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Lead-free and RoHS Implimentation
Questions from the Frontline

As 2005 moves forward Kester is receiving a continuous flow of questions from assemblers transitioning to lead-free soldering and RoHS compliance for products destined to European markets. The start date for compliance in Europe being July 1, 2006; this doesn't give assemblers much time to transition.

RoHS is not going away in fact, it has gained momentum; on July28th six Chinese ministries signed a similar RoHS directive. In California there is the SB20 bill and Canada also is looking at various regulations that will restrict the use of hazardous substances in electronics and tighten recycling of electronics.

This article is a compilation of some of these questions and their associated answers. As the year progresses Kester will bring more of these questions to you and a summary answer. They are summaries since each question could be answered in expanded form and if a diligent search is done papers on each topic can be found.

Stay tuned for more answers coming from customers on the frontline of the transition. Here are some often asked questions for August, 2005.

Where can I get up-to-date web information on WEEE and RoHS directives and progress?

Getting up-to-date information is critical to your company's transition roadmap. A good place is the web and the following website contains updates originating from the TAC (Technical Adaptive Committee) for the RoHS.

The website **www. dti.gov.uk/sustainability** contains copies of the WEEE and RoHS Directives but also the latest minutes of the TAC (Technical Adaptive Committee) meetings.

Another useful website in reference to the WEEE directive which includes the EU's perspective is **www.europa.eu.int/comm/environment/waste/weee_index.htm.**

What are the new IPC-1066 and IPC-1085 Documents and how can they help you in the RoHS-Lead-free transition?

These IPC documents were issued in January 2005. The IPC-1066 is titled "Marking, Symbols and Labels for Identification of Lead-free and Other Reportable Materials in Lead-free Assemblies, Components and Devices" is a document detailing ways to identify components with lead-free finishes, but it can be expanded to board finishes and solder used for assembly. This document is new and now beginning to be used by component manufacturers; it is important to note that full adoption will take time.

Once fully used it will beneficial especially to those assemblers doing dual soldering such as lead-free and leaded.

A letter system from e1 to e9 will identify the various lead-free finishes. Component manufacturers for the identification and labeling of lead-free components will use this document.

This document should be used to train procurement, inventory control and production personnel, so as to create an awareness of the component finishes intended to be soldered.

The IPC-1065, Material Declaration Handbook details the hundreds of other controlled chemicals restricted in electronic assemblies and also details approved test methods for their detection. It will be useful if a RoHS banned substance must be tested for.

Also as a note the EIC is presently working on a new standard for testing of banned substances in electronics; this document should be available next year however.

What are the changes in reference to lead-free assembly in the J-STD-020C, dated July 2004?

The IPC/JEDEC J-STD-020C, issued July 2004, entitled Moisture/Reflow Sensitivity Classification for Non-hermetic Solid State Surface Mount Devices details the thermal profiles SMD components must meet to be classified as lead-free process capable.

Higher thermal profiles with lead-free in the range of 235-255º C, may require component re-qualification to new moisture sensitivity limits. This needs to be known and adequate measures taken to avoid moisture issues such as popcorning, delamination and cracking issues during lead-free reflow.

This document is also useful to procurement, where lead-free components can be referenced to the requirements set in this standard.

What are the labeling requirements to indicate RoHS product compliance?

The RoHS Directive doesn’t require any specific label to be put on assemblies or box builds. Although some companies have designed their own label and some are using it, by law it is not necessary. Any product entering the European market will be assumed to be RoHS compliant. The same applies to the lead-free logo; it too is not required.

Some manufacturers are using their own Lead-free or RoHS logos to indicate the product is lead-free but this is usually for marketing purposes and not legally required.

However the IPC-1066 does recommend the use of labeling to identify the solder used for assembly. The JEDEC JES-D97 states the same recommendations.

Do I need a Material Declaration for my finished product?

A Material Declaration showing compliancy for your product is not required by the EC law. However, if a product entering the European market is intercepted and found to be

non-compliant to the RoHS after July 1, 2006, it will be important to demonstrate that a company has done all that is possible in insuring compliancy.

Material Declarations or data from each component used in the assembly will then be required. Keeping Material Declarations for each individual item used in a build is important and can show good due diligence has been exercised. A close relationship with suppliers is essential.

It is worth mentioning that in a recent webcast sponsored by IPC, Markus Stutz of Motorola working on the E.I.C. Test Methods Group did mention, China may require all products that enter their markets to have a Material Declaration. This is more demanding than the European directive.

What are the main elements required from a Material Declaration Form for my components, boards, wiring etc?

The essential elements a Material Declaration must contain are as follows:

- Compliancy to European RoHS Directive banned substances,
- Free of Polybrominated Biphenyls and Polybrominated Diphenyl ethers flame retardants, can be found in some plastic molding compounds and laminates
- Temperature maximum limits for a lead-free soldering process
- New Moisture Sensitivity rating for lead-free assembly

The key is to insure banned substances are not present, but also that the parts are lead-free process compatible. Lead-free soldering when using SAC alloys will require hotter thermal profiles. To insure reliability close attention must also be placed on the maximum temperature the part can see but also the impact of moisture.

Can I solder leaded components in lead-free wave soldering?

Leaded terminations cannot be soldered in a lead-free wave solder process. Lead-free solder bar will have a small amount of lead when received usually in the range of 0.01 to 0.08%. The RoHS Directive states a maximum of 0.1% lead; it does not take very much lead to surpass this limit. To avoid surpassing this limit, leaded terminations should not be allowed. There is no effective way to reduce lead content except by dilution if lead were to go beyond 0.1%.

Also lead contamination can be a contributor to fillet lifting and fillet tearing. Although this is not considered a defect as per IPC-610D, further studies are required to determine the impact on high reliability assemblies. For consumer electronics reliability would not be an issue since most are not exposed to thermal cycling or thermal shock during their use.

Can I solder reliably leaded terminations with lead-free solders in an SMT process?

The amount of lead on SMD terminations can be small often component manufacturers will use 10/90 or 15/85 for the tinning. A small amount of lead will be introduced into the lead-free joint and for small amounts of lead under 2% by weight this doesn’t impact the pull and shear force results when tested. Some assemblers have used a mixed bag of

leaded and unleaded SMD’s with no impact to product reliability. Most are in consumer electronics.

For the highest reliability a complete lead-free system is preferred. If leaded SMD components must be used, it is recommended to access product reliability and therefore some testing may be required. An important note, for RoHS compliancy is lead must be kept below 0.1% lead in the joint also, lead in terminations may impact this negatively. Verification of the final composition may be needed.

Can I solder lead-free terminations with leaded solders such as 63/37?

Lead-free terminations such as pure tin, silver palladium and tin bismuth have been in use for years. So they are already being soldered with 63/37 solder without much issue.

Today more and more components are coming lead-free, where they may have had a leaded finish before. Some component manufacturers are issuing different part numbers some are not; some companies are notifying distributors and assemblers of the change some are not.

For the assembler, even if it is not going to lead-free soldering, it becomes important to know what these new finishes are since solderability may change requiring process optimization to maintain product reliability.

What is the impact of lead contamination on lead-free joints on pull and shear test results?

For small amounts of lead in SAC alloys, no difference was noticed in pull or shear test data. Gintic Singapore Consortium report showed that up to 2% by weight lead in lead-free SAC joints had no discernable negative impact. However, lead-free terminations soldered with lead-free solders are still considered the most reliable.

Lead in wave soldering however can result in some fillet lifting to occur.

What are the first steps to take to insure a reliable SMT, wave solder process with lead-free solders?

The knowledge base for Lead-free Assembly is still rapidly increasing. Choosing an alloy, which has been studied carefully is essential. SAC solders would fit this category and lots of data now exists; however this is not the case with other alloys.

Choosing an alloy, which does not have substantial historical use or limited data will therefore require substantial investment in reliability testing. Often the assembler will have to assume the costs associated with pull testing, shearing testing, vibration studies, thermal cycling, thermal shock and more. This can be cost prohibitive.

Understanding the physical and chemical properties of the lead-free solder alloy is important since many have reduced wetting behavior and higher surface tension. This will enable an engineer to optimize the soldering process to account for these differences and insure a solid solder joint.

Knowing the component finishes and board finishes and what can be expected during soldering will enable proper selection of fluxes designed to solder them. Choosing a flux system designed for lead-free is a basic requirement.

After consideration is given to equipment compatibility a DOE should be run to determine the best process parameters to achieve good lead-free solder joints. Proper training will be required since the cosmetics of lead-free joints are different in cosmetics and wetting spread and wetting angles when compared to 63/37 leaded joints.

How can I develop a good lead-free hand-soldering process, which will ease the operation and insure reliable solder joints?

In a recent study, which appeared in the Lead-free Update by TechSearch International in December 2004, hand-soldering was found to be more problematic to implement when compared to lead-free wave soldering and SMT.

The reason could be that hand-soldering is more operator dependant than reflow and wave soldering but also the surface tension in lead-free solders is slightly higher. Wetting or spread is also a little slower when compared to 63/37.

To reduce operator issues and reduced wetting proper optimization of the soldering process is key. To avoid issues use a flux content of 2-3% by weight in the solder wire, use a solder tip temperature of 700-800º F. Also Tin-Silver-Copper (SAC) solder will flow more readily than Tin-Copper (SnCu) solders.

The main issues encountered with lead-free hand-soldering are cold solder joints, poor wetting and de-wetting. These can be avoided.

About the author:

Peter Biocca is Senior Market Development Engineer with Kester in DesPlaines, Illinois. He is a chemist with 24 years experience in soldering technologies. He has presented around the world in matters relating to process optimization and assembly. He has been working with lead-free for over 8 years.

He has been involved in numerous consortia within this time and has assisted many companies implement lead-free successfully. He is an active member of IPC, SMTA, and ASM. He is the author of many technical papers delivered globally. He is also a Certified SMT Process Engineer.

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