Adaptation to scientific and technological progress under Directive 2002/95/EC

Joint response from EICTA and AeA Europe, to the general and specific questionnaires

relating to exemption 11

31 March 2008

Content

General questionnaire

1. For which substance(s) or compound(s) should the requested exemption be valid?	Lead
2. What is the application in which the substance/compound is used for and what is its specific technical function?	Compliant Pin Connector Systems provide a method of attachment and electrical contact between a connector and printed circuit board (PCB) which does not require a soldering operation. The pin contacts are inserted into plated through holes (PTH) in the PCB and the mechanical design of the pin provides reliable electrical contact.
3. What is the specific (technical) function of the substance/compound in this application?	Tin-lead plating covers only the termination portion of the contact, which includes the compliant section. The lead provides lubrication while the pin is inserted and withdrawn, its oxide can be displaced during insertion and ensures good electrical contact once the pin is inserted.
4. Please justify why this application falls under the scope of the RoHS Directive (e.g. is it a finished product?	Lead coating is used on the compliant pin connectors which are used on printed circuit board assemblies (PCBAs) contained in many types of computer and telecommunications equipment.
- Is it a fixed installation?	No
- What category of the WEEE Directive does it belong to?).	Category 3 – IT and Telecommunications Equipment
5. What is the amount (in absolute number and in percentage by weight) of the substance/compound in:	
i) the homogeneous material[1]	The amount of Pb in the SnPb plating can range from 3%-40%. Typically, the Pb content in the plating alloy is in the 3-10% range. The plating thickness is thin, approximately 0.4-4.0 microns. Depending on the pin style and the number of pins on the connector, the total amount of Pb on a compliant pin connector may range from <0.001 gram to approximately 0.1 gram.
ii) the application, and	A typical Server printed circuit board assembly (PCBA) might have 4 to 8 connectors per PCBA, up to as many as 20 connectors for a very complex PCBA. Based on these estimates, any PCBA should contain less than 2 gram of Pb from the compliant pin connectors.
iii) total EU annually for RoHS relevant applications?	Based on estimates of the number of contacts per connector, connectors per PCBA, PCBAs per system and number of systems using compliant pin connectors shipped into the EU, the compliant pin connector exemption is estimated to account for 20-50 tonnes of lead shipped into the EU annually. Note that as additional matte tin plated compliant pin part numbers are qualified for use in certain applications, the amount of lead shipped into the EU under this exemption will decrease.
6. Please check and justify why the application you request an exemption for does not overlap with already existing exemptions respectively does not overlap with	Not applicable – this is not a new exemption request.

exemption requests covered by previous consultations.	
7. Please provide an unambiguous wording for the (requested) exemption.	Lead in Compliant Pin Connector Systems
8. Please justify your contribution according to Article 5 (1) (b) RoHS Directive whereas:	
o Substitution of concerned hazardous substances via materials and components not containing these is technically or scientifically either practicable or impracticable;	Eliminating Pb from compliant pin connectors results in a decrease in the lubricity of the plating on the compliant section and increases the likelihood that there will be damage to the PTH in the PCB. Pb added to Sn in the connector finish significantly decreases the risk of tin whisker growth. Compliant pin connectors are particularly susceptible to the formation and growth of whiskers due to the compressive stress state imparted on the press fit component during service life.
o Elimination or substitution of concerned hazardous substances via design changes is technically or scientifically either practicable or impracticable;	Compliant pin connectors are required in many computer and telecommunications equipment applications based on the advantages these technologies offer, including: higher signal density, enhanced signal integrity, higher connector density, ease of reworkability and the fact that heat is not required to attach connectors. Changes to the PTH groundrules may decrease the failure occurrences but have not been proven 100% successful.
o Negative environmental, health and/or consumer safety impacts caused by substitution are either likely or unlikely to outweigh environmental, health and/or consumer safety benefits thereof (If existing, please refer to relevant studies on negative or positive impacts caused by substitution).	To implement certain Sn-plated compliant pin technologies that have not been able to meet qualification requirements would risk the reliability and availability of mission critical Server systems. The damage that can be caused to the printed circuit board (PCB) by the increased insertion and removal force of these un-qualified connectors could result in internal failure of the PCB material that would result in failure of the Server system. The risk of failure is higher when the connector must be reworked and to eliminate rework would have a negative environmental impact as the amount of scrap hardware that would have to be disposed of would increase. Network Infrastructure Equipment generally requires reliability for 10 – 15 years. Whisker growth can cause short circuits between compliant pins at connector and therefore suspend network communication.
9. Please provide sound data/evidence on why substitution / elimination is either practicable or impracticable (e.g. what research has been done, what was the outcome, is there a timeline for possible substitutes, why is the substance and its function in the application indispensable or not, is there available economic data on the possible substitutes, where relevant, etc.).	Board attach testing of some Pb-free compliant pin connectors has found the change to Lead-free coating to be acceptable. Positive results have been obtained in qualifying "eye of needle" and "C-press" configurations from several suppliers. But, testing of other compliant pin connectors, such as "bowtie" and "action pin" designs, has uncovered unacceptable damage to plated through holes (PTH) in the printed circuit board (PCB), especially after rework, as a result of the significantly higher insertion/retention forces. In addition, the results for the "eye of needle" designs vary based on supplier and connector specifics. Some "eye of needle" designs have positive qualification results, while others have failed due to PTH damage. Failure mechanisms are not yet well-understood. Contributory factors to these failures may be the design of the compliant section, the interference fit between the compliant section and the PTH, and/or the material properties of the plating. Pending

	a complete understanding of the failure mechanism(s), and a practical means of eliminating them, continuation of the exemption is necessary.
10. Please also indicate if feasible substitutes currently exist in an industrial and/or commercial scale for similar use.	Compliant pin connector systems are typically used in more complex PCBAs and not as often in consumer electronics. Server and Storage applications require thicker printed circuit boards (PCB) and do not accept any internal defects or damage to the PCB material surrounding the plated through hole (PTH). Server and Storage applications have complex printed circuit board assemblies that require the capability to rework connector sites to maintain a high yield and reduce the amount of scrap hardware that must be disposed.
11. Please indicate the possibilities and/or the status for the development of substitutes and indicate if these substitutes were available by 1 July 2006 or at a later stage.	Over several years, a significant number of compliant pin connectors with a 100% Sn plating on the compliant section have been qualified for some Server applications. This work involves several connector manufacturers and many compliant section designs. A significant number of qualifications, however, have not been successful. Problems with high insertion/retention forces and unacceptable damage to PTHs (especially during rework) have been identified for particular connector designs, often related to specific pin configurations. These findings have prevented full qualification and implementation of Sn plated compliant pin connectors for all products. Pending a complete understanding of the failure mechanism(s) and a practical means of eliminating it (them), continuation of the exemption is necessary.
12. Please indicate if any current restrictions apply to such substitutes. If yes, please quote the exact title of the appropriate legislation/regulation.	No
13. Please indicate benefits / advantages and disadvantages of such substitutes.	The substitute coating materials do not provide as good lubricity and, therefore, risk damage to the PCBs.
14. Please state whether there are overlapping issues with other relevant legislation such as e.g. the ELV Directive that should be taken into account.	No
15. If a transition period between the publication of an amended Annex is needed or seems appropriate, please state how long this period should be for the specific application concerned.	Solutions to replace 100% of the compliant pin connector systems with lead-free alternative coatings is anticipated to take more than four years to complete, thus the exemption is requested to remain until at least 2012.

Specific questionnaire

1. Please state the **amount of lead** used per application, the lead content in the homogeneous material, the annual production volume as well as the number of applications related to exemption no. 11 put on the EU market annually.	"Please see answer to Q5. General"
2. Please **justify** why this exemption is still necessary. Previous related exemption requests for fine pitch connectors, flexible flat cables etc. were not granted during the last evaluation in 2006 since one of the stakeholders withdrew his request stating that he will accept gold as a viable alternative for the time being. Explain and justify why e.g. gold is not a **viable substitute**.	Over several years, a significant number of compliant pin connectors with a 100% Sn plating on the compliant section have been qualified for some Server applications. This work involves several connector manufacturers and many compliant section designs. A significant number of qualifications, however, have not been successful. Problems with high insertion/ retention forces and unacceptable damage to PTH (especially during rework) have been identified for particular connector designs, often related to specific pin configurations. These findings have prevented full qualification and implementation of Sn plated compliant pin connectors for all products. Pending a complete understanding of the failure mechanism(s) and a practical means of eliminating them, continuation of the exemption is necessary. See Annex I for example photographs comparing acceptable and unacceptable results with matte Sn plated compliant pins. In limited evaluation of gold plated compliant pins, the insertion force was found to be twice that of SnPb plated compliant pins. As mentioned previously, higher insertion forces often result in unacceptable damage to the plated through holes (PTH). In addition to insertion force concerns, the metallurgical properties of the gold plated compliant pins also pose concerns for rework. Gold and copper are 100% miscible and therefore interdiffuse quite readily. The high contact strains of pin insertion produce a substantial level of diffusion bonding at the contact points. Once local bonding occurs, pin retraction can result in an unacceptable level of PTH damage. Examples of PTH damage from both initial insertion and rework of gold plated compliant pin are included for reference in Annex II. 100% Sn plating and Au plating connectors exist as a potential substitute of Pb-Sn plating connectors, but at present no whisker evaluation record exists concerning 100% Sn plating press-fit connectors. The propriety of an acceleration examination condition is unidentified for compliant pin connector. (JESD201: the fundamental mechanisms of tin whisker growth are not fully understood and acceleration factors have not been established. Therefore, the testing described in this document does not guarantee that whiskers will or will not grow under field life conditions.) Connector manufacturers do currently not guarantee non-growth of whiskers. Regarding high-density implementation and the use of Sn plating connectors, there is a risk of short circuits:

	- Minimum space between compliant parts of connectors is "0.77mm". - Maximum length of Sn whisker is "0.62mm" (Please see Annex III) Additionally, some connector makers state that they are concerned about reliability (i.e. fragility problem) in relation to the issue of co-diffusion between Au and Cu.
3. Besides a possible gold alternative, more knowledge is available on whisker generation and mitigation mechanisms that can avoid whiskers (post-bake of components after finishing, layers under the tin to mitigate whisker growth…). What has changed since the last evaluation in 2004 and where is **substitution** now technically feasible?	Proposed tin whisker mitigations such as a post-bake heat treatment and Ni underlayer may be effective for reducing whisker growth on IC components but have not been proven for compliant pin connector applications where an additional compressive stress is imparted on the press-fit component during service life. Anecdotal evidence is available showing whisker growth that exceeds JEDEC standard acceptance criteria when inserted connectors were subjected to industry standard tin whisker test conditions. Furthermore, recent experiments by iNEMI show that tin whiskers form under conditions of high temperature and humidity, even for platings subjected to the "post bake anneal" treatment. There is also evidence that the post bake anneal may simply slow the initiation of tin whiskers, rather than eliminate their formation (ref. 1).
4. Results of the previous evaluation in 2004 state that a reflow or wave soldering process heating up the coated pins would reduce the **whisker risk**. Why can the pins not be heated up simulating a soldering process in order to mitigate the whisker risk? This approach would also be compliant with a post-bake treatment of copper-based components to mitigate the whisker risk.	Please see answer to Q3 Specific above. Compliant pin connectors are particularly susceptible to the formation and growth of whiskers due to the compressive stress state imparted on the press fit component during service life. Neither reflow , wave soldering, nor the application of a post-bake heat treatment counteract the stress experienced by the compliant pin, press-fit connector in service.
5. Assuming the current exemption will be given an **expiry date**, what date do you think is technologically feasible for industry?	Solutions to replace 100% of the compliant pin connector systems with lead-free alternative coatings is anticipated to take more than four years to complete, thus the exemption is requested to remain until at least 2012.

References:

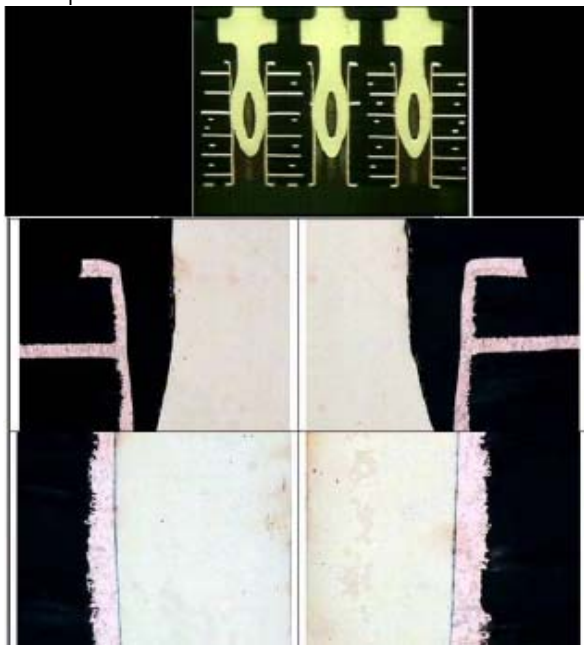
1. J. Osenbach, et al., J. Mater. Sci: Mater Electron, Sept 2006.

Bibliography :

a. Lead-free press-in (presentation by T. Ocket from Tyco) July 2002.
b. Toward lead-free compliant pin connectors (George J.S. Chou, Robert Hilty Tyco Electronics), proceedings SMTA International, Chicago IL, Sep. 25, 2005.
c. Evaluation pf plated-Through-Hole Deformation in lead-free press fit connections (Dr. George J.S. Chou Tyco Electronics), 2004.
d. "Effect of Lead-Free Surface Finishing on Press Fit Connectors" presented at IPC annual meeting, Minneapolis, MN, Sep. 28 2003.

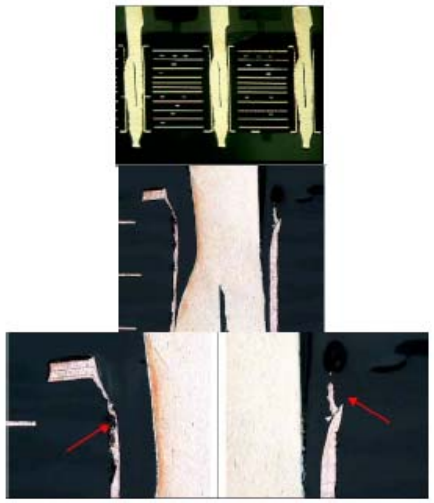
ANNEX I - Matte Sn Plated Compliant Pins

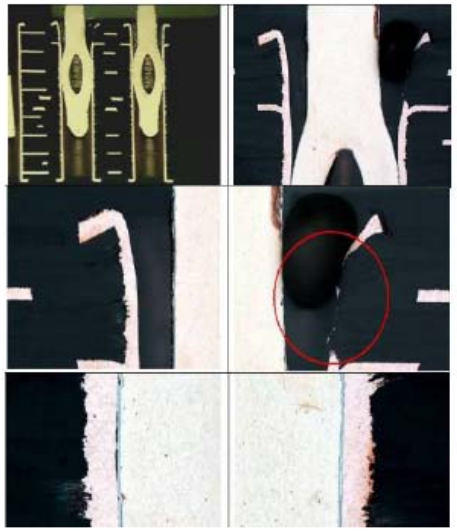
Acceptable cross section results

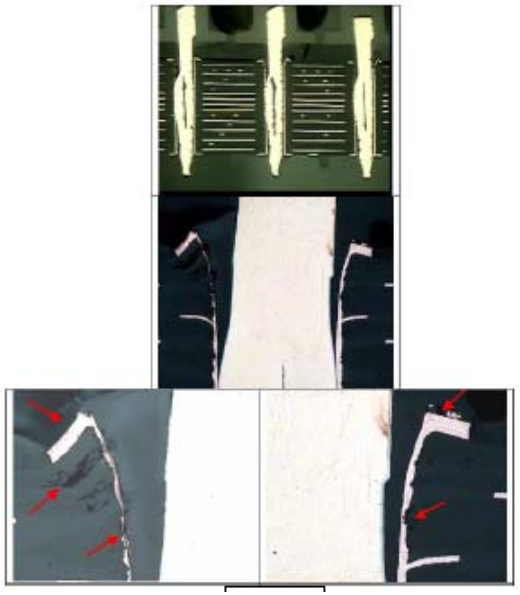


Unacceptable cross section results after 1X Rework

Unacceptable cross section results after 2X Rework

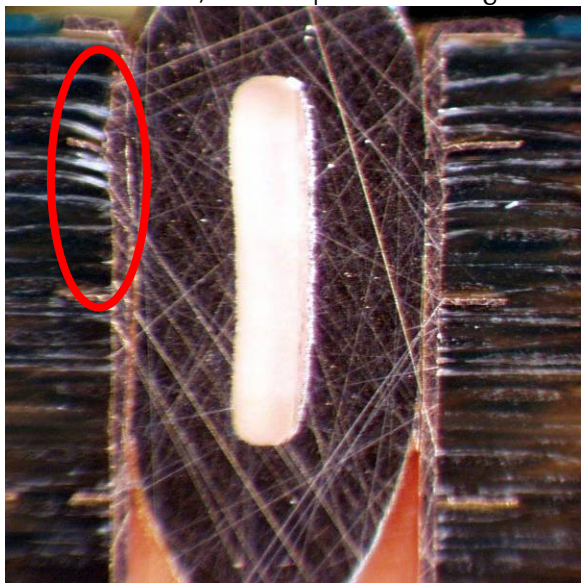




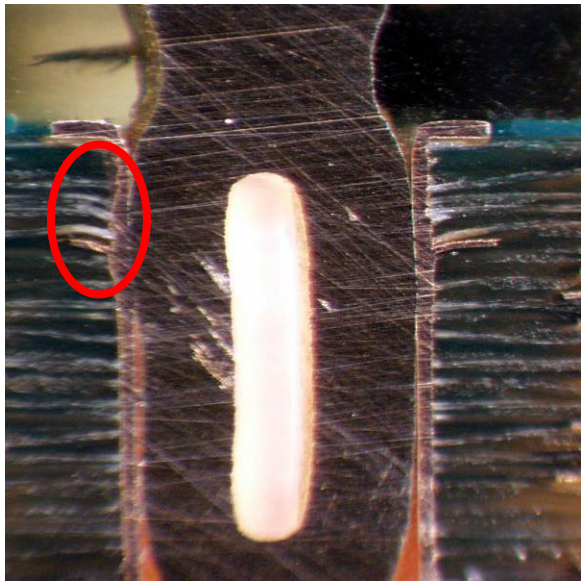


ANNEX II - Gold Plated Compliant Pin Results – unacceptable examples

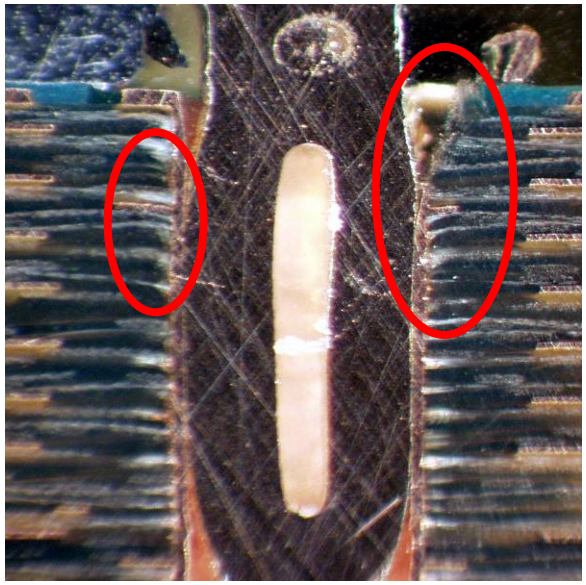
Initial insertion, unacceptable damage to PTH



1X rework, unacceptable damage to PTH



2X rework, unacceptable damage to PTH



Sample of assembled dimensions of high density compliant pin connectors and PCB
(for computers and NW infrastructure)