Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

Fraunhofer Institut Zuverlässigkeit und Mikrointegration

Adaption to scientific and technical progress under Directive 2002/95/EC

Results previous evaluation
Exemption No. 11

"Lead used in compliant pin connector systems"

(Excerpt from ERA Report 2004)

Öko-Institut e.V.

Freiburg Head Office
P.O. Box 50 02 40
79028 Freiburg, Germany
Street Address
Merzhauser Str. 173
D-79100 Freiburg
Tel. +49 (0)761 – 4 52 95-0
Fax +49 (0)761 – 4 52 95-88

Darmstadt Office
Rheinstraße 95
64295 Darmstadt, Germany
Tel. +49 (0)6151 – 81 91-0
Fax +49 (0)6151 – 81 91-33

Berlin Office
Novalisstraße 10
10115 Berlin, Germany
Tel. +49 (0)30 – 28 04 86-80
Fax +49 (0)30 – 28 04 86-88

2.4 Compliant pin VHDM (Very High Density Medium) connector systems

2.4.1 Introduction

Compliant pin or press-fit connectors are used in a variety of electrical equipment. VHDM is the trade-mark of one manufacturer but all types are being considered under this exemption request. Compliant pins have tin/lead alloy coatings and this exemption has been requested to allow the continued inclusion of lead in these coatings.

Several of the larger compliant pin connector manufacturers have stated that there is no need for this exemption as tin can replace tin/lead coatings. This change of materials will increase the insertion force but connector manufacturers and users disagree whether this should be overcome by a small increase in the hole diameter (not always feasible) or decreasing the pin size.

The main concern of users is tin whiskers, for the reasons discussed in section 2.2, but also because these coatings are not heated in the soldering process. There is evidence that soldering heat reduces the stress in coatings which in turn reduces the risk of whiskers being formed. The compliant pin connector manufacturers believe that they can produce tin coatings that are not susceptible to tin whiskers and so the risk is small, however their customers, who produce high reliability products such as Servers and Networks, are concerned that there is a small risk as this issue is not fully understood and so are asking to be able to continue to use tin/lead coated compliant pin connectors in their products until 2010.

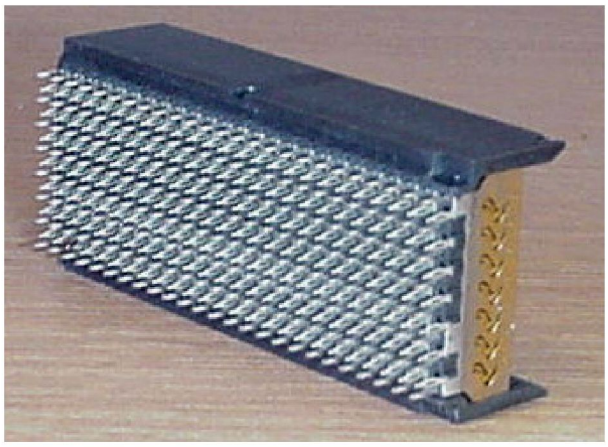

Figure 6. Example of a typical compliant pin connector (length 50 mm)

2.4.2 Construction

These connector systems generally have a large number (hundreds) of closely spaced pins. These compliant pins are inserted into holes in the printed circuit board. These connectors were developed to avoid the difficulties encountered in soldering such a large number of closely spaced pins because the total thermal mass would be so large that it was difficult to achieve the correct temperature throughout the connector for the solder to flow and wet the surfaces. (The situation would be even

more difficult with lead-free solders due to their slower wetting and higher assembly temperature). These connectors can be extracted and reinserted several times for repair or to change PCBs (upgrade or repair). As solder is not used, smaller pads can be used around each pin, so that they can be placed closer together. The connectors can also be inserted from both sides of the board, which is a major advantage in backplanes.

The compliant pins have a controlled degree of flexibility, allowing them to be forced into the holes, while clearing away any oxides on the surfaces and then applying sufficient outward force to maintain a good electrical contact. The insertion force is mainly dependent on the hole size with only a secondary dependence on the plating on the pin and the internal hole coating. The retention force is also dependent on the hole size, but much more dependent on the coating composition than in the case of the insertion force. Compliant pin manufacturers claim that average insertion force is increased by about 8 –10% when changing from tin/lead to matte tin (it would be reduced if bright tin were used). Some users find similar or slightly higher figures, up to 15% but these are average figures and one manufacturer has found an increase of 30% for one particular application. The insertion force could be reduced by increasing the hole size but users claim that this is not always possible due to space limitations and in some cases would require a re-design. Users would prefer connector manufacturers to slightly reduce pin diameter.

There are several designs of pins available from different manufacturers. One common type is called "Eye of a Needle" as it looks rather like the end of a sewing needle. The Tyco version is called an "Action Pin" and each side of the eye is bent slightly away from the plane of the pin in opposite directions. Winchester Electronics uses an approximately "C" shaped cross section. The shapes are distorted as the pins are pushed into the board.

2.4.3 Properties required

Compliant pins should:

- be sufficiently flexible to deform as they are inserted into the holes without an excessively high force that might damage the plating in the holes,
- be extractable for repair without damage to the board.

The tin-lead plating on the pins contains only about 10% lead and is only about 1.5 microns thick. It is required to:

- provide lubrication while the pin is inserted and withdrawn,
- have an oxide that can be displaced during insertion,
- ensure good electrical contact once the pin has been inserted.

2.4.4 Alternatives

The request for this exemption is solely for tin/lead plating on the compliant pins. Even though it is used in servers and networks, it is not used as part of a solder joint, as the tin/lead does not melt to form a bond.

Alternative coatings for compliant pins include matte and bright pure tin, and gold. Gold is not suitable for PCBs as it is too hard and increases the insertion force significantly although it is used in applications where very high frequency signals are used.

Tests by Tyco Electronics[11] and other connector manufacturers with pins pressed into PCB holes of a range of sizes with a range of coatings gave good performance. They found that the insertion force was mainly dependent on the hole size and the plating type was a secondary factor. The retention forces depend on the coating on the pin due to the static friction at the points where the metals are in contact. IBM and other users contend that:

- the tests were made only on thinner boards (2.36 mm as against the 3.175 mm used in IBM back planes),
- the tests used only a single layer board compared to IBM's boards of about 30 layers,
- the insertion forces with tin coated pins are on average 15% higher,
- there has been more damage to the plating of the holes,
- there is the possibility of tin whiskers.

At present compliant pin manufacturers and users have not been able to resolve concerns over insertion force. It seems reasonable that by July 2006, this should be resolved by small changes in the design of pins and in some cases, where practical, a small increase in PCB hole size. This would not allow users sufficient time to qualify new connector designs, however, as, they claim, this takes over 2 years and the RoHS Directive comes into force in only 18 months.

The main long-term risk is tin whiskers. This is discussed in detail in section 2.2 and is unlikely to be resolved by 1st July 2006. There has been research as well as informal observations from a variety of manufacturers who are evaluating lead-free production that any tin plated component that is reflowed, has a low susceptibility to whiskers in accelerated tests whereas the tin coatings that are not soldered suffer from a much higher risk of whisker formation. It therefore is a concern that this type of component with tin coatings is more at risk than soldered components.

2.4.5 Future plans

Equipment manufacturers are continuing to examine and test alternative types of compliant pins as they become available but, in many cases, their tests have found that these are unsuitable for their requirements.

2.4.6 Summary of the case for an exemption

There are genuine concerns from manufacturers of high reliability equipment that tin plated compliant pin connectors will have a risk from whiskers. Until this is well understood and a shorter reliable test that is known to reflect field conditions becomes available, this concern will remain.

There is also concern over the potential for damage to holes due to the increased insertion force. Research by the connector manufacturers has identified the causes of increased force and there is no reason why this cannot be resolved by a combination of small modifications to pin diameter and hole diameter.

Connector manufacturers and their customers are already discussing these issues but it seems unlikely that they will be fully resolved before 1st July 2006.

4. Proposed guidelines to define the scope of exemptions

The following sections provide clarification of the scope of each exemption.

4.1 Mercury in straight fluorescent lamps for special purposes

Straight fluorescent lamps not intended for general illumination. Examples include:

- LCD backlights
- Light sources in scanners, printers, photocopiers and fax machines
- Disinfection lamps
- Medical/therapy lamps
- Pet care lamps (such as those used within aquaria)
- Lamps for use at low temperature
- Extra long lamps which contain > 10mg of mercury
- Amalgam lamps

4.2 Lead in solders for servers, storage and storage array systems, network infrastructure equipment for switching, signalling, transmission as well as network management for telecommunications

A proposed definition of the scope has been produced by equipment manufacturers with input and some amendments by ERA. This is given in Appendix 1. Equipment that is covered by this exemption is of the type which is intended for continuous use for at least 10 years and has a high reliability. Personal computers, laptops, telephones, etc. are not covered by this exemption.

4.3 Light bulbs

This refers to filament or incandescent light bulbs. These can be included in the scope of the RoHS Directive. An exemption for one type of filament lamp has been reviewed. These are straight filament lamps that use lead to attach a silicate coating to the interior of the glass tube.

4.4 Compliant pin connector systems

This title has been rewritten since "VHDM" is a trade mark and this exemption request is for all types of compliant pin and press-fit connectors. Compliant-pins are used as connections in multi-way connectors. The compliant pins are of various designs and have electroplated tin or tin/lead coatings which are inserted into a matching array of plated through holes in printed circuit boards to make an electrical and mechanical connection. These connectors are designed to make multiple reliable

connections to PCBs without soldering but which can be removed and re-inserted without damage to the connector or the PCB.

4.5 Lead as a coating material for the thermal conduction module C-ring

Thermal conduction modules are the central processor units used in the Z-Series main-frame computers produced by IBM. The C-ring is the seal used between the glass-ceramic circuit and the liquid cooled copper plate, which is used to remove heat from the semiconductor chips.

4.6 Lead and cadmium in optical and filter glass

Optical components used in electrical equipment such as glass lenses, optical filters and prisms where no lead-free alternative is suitable. Lead in the glass of electronic components is not included in this exemption as this is covered by item 5 of the Annex of the RoHS Directive.

4.7 Optical transceivers for industrial applications

This exemption request was made to cover optical transceivers and the solder connections made to the PCB to which they are attached. Optical transceivers convert optical signals into electrical signals using glass-fibre connected to a photosensitive semiconductor, convert electrical signals into optical signals using a laser diode or LED attached to an optical fibre or one device may contain both functions.

4.8 Lead in solders consisting of more than two elements for the connection between the pins and the package of microprocessors with a lead content of more than 85% in the proportion to the tin-lead content (exemption until 2010)

A lead-based solder with a melting point higher than standard lead-free solders and eutectic tin/lead but containing <85% lead which is used to attach pins to the carriers of microprocessor packages. This alloy is not covered by the exemption listed as item 7.1 of the Annex of the RoHS Directive which is for solders which contain >85% lead (see section 1.3).

4.9 Lead in high melting temperature type solders (i.e. tin-lead solder alloys containing more than 85% lead) and any lower melting temperature solder required to be used with high melting temperature solder to complete a viable electrical connection

This exemption is intended for internal (Level 1) connections made between the semiconductor die and the carrier in flip-chip packages which have higher power consumption and currently use high melting temperature solder bumps (>85% lead) which are connected to the carrier with eutectic tin/lead (~37% lead). The bump composition will have <85% lead. This exemption would also include situations where high melting point solder balls (e.g. on ball grid array packages) are attached to a PCB with a lead-free solder. It is not intended to permit the use of solders containing lead for