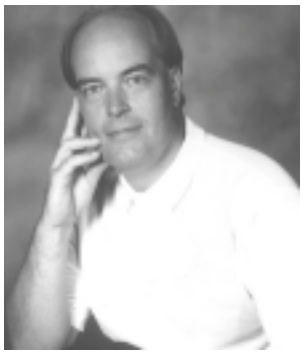
Component Requirements for Odd Form Assembly & Intrusive Reflow Pin in Hole Reflow



Pin-in-hole/Intrusive reflow assembly is becoming more and more popular in the industry. It eliminates the need for selective soldering processes or wave soldering with exclusion pallets. Each of these have cost implications where the use of intrusive reflow can be implemented very easily. A key issue as we move further into the process is the possibility of automatic assembly, unfortunately there are many issues often not considered in the component design which need to be addressed.

The following outline checklist has been put together to help the design and specification of components for use in the pin in hole intrusive reflow assembly process. It also covers the needs of automatic off form and pick and place assembly. If you have any other suggestion on areas not cover here please let us know.

Connector Pin Design

The length of the pin below the surface of the board should be a minimum of 1mm with a maximum of 2mm protrusion. This is all related to inspection criteria for the final solder joint, it has little effect on the joint strength. Longer pins tend to push paste too far out of the hole, paste volume is also wasted wetting the surface of the protruding pin. If the pin is less than the thickness of the board the pin volume is lost hence there may still be a sunken joint.

The plating on the lead should ideally be tin plated with a minimum solderable life of 2 years. The plating should also consider the future lead-free requirements so that it can be very quickly changed. The current tin 95% tin 5% tin is not suitable for future lead-free process. Ideally the pin is tin or silver coloured. When reflowed the soldering appears to be satisfactory all over the pin even if there is a problem of solder volume. If a gold plated pin is used any difference in the solder volume will be seen as a contrast on the surface of the gold and rejected as poor wetting. This is only due to a lack of paste volume but difficult to determine by the shop floor inspection department.

Ideally either square or round pins are right for the pin in paste application as the calculation for solder fill is easier. An oblong pressed and formed pin requires a hole defined by the maximum width of the pin but has a very small volume. This requires a far larger volume of paste to achieve the ideal solder fillet.

Component/Connector Weight

For obvious reasons the component weight should be minimised to benefit the product application and also assembly. The higher the basic weight the higher the force to grip the part or the higher the vacuum force is required to pick up parts. As the weight or size increase it is also more likely that the component will move on the pick and place head as the head travels across the board, the enersure. A dedicated grimmer head on an odd form system would not be affected by this issue.

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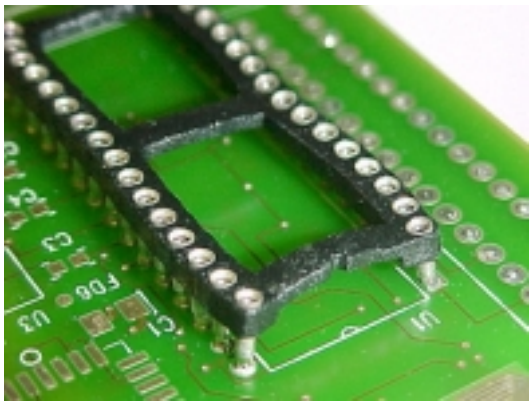
Connector Body Material

The material should be able to stand a peak temperature of 260°C for a period of 60 seconds. This requirement should also meet the requirements of the future lead-free solders when and if this legislation comes into play. Although reflow is conducted at 215-225°C The higher suggested range will rule out problems and many suppliers of parts for reflow do make them compatible with wave soldering as well.



Connector produces from the incorrect material for Pin In Hole/Intrusive reflow

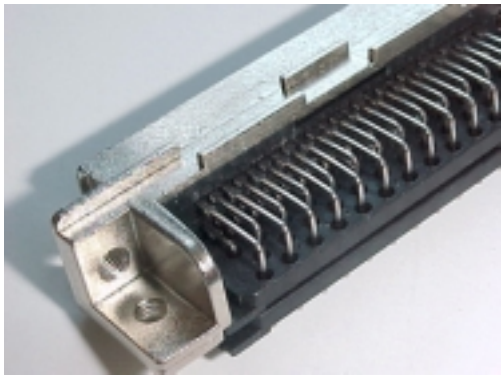
Connector Body

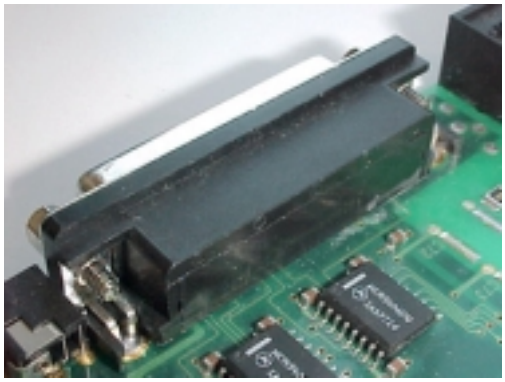
Wherever possible the body of the connector should not mask the terminations on the top surface of the board. This allows joint inspection on both sides of the board plus inspection for solder balls and complete reflow of the paste. It also assists the reflow process and reduces heat shielding effect during soldering and decreasing the differential temperatures.

If electrical shielding is used on the connectors it should be made of the thinnest material possible to avoid heat sinking the connector during reflow. Having metal surrounding the connector will impact reflow to some degree. If the shielding is to be soldered to the surface of the board the design of the pin should not allow heat sinking. The pin should be designed with thermal relief. The solder joint should be able to form but without the solder wicking up the pin body, again good design can eliminate this problem.

The body design should allow ease of pick and place assembly using vacuum pick up. The use of existing pick and place machines would allow a greater acceptance of the technology in the market place avoiding the necessity to purchase an odd form assembly system.

Although it is possible to use gripper assemblies on odd form components on pick and place equipment it requires special tools to be produced between £500-£1500. There is also a limit to the number of tools in a machine's feeder bank, engineers demand the maximum flexibility of tooling with the minimum changing of tools.





The connector would require a griper to pick and place the part as there is no flat surface for a vacuum tip to lift the part over the group of pins. Alternatively the second example shows a flat surface provided for vacuum pick up on the second figure.

A pick and place compatible component requires a flat surface for a vacuum tool. The position of pick up should be directly over the centre of the connector pin group in x & y. This allow the maximum force to be used, if required, without the connector tilting in any direction. Most connectors, sockets and off form parts do not currently have this facility.

Body Stand-Off Feature

Stand off features should be used sparingly on the base of the connector. They should be positioned with the maximum gap possible from any through hole feature. This opens up the window during the design of the stencil for solder paste printing.

The height of the standoff should be a minimum of 0.010" to avoid contacting the solder paste during component placement. Ideally the stand-off will be 0.015-0.020". Each connector family should have the stand-offs in the same relative position. The stand off height is not just required to avoid paste contact but also the liquid solder. When the solder paste reflows it coalesces in to a ball which initially will be higher off the surface of the board before going in to the hole to form the joint.

Connector Hold Down Features

The hold down and the design of the board should minimise the force required to insert the component. This should be controlled by the connector. Adjusting the hole size is possible to reduce the force. However, the larger the hole the more difficult it is to fill with solder for a 100% joint.

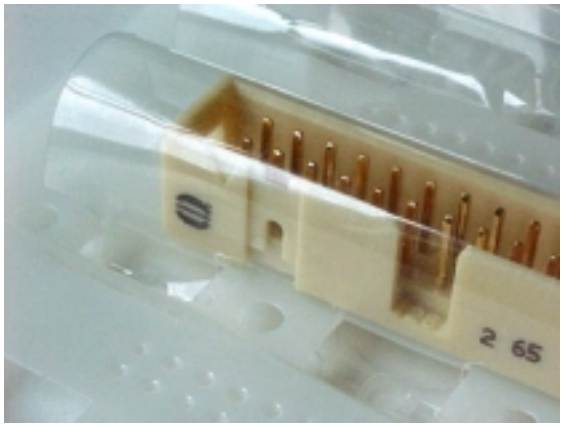
The design of the hold down feature should require the minimum force to assemble it into the board assembly; as an example use 1kg maximum as a reference. You will however have some movement of the board when using such a high loading. The hold down feature should be solderable if required and should not extend any further than 2-2.5mm below the board surface.

Wherever possible the hold down feature should be recessed in the connector body. This allows paste to be printed on to the surface of the board and not just into the hole, if it is required to solder the clip to the board.

Odd form machines can handle connectors but it is difficult to justify a machine for one or two components. Hence the growing interest in using existing pick and place machines to assemble odd form parts, provided they are compatible.

Connector Packaging

The packaging of connectors should be compatible with automatic assembly. It must be designed to eliminate connector pin; damage existing packaging is mostly unsuitable. The pin position is very important to automatically insert the connector and it must not become damaged prior to insertion. Ideally the hole size in the PCB will be just 0.010-0.015"" larger than the maximum pin diameter which requires an accurate positioning of the pin. Any less than 0.010" will make auto insertion impossible. Tape and reel is the most common format for volume applications, GEPAX is the tape system most often used for odd form parts if standard tape and reel is not large enough. Gepax tape can also be used on pick and place systems provided a feeder is available.



Example of connector held in GEPAX tape prior to automatic assembly

Vision

There are two vision methods of checking a connector for off form automatic assembly - imaging the lead position or viewing the body outline. In the case of the body outline it is important the leads are accurately positioned in relation to the body of the part. If the leads are deformed or damaged the machine would still attempt to insert the part into the board and damage the parts.

If vision is used to check the lead position it is the tip of the pin which becomes the key feature and nothing must affect its view. Most right angled connectors would be unsuitable for this process unless the vision system was specifically able to see the tips as there would be a reflection from the pin and the tip. Mechanical alignment is used with some machines, the part is picked and placed into a machined locator plate which maintains an accurate pick up position for insertion into the board. This technique is labour intensive but does work in practice. The suggested guidelines are not exhaustive but are provided as an overview to the requirements in the process and could become a design for manufacture guide as you introduce through hole reflow and assembly. The author produced the first video tapes on PIHR Assembly and has produced CD-ROM on the technology. He has also run several production lines with conventional and lead free alloys.

Bob Willis is a process engineer providing engineering support in conventional and surface mount assembly processes. He runs production lines for suppliers at exhibitions and also provides seminar and workshops world wide. Bob has one of the largest collection of training videos, interactive CD-ROMs and training material in the industry. Bob will be presenting four Master Classes at APEX in California, he will also be presenting classes at SMT Nuremberg in Germany for those engineers visiting the show. For further information on how Bob may be able to support your staff contact him via his web site **www.bobwillis.co.uk**