SOME PROPOSAL TO SOLVE SOLDER BRIDGE CAUSED BY POOR PCB DESIGN IN WAVE SOLDER PROCESS

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ABSTRACT
To assemble electronic products by wave solder process is well known method electronic industries. Several issues related to pcb defects like solder bridges, tombstoning, solder fail and crack component are solved by using manual solder re-process. It means an extra operation to re-work pcbs, increased cost and risk of poor quality related to these re-operations. In this article is presented in some pcb layout design technique to help in solving these issues. This article shows the root cause of these defects and provides suggestion to solve them based on interactive development with more than 20 years layout experience using planned design of experiment (D.O.E) tools to simulate defects and project review to take decision based on data and effects. In some high volume market, re-work and re-process is not a option.

Key words: pcb defects, layout, pcb, assembly, wave solder, solder bridges, tombstoning, solder fail, crack component and pcb rework.

INTRODUCTION
Production of high-volume electronic need to met a very high quality standards products is not allowed to coexist with rework. Rework means added costs, loss of time and poor the quality of the product. For these reasons it is undesirable for any branch of industry especially when related to high volume to electronic boards. Usually during the development phase of the product, the industry seeks to mitigate all defects conducting a series of tests assemblies process and prototypes looking closely to monitor the manufacturing line in order to feedback their designers seeking continuous improvement to the phase of large scale production of products. Many defects of electronic assembly are found during the development phase and are related to the process of wave soldering and can be solved through adjustments of the process such as temperature control, the belt speed, the height of the wave, amount of solder flux, preheat temperature, etc.

But related of solder bridges there are many factors that cause this type of defect and that are related to the layout of the Printed Circuit Board (PCB) design [2]. In this case there are some situations where the solder bridges appears more frequently causing unwanted rework. These situations are related to the following facts:
1- Proximity between the solder joints of the components.
2-Position in which the component is positioned on the plate in relation to the direction of wave soldering.
3- Geometry of solder pads.

METHODS:
You can improve your layout pcb design to reduce this defect and save time and money. Below are shown some recommendations related to the design of the pcb to minimize and resolve many cases where solder bridge solder caused during the assembly process of electronic plate occur [2]. Experiments with test plates based on the main drivers of this defect are shown in Figure 1:
Figure 1: Method used in the experiment for wave solder.

The resulting test plate of Figure 1 is shown below and reflects the various conditions related to component position for wave soldering, the existence or not of the thief solder, solder pad geometry and the existence or not of silkscreen.

These well when used features ensure a substantial improvement in the process of assembling the electronic board.

Figure 2: PCB test for assembly using wave solder process.

Solder bridges often can solved if pcb designer just take care when place this components using right position related the wave solder direction.

These is the factor 1 (Position related to wave solder) consideration showed in Figure 3 [1].
Figure 3: Preferential place position componentes for wave solder process.

Factor 2 (solder thief) is showed in Figure 4-C and solder pad geometry (Factor 3) is showed in Figure 4-B. The right position to place components with footprint like DIP (Dual In-line Package) or connectors need be place like Figure 3 – Preferred IC orientation.

Wave solder is still widely used when assembling PCBs with through hole components like connectors, power resistors, electrolytic capacitors, rectifiers and diodes, varistors. For these components the wave solder is the best solution, however solder bridges is a common issue related to wave solder.

Figure 4: Examples of some right component place position resources to avoid solder bridges.

Where:
(A) Using generic solder pads
(B) Using solder pads oblongs alternative
(C) Using solder thief together alternative solder pads.

RESULTS:
Solder pads alternative and solder thief can be used for robust design and increase your pcb design to avoid solder bridges [2]. Not follow this recommendation means you can have some solder bridges and re-works Figure 4(A). If is impossible to place component in right position you can improve using solder pads alternative to minimize this defect showed Figure 5(B).
Figure 5: No preferential place direction for PTH components and solder pads proposal to reduce solder bridges.

Silk trace between solder pads is another technique to prevent solder bridge (Figure 6) but you need take care to never introduce a contamination over solder pads if silk trace touch it.

Figure 6: Silkscreen traces used to avoid solder bridges between solder pads.

The greatest challenge to assembly pcb smd components for wave solder process. In this case I recommend never use smd family smaller than 0603 because certainly you'll have problem to fix it with glue, these statements are also made by pcb assemblies companies that the experiences in assembly eletronicas cards, avoid this process to keep the process quality indices. For QFP (Quad Flat Pins) footprint the good tip is place it 45º related wave solder path, Figure 7.

Figure 7: QFP component placed right position without solder thief(A) and using solder thief (B).

Others componentes you need take care to avoid solder bridge is all PTH (Pin Through Hole) components with footprint using 3 pins in line like TO220, TO226AA,TO92, in these case
recommendation is separate your pins and misalign it according to Figure 8.

Figure 8: Proposal to misalign pins to avoid solder bridge.

Many other factor can contribute to introduce defects. Some of them are related to wave process solder temperature, preheat temperature, wet flux quantity, contact time on wave solder [3][4]. Another one can be related to assembly process for example when using automatic PTH insertion machine. When the pcb designer understand how this process works so he can improve your design using special solder pads exactly the same size and direction that pins is cut. It really works to improve your design and contribute to minimize solder defects, Figure 9.

Figure 9: PCB design not consider pin clinch direction an lenght (A) and with considerations (B).

In the Figure 9(A) the probability of solder bridge is high because there are many pins folded and cut of PTH components to close other solder points like test point or other PTH pin. The Figure 9(B) is good design pcb because all the PTH pins are occupying just the solder pads. This details when observed by pcb designer can save much money for industries and improve quality and reliability for our products. PCB designers need understand assembly process to improve your design mainly for wave solder because for most electronic pcb design there are PTH components assembled. For future studies industries have others many problems related with wave solder like solder balls, solder fail, blow hole, inverted component assembly, solder joint, etc so it’s necessary understand this issues to improve our pcb design and not leave solution exclusively for process.
**Conclusions:**
The correct positioning of components in relation to the direction of wave solder showed high efficiency to prevent solder bridges. Solder thief (Figure 3C and Figure 7B) also show be efficient in removing 80% of cases where the solder bridges appear between the two last pins of components (based on results achieved in the industry). Using the sum of the techniques mentioned in this article is a strong tool set that have reduce and even eliminate solder bridges occurring in pcb assembly under wave soldering process.

**REFERENCES**

