

## THE LASER IN THE SELECTIVE SOLDERING

Several reasons urged in the last years the development and improvement of selective soldering systems with LASER technologies. On one side, the wide range of electronic equipments on the market combined with the miniaturization and integration of electronic components, on the other side, the restrictive environmental directives, concurred in the rapid growth of this field.

It is evident how it is more and more important the availability of punctual soldering systems, capable of reaching even the most critical points of the electronic circuits and the use of Lead-Free alloys which are less aggressive in order to complete the solderings on traditional type components without interfering with the adjacent components.

All the solutions allowing to prevent or reduce manual soldering available on the market today have both advantages and disadvantages; so it is important an accurate assess for which a comprehensive view of the manufacturing process is fundamental.

### Technology comparison

The selective soldering with use of LASER technology was born aiming to solve all the manufacturing problems come out in the years due to the traditional technologies.

The manual soldering, for example, despite of using not high working temperatures, is linked to the operator capability and experience and is, in the majority of cases, unprofitable.

The wave soldering both with masked carriers and mini-wave, requires restrictions in the board layout and considerable investments in design and production of pallets. Also the use of the glue point can not be applied to all the components and requires further manufacturing steps as the dispensation of glue and post-treatment

The use of pre-forms implies positioning and location problems.

The pin-in-paste allows reflowing at the same time both the PTH and SMD components but the difference and distribution of thermal masses on circuits may lead to different results in terms of quality for the different types of components.

The LASER selective soldering is hence a solution capable of meeting the requirements of mixed SMT and TH manufacturing in terms of quality, repeatability and flexibility.

A relevant and fundamental boost for the development of this technology came from the application of new and more performing laser sources.

### LASER Technology

The L.A.S.E.R. acronym for Light Amplification by Stimulated Emission of Radiation was invented in the beginning of the 60s. Even though the inventorship is doubtful, we can observe that the development of this technology did not stop and is now employed in different manufacturing sectors.

If compared to other light sources, the LASER radiation is featured by: directionality, monochromatic, brightness and coherence. The LASER source, in fact allows the emission of the radiation in a single direction, at a known and steady frequency and energy much higher if compared to the traditional sources.

The main features of a laser source are: the power, the wavelength, the type of irradiation and the optic used to transfer the beam.

Different arrangements of these parameters make the LASER suitable for different sectors as medical, electronics and industrial.

What made possible the integration between the LASER technology and the selective soldering was the improvement of some fundamental aspects in the soldering process.

The power control of the LASER source and the steadiness of the output power are essential to guarantee a steady and repeatable process.

The features of the power trend make the LASER source exploitable for the whole work range available. The use of optics developed for soldering present perfectly conic beams. This aspect is essential since it allows, by moving the optics, to be always focused on the solder joint and no oval beams. Optics on purpose present the peculiarity of very concentrated and uniform spots. The uniformity of the light radiation must not be underestimated to transfer the appropriate amount of energy on the solder joint. Optics not correctly collimated or bad located, may output an irregular spot and not right focused on the whole area.

The performances described above come from years of research and development and allow today increasingly performing LASER selective soldering systems.

The use of LASER technology for selective soldering grants a punctual heating, thus preventing from high thermal stresses and solder the more sensitive components at high temperatures. The transfer of heat and energy through a Laser beam completely eliminates mechanical contact, the components do not require to be fixed and also usury and maintenance of the parts involved are considerably decreased. The use of very thin beams allows the soldering in small spaces and also the fine pitch components. The availability of motorized optics optimizes the heat surface for each solder joint. Besides, the restrained electric consumption of these systems combined with the absolute lack of warm-up times must be taken into account.

### **Parameters of process**

Several variables interfere with the laser selective soldering process – as for other technologies- such as the pad geometry or the size of the crown which can affect the formation of the solder joint. In particular, the ratio between the crown size and the through hole are important.

If the ratio is not optimal, e.g. the hole is too big or too small with regard to the pin diameter, problems in the reflow of tin on components side may occur.

If the pin is either too long or too short, problems of poor adherence may occur both on the pin and pad. In addition to the physical and geometrical variables of the printed circuits and components it is necessary to take into account the soldering parameters applied during the process. The thermal profile control, combined to each joint allows the optimization of the soldering parameters in those instances where the pads are connected to ground planes, the circuit has a high number of layers and when the components to be soldered have a big thermal mass.

The use of tools for temperature measurement such as performing pyrometers capable of detecting the exact temperature on the joint to solder with response times lower than 10ms, allow featuring uniquely the thermal profile for each solder joints. This capability is essential to prevent soldering problems such as voids or cold solderings.

Besides, the use of a pyrometer considerably speeds up the soldering program generation and is a fundamental tool for those operator with little familiarity or experience with the soldering profiles. The acquisition of temperature on the joint and the possibility store the thermal profile are useful when it is necessary to grant the full traceability of process.

### **Firefly LASER selective solderings**

SEICA, strong of its experience matured in the axes motion and driver on Flying Probe systems proposes, with the Firefly Line selective soldering systems, a perfect example of integration between software, mechanics and LASER technology. On FireFly soldering systems, it is possible to program a specific thermal profile for every single joint. This is made up by three phases and is characterized by the trend of temperature in time unit.

In the first phase are defined the temperature and time required to heat the pad and pin surface. In a subsequent phase, it is defined a temperature higher with regard to the first phase which allows melting the tin which is automatically dispensed on the joint. The time of the second phase is proportional to the speed and tin alloy dispensed. In this second phase is formed the solder joint. As soon as the emission of the tin wire has been completed the third phase will improve the wettability and reflow to complete the solder joint correctly.

As you can see, the thermal profile control is performed through a pyrometer which, on the ground of the detected temperature and the thermal profile defined for the specific joint, controls the power of the LASER source in order to couple the real thermal profile with the theoretic thermal profile.

To make the most of the advantages of LASER technology on FireFly selective soldering systems, all the operating elements are inserted into a soldering head capable of a 180° rotation pivot.

This allows reaching the solder joint at any time, if necessary, performing rotations in the soldering phase to improve the wettability above all on big sized joints.

The optic of the 60 watt power LASER source is connected to the soldering head through optical fiber and is assembled on a motor which allows to fit the LASER beam spot according to the solder joint size. The feeling of tin on the solder joint is granted by a motor and a sensor which detects the tin in the nozzle of the wire feeder and the amount of tin fed on the joint. Due to the different dimensions of electronic components and circuits, it is possible to use on Firefly systems 500 g. alloy coils with diameter ranged between 0,5 and 1mm.

By definition, the selective soldering was born to complete the electronic circuits. This implies that, before being completed the electronic circuit may go under mechanical and thermal stresses and hence being affected by warpage. The use of laser technology requires that the laser beam is always perfectly focused on the solder joint. In case of board warpage, the focus may not be granted. That's why on the soldering head is located a warpage recovery sensor to detect and adjust the warpage and guarantee the right focus.

As for any other system aimed to manufacturing activities, the check of efficiency and correct operation of the different parts is necessary to grant a steady and repeatable process in time. Besides, it is important to consider, that the times required for maintenance and manufacturing changeover must be as short as possible, not to affect negatively the system throughput.

The FireFly selective soldering systems are equipped with a system capable of checking, at regular intervals the operation of laser and pyrometer. This operation reduces and optimizes the intervention time and prevents unnecessary system downtime.

A camera at the center of the soldering head, in addition to fiducial recognition and storing the video of soldering, allows the monitoring of the soldering system in any phase of the manufacturing process.

## Management software

Every system designed and manufactured for productivity, must have a software interface capable of granting the use of the system also by the less skilled operators. The system management software plays a considerable role in the management of a system. This aspect is amplified in the use of LASER technology both due to the poor knowledge of the LASER technology and the amount of parameters to be handled.

Among the basic features of a software there must be the possibility to create a comprehensive soldering program, processing the information on the solder joints from the CAD/CAM data.

For example VIVA, the management software of the Firefly laser selective soldering systems, can create the suitable parameters starting from CAD/CAM data or data manually supplied by the operator, thanks to a dedicated Macro for soldering purposes. The daily experience in soldering teaches how the surface finish of the circuits and the alloy used, considerably affect the soldering results. The use of Lead-Free alloys with flux developed on purpose for Laser technology combined with the use of tin-based finishes are a guarantee to achieve the expected results. That's why the VIVA software can manage PCB features such as the color, the surface finish and the composition of the tin to use in order to create the suitable soldering parameters and thermal profiles for every type of board and component.

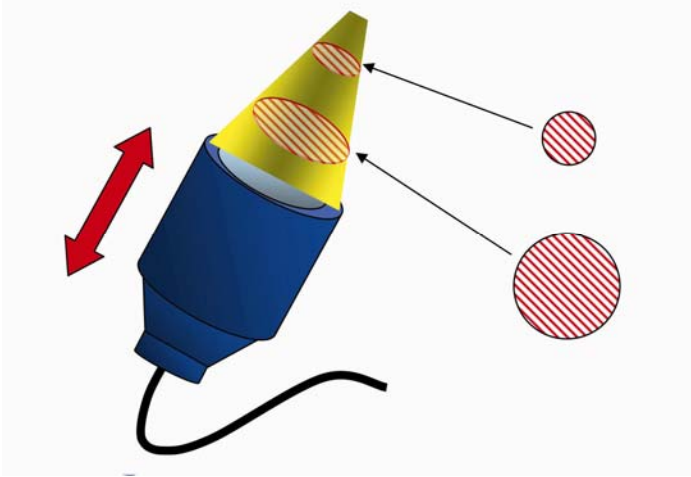
Another important aspect is related to the **process traceability**. A process controlled in time immediately supplies the accurate index of production stability and consequently, the quality and repetitiveness of results thus allowing the detection of possible production drifts.

The VIVA software allows to store the thermal profile in use for each solder joint, the exact temperatures detected and the video of solderings. This way it is possible, at any time, to check the manufacturing samples and inquire on possible manufacturing errors bringing the appropriate changes.

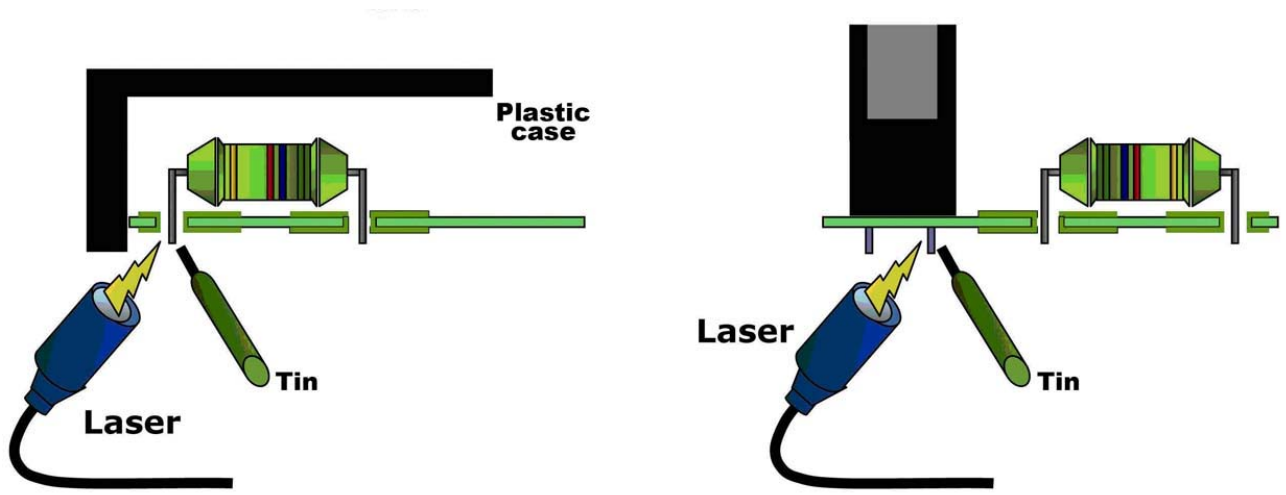
The automation of a such critical part of the of the process like soldering and, specifically, the video recording and completion becomes a relevant requirement to achieve the highest repeatability in results and a natural lowering and cost optimization. Considered in this perspective, is evident that if the soldering technology will not progress quickly enough, the capability to output quality products at reasonable costs is lost.

The commitment of Seica in the development of selective soldering systems and improvement of laser technology flew into the FireFly Line systems, capable of meeting the requirements of quality and throughput of the market.

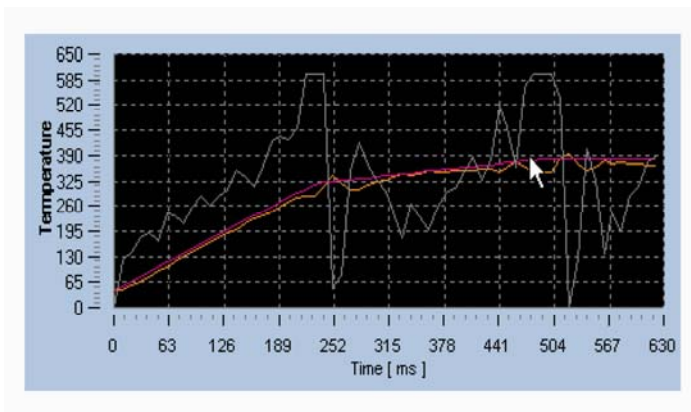
**Focusing:** a conic beam allows to adjust the spot by controlling the position of optics.



**The advantages of laser:** punctual heating, soldering of components in small spaces, fine pitch, proximity with plastic casing.



Possibility to select and control a thermal profile for every joint



Firefly T 60 system



Detail of the soldering head

