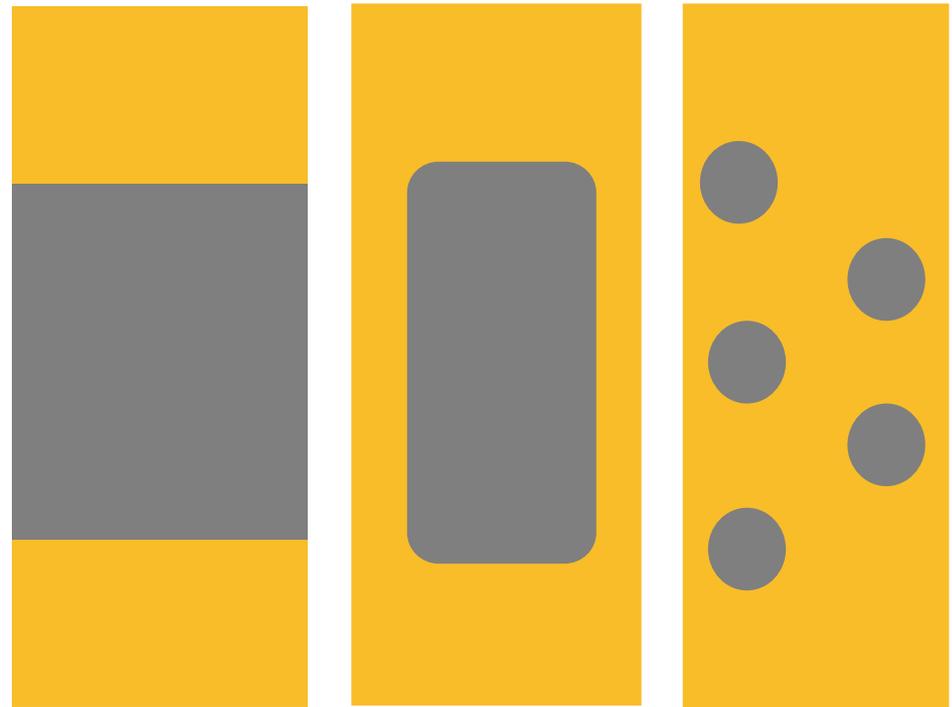
- Thickness of polyimide in solder area should be as thin as possible
- Recommended diameter for locating pins should be at least 1,5 mm
- Locating pins should have a minimum distance of 1,5 mm from the outside tracks



- Ground planes and through holes should be isolated from the tracks with thermal necks with a length of 2 mm and a width as small as possible
- Ground planes in layers below the soldering area should be minimized in size and mass



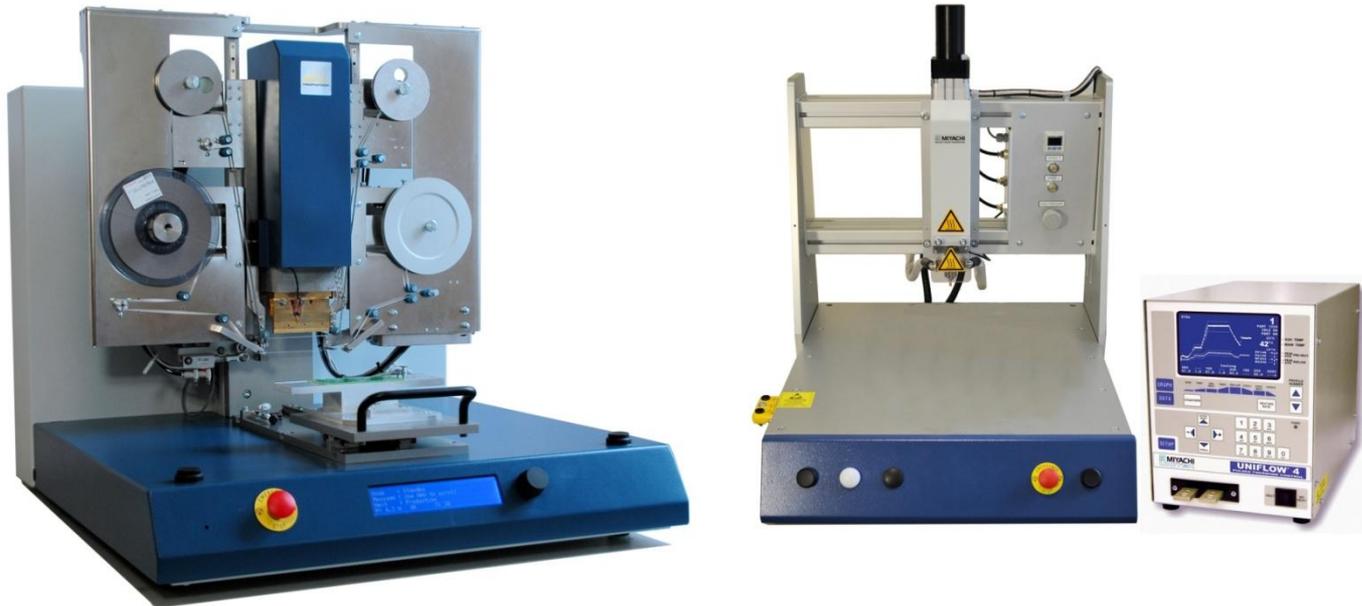
- Solder must be pre-tinned on PCB prior to Hot Bar process
- Start point for screen printing is a 150 microns thick stencil with a mask opening that results in a 40% pad coverage.
(After reflow oven approx 40 % of the solder paste remains)
- For small pitch applications it is recommended to pre-tin the parts by electro plating as being the most accurate technology.



MIYACHI EAPRO Reflow Soldering Desktop Systems

Hot Bar Reflow Soldering Equipment

The Miyachi EAPRO Desktop Systems are a line of (semi-) automatic systems developed for Hot bar Soldering, Heat-Seal Bonding and ACF Laminating. The Desktop Series deliver the same high bonding quality as the larger and more automated systems. For all production environments where labor costs are conservative, it offers an ideal price-performance (throughput) ratio. The system flexibility makes it also perfectly suitable for R&D environments and integration in larger systems.



MIYACHI EAPRO Reflow Soldering Standalone Systems

Hot Bar Reflow Soldering Equipment

Amada Miyachi Europe has a proven track record of systems completed successfully as fully or semi-automated units. Amada Miyachi Europe combines knowledge from our in-house design department with the expertise in our in-house application and research labs when screening the feasibility of your application.



Enjoy maximum process stability and excellent reproducibility with our reliable and proven Reflow Soldering systems. Typical examples are LCD repair systems, turntable systems for quality connections between PCBs, flex-foils, LCD's and other components and fully automated production lines.

MIYACHI EAPRO Reflow Soldering Modules

Hot Bar Reflow Soldering Equipment

MIYACHI EAPRO provides a range of Hot Bar Modules suitable for your specific application, such as Bonding Heads in different sizes and forces, adjustable Thermo-plane Thermodes, Interposer Modules, Calibration Tools and process monitoring tools. Contact our Sales Department for more information.



Hot Bar Reflow Soldering Troubleshooting Guide

Problem	Possible Causes	Possible Root Causes	Possible Solutions
Solder bridging	<p>Too much pressure on the lead</p> <p>Too much solder</p> <p>Isolation surface too wettable</p>	<p>Too much force</p> <p>Distribute pressure better over all joints</p> <p>Too much solder</p> <p>Not enough space for the solder</p> <p>Not enough separation room</p>	<p>Reduce force</p> <p>Improve flatness</p> <p>Improve Hot Bar alignment</p> <p>Reduce amount of solder</p> <p>Change position of solder</p> <p>Change shape of solder</p> <p>Reduce Hot Bar width</p> <p>Increase bevel Hot Bar</p> <p>Increase flexibility of flex</p> <p>Decrease pad width</p>
Solder balling	<p>Too much vapour pressure from flux</p> <p>Too much solder for the available space</p> <p>Too much vapour pressure from polutions</p>	<p>Flux not dry</p> <p>Too much flux</p> <p>Wrong flux</p> <p>Improve available space</p> <p>Reduce amount of solder</p> <p>Remove polutions</p>	<p>Longer time after flux dispensing</p> <p>Longer upslope</p> <p>Use flux activation stage</p> <p>Reduce amount of flux</p> <p>Change to different type of flux</p> <p>Increase pad width</p> <p>Increase pad length</p> <p>Reduce Hot Bar width</p> <p>Increase flexibility of flex</p> <p>Reduce amount of solder</p> <p>Change position of solder</p> <p>Change shape of solder</p> <p>Clean part before usage</p> <p>Avoid part polution</p>
Burning	<p>Too high temperature</p> <p>Wrong materials</p>	<p>Hot Bar too hot</p> <p>Not enough heat dissipation</p> <p>Material not temperature resistant</p>	<p>Lower Hot Bar temperature</p> <p>Increase width Hot Bar</p> <p>Redcuc process time</p> <p>Increase pressure</p> <p>Increase flatness</p> <p>Change materials</p> <p>Change to thinner materials</p>