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Aligning system for a pick-and-place BGA soldering equipment

Sistema de alineación para un equipo de selección y colocación componentes BGA para un equipo de soldar

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Abstract

The necessity to have semiconductor components inside mobile, thinner and lighter devices, has created a new form to solder these electronics components to their main boards. This work for soldering superficial mounting semiconductors has become a precision task. For that reason, nowadays, the construction of equipements to pick and place semiconductors, has got an important attention. A high accuracy aligning systems are required in those equipements. In this work, an aligning prototype for superficial soldering systems is presented, using a laser devise with a set of mirrors, and an aligning mechanic system, which is low-cost, modular and upgradeable.

Superficial mounting, Aligning system, Automation prototype

Resumen

La necesidad de tener componentes semiconductores en dispositivos móviles livianos y delgados, ha hecho que la forma de soldar estos componentes a sus tarjetas base se haya vuelto ahora de forma superficial y una tarea que demanda mucho cuidado. Por tal razón actualmente se construyen sistemas que sean capaces de colocar a los semiconductores en su lugar dentro de la tarjeta para que estos puedan ser soldado. Dicha tarea requiere un equipo que pueda tener un sistema de alineación de una gran precisión. Este trabajo presenta un sistema alineador para equipos de soldadura de montaje superficial, utilizando un sistema laser, con un conjunto de espejos y un sistema mecánico posicionador de bajo costo, modular y actualizable.

Montaje superficial, Sistema de alineación, Prototipo de automatización

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Introduction

Nowadays, in the manufacturing of electronic boards for several devices such as cellular phones, computers, tablets, house appliances, TVs, etc., which uses semiconductors devises, the use of micro-placing systems is required. High-resolution optical systems demand a micrometer precision aligning, using X, Y and Z mechanisms, according to Mearig 1995. Also, the use of micro-placing equipment with automatic control to align is required in the construction of laser beam devises in order to keep in its place the laser beam generator cavity, Pascariu 2003. In this work, an aligning mechanism is developed based on a laser with a micrometer precision and this system allows to align a BGA component soldering pick-and-place equipment.

The misalignment effect on the ball pins under BGA semiconductor can be a server problem during reflow soldering, even using flux the correct contact between board tracks and electronic devise can be in risk of a weak union, which can produce that union cracks later with time, as explained in Chan 2001.

Moreover, another important thing to consider is the restoring force arising and the self-alignment occurring during reflow soldering, Krammer 2014. The microplacing devises are widely used in the fields of optic, medicine, industry, mechatronics, mechanics, aeronautics and, electronics, among others, where movements in the order of micrometers are required.

The design and construction of microplacing devises, needs of a high accuracy and a resolution, as described by Talavera 2016 and Huang 2013. Also, the development for a three-axe microplacer in Carrero 2021. Construction of two flexible mechanism activated by SMA, Abiud 2015.

Finally, in Vona 2006 microplacer are used to control robos considering friction compensation. In fact, recent works for XYZ table, such as Filer 2022, Hernandez 2022, Maldonado 2002 and Saavedra 2022 where new strategies to control the system are presented and not only hardware descriptions are reported

Pick-and-place systems

Evidently BGA component soldering is a complex task, since semiconductor must be picked and placed in its right place, high accuracy is needed. These pick-and-place devises are design from low integration equipment to high density circuit boards, their cost is depending on the component-handling capacity, in the figure 1, and a basic pick-and-place machine is presented.

For example, on every bord there are spots especially located so the system knows the board orientation and the exact place for BGA components. This positioning is accomplished by an image recognition system and an X-Y table. The equipements based on image reignition, tend to be expensive, a commercial image recognition machine is presented in figure 2. Additionally, since they are commercial devises, they usually are closed architecture, so maintenance is only done by manufacturer.

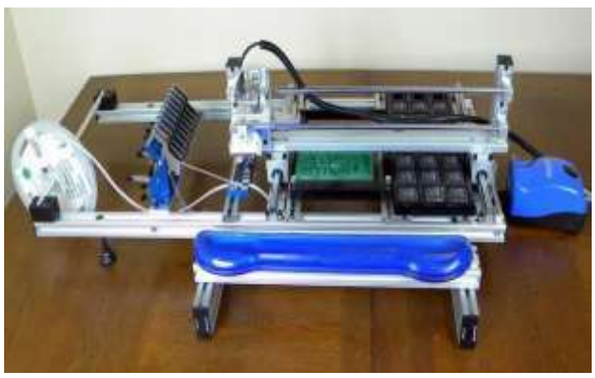

Figure 1 A commercial equipment model SMT pick-and-place system SMT-PLC-2

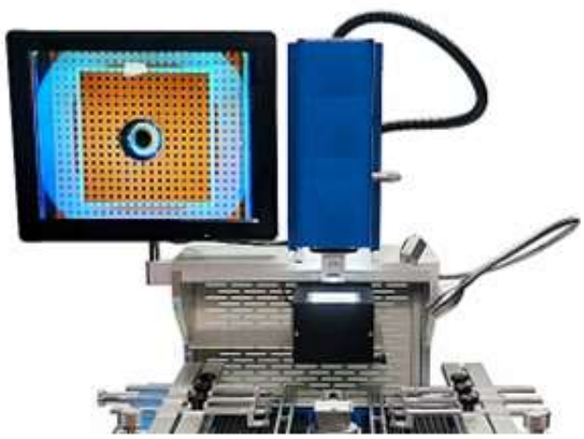

Figure 2 An image recognition and position equipment

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Aligning system operation

First, this work is focused on the alignment by means of a green laser, which is based on an experimental setup very similar to a Michelson-Morley interferometer. When the alignment is taking place in the mechanism and force a laser beam through one of the holes, which are drilled on a n inner side of the structure left arm. BGA pins are simulated by these holes and PCBs are settled in rectangular sets where they must be soldered. It is inside these holes, where the intensity of the optical light power, is measured by a photodetector.

Afterwards, vertical and longitudinal axes are moved different distances in millimeters, until the same optical power measurements are accomplished. In this form, alignment is corroborated. Then, the pick-and-place soldering station will be aligned with this system. The control stage is the one in charge of performing the micromovements in each axe, the vertical and the horizontal one. In figure 3, this part of the platform is presented

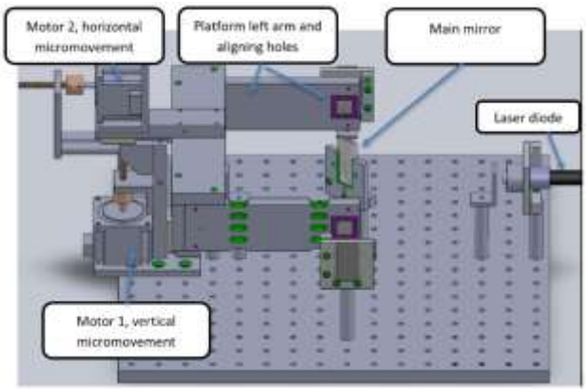

Figure 3 Design of the aligning system and its parts

System proposed

Afterward, the aligning platform is form by two stepper motors connected to a Tb6560 driver, which is connected and controlled by an ATmega 2560 board, as seen in figure 4. the system is communicated to the computer by USB-port. The X and Y axes are mechanism mounted on lineal rails; both axes are moved by the two stepper-motor with micrometric screws. The tow motors are independently controlled by the main board and the optical power meter. The screw shaft-connected to the motors give linear movements with a chord pitch resolution of 0.3175 mm.

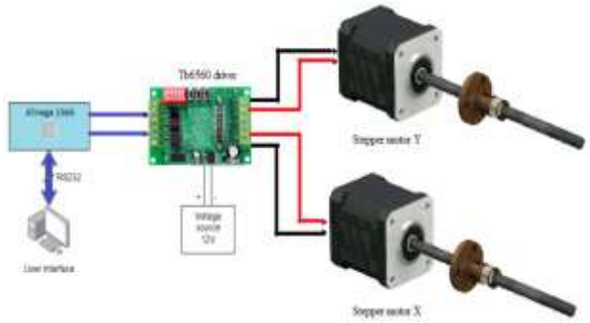

Figure 4 Electronic stage to move the stepper motors

Hence, the optical system is developed and presents some similarity with a Michelson-Morley interferometer. It uses a CCD camera, a set of mirrors is used to split the laser in two directions, come back to one point and get back to the laser power intensity meter, The part of the system for laser measurement is presented in figure 5.

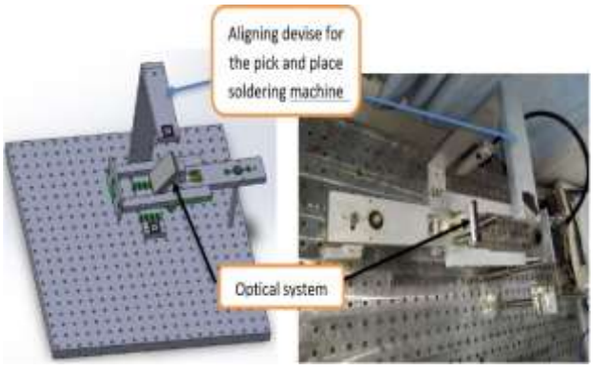

Figure 5 Power intensity meter settled on the platform

Then, the complete system is integrated and conformed to align pick-and-place machines, the aligning station and function can be observed in figure 6.

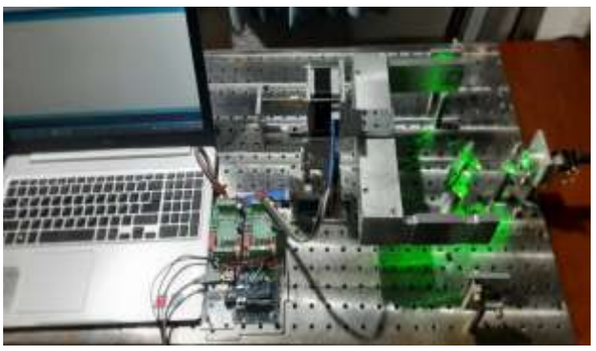

Figure 6 Aligning platform in operation

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Finally, in order to determine the system is aligned and the pick-and-place machine can start moving, a leaser power meter is used, now with that, it is able to observe and determine the mechanism is completely aligned, as illustrated in figure 7. At this part of the project the measurement is observed on a display; however, the objective is to take this signal to the computer interface so the system performances all the aligning process by itself.

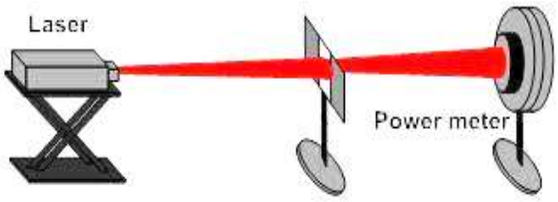

Figure 7 Aligning platform in operation

Results

The system shows a high accuracy when moving, since micrometric screw were used to move each axe and motors are configurated to turn in half steps. Displacement of 0.01 mm were measured during its aligning test. A new design of aligning is presented for Pick-and-Place machines and other systems, where alignment is required

Conclusions

A high accuracy aligning system is achieved by using a laser beam, a set of mirrors and stepper-motor controlled platform. The system has the advantage of easily being reconfigured and updated at low cost. Micromovements are ensured and performed thanks to the micrometric screw. A Michelson-Morley interferometer was developed and manufactured.

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