HP's Position Statement on Tin-based Plating for Lead-free Components

April 7, 2003

Draft History
Version 1: April 7, 2003 First release
Version 2: June 30, 2003 Decreased preferred Ni thickness for the Sn on Ni plating from 2 μm to 1.3 μm. Removed Sn-Bi from preferred matte Sn platings over a Ni layer.

> **Note:** This is not a request from HP to adopt a lead-free component plating at this time. If your company is already supplying components with tin-lead plating to HP, do not stop shipment.

HP has learned that a number of its suppliers are introducing lead-free tin-plated components to satisfy the impending European Union ban on the use of lead in electronics. HP is concerned about potential reliability problems with lead-free tin-plated components, which are susceptible to failure by electrical shorting between leads or closely spaced parts, and may cause electrical shorting between leads of another component. HP's goal for lead-free products is that their reliability will be equal to or better than existing products using tin-lead processing.

After reviewing extensive supplier feedback regarding lead-free material transition plans, it is clear that many suppliers plan to use lead-free tin plating (tin > 95%, which includes Sn, Sn-Bi, Sn-Ag and Sn-Cu) as a substitute for tin-lead plating used on terminations of lead frame packages and discrete components, as well as on other parts such as heat sinks and buss bars. A potential benefit of this approach is that a single plating metallurgy may be used for both tin-lead and lead-free solder processing. However, tin platings are susceptible to the well-known reliability problem of tin whiskers. Whiskers may form as thin filaments of tin after plating and can cause electrical shorts and product failures. At this time, there are several critical and unresolved questions regarding tin plating and tin whiskers that need to be satisfactorily answered before all of HP can support the transition to tin plating and begin broadly accepting tin-plated parts.

Position

All HP businesses are concerned about potential reliability problems with lead-free tin platings. However, HP businesses may respond differently based on their product lifetime and reliability requirements. If your company is planning to transition to Pb-free platings, please, consider HP's preferences below. If your company is already supplying a lead-free tin-plated component to HP, do not stop shipment and at the same time please communicate clearly to the concerned HP Division that you are shipping a lead-free part**.**

Preferred platings:

- A layered plating of nickel (Ni)/ palladium (Pd)/ gold (Au) flash
- A layered plating of nickel (Ni)/ palladium (Pd) (is generally preferred, but may not be accepted by some HP businesses for fine pitch components)
- A layered matte tin (Sn)-based plating on top of a nickel (Ni) layer.* The nickel (Ni) layer is critical and will be at least 1.3 µm (50 µin.) thick. It is preferred, but not required, that the tin-based plating be ≥10 µm thick. Tin-based platings will be matte, not shiny or bright, and include 100% Sn and Sn-(1-4%)Ag.
- Solder dipped terminations for components with ≥1.27 mm pitch (possible alloys include Sn-Ag-Cu, Sn-Ag, or Sn-Cu)

* HP will require additional reliability tests, in addition to any industry standard whisker acceleration tests, to guarantee that our products meet our reliability requirements.

Unacceptable platings:

- Bright or shiny lead-free tin plating (characterized by small grains and high carbon content) *for all applications.*
- Lead-free matte tin-copper plating *for most applications*.
- Lead-free, matte tin plating (tin > 95%, which includes Sn, Sn-Bi, Sn-Ag and Sn-Cu) *for HP applications requiring high reliability*.

Limited application for tin-based platings:

- Some HP businesses may accept matte tin and tin alloy plated components for certain applications, **only** with written approval. It is preferred that the tin-based plating is ≥10 µm thick.
- This written approval from a specific business does **not** constitute acceptance of tin plating for other applications or other HP product lines.
- Finally, if field failures occur due to tin whiskers, tin plating will **not** be an acceptable lead-free plating solution for **any** application.

Critical issues

In the bullets below, we have identified the critical issues that have led us to this conclusion. We have also listed the areas where significant progress is needed for us to support tin plating as an acceptable alternative for lead-free components. We invite your comments to our position statement, and want to work with you to find an acceptable plating alternative for lead-free components. We are also working with other consumers of plated components in the National Electronics Manufacturing Initiative (NEMI) consortium to develop an industry standard position that should be available soon. Some of the critical issues, associated with tin whiskers, which need to be addressed are:

1. The fundamental mechanisms that drive tin whisker formation and growth are not well understood or characterized. As a result, acceleration factors are not yet developed; making it impossible to perform accelerated long-term reliability tests to validate the absence of the tin whisker failure mode. Many of HP's high end products have lifetimes of over 7 years, and an accurate accelerated long-term reliability test is essential to ensure our product reliability goals are met.

2. The plating process parameters and plating chemistries needed to control the tin plating in a repeatable "no whiskers condition" are not understood adequately by the plating industry. As a result, only a limited set of suppliers may be able to demonstrate that their processes repeatably result in plating that does not whisker. In order to make tin plating an industry-standard solution, the plating process parameters and conditions required to eliminate whiskering need to be widely understood. Moreover, the mechanisms for controlling the conditions that lead to tin whiskers must be foolproof and acceptable to the plating sources used to supply our components.

Our observation of industry consortia, conference proceedings and technical journals indicates that there is a strong disagreement in the industry on what causes tin whiskers and how they can be completely controlled. One of our qualitative acceptance triggers will be that a consensus emerges in these forums that: (1) the fundamental factors that influence tin whisker formation and growth are understood, (2) standard acceleration models and test conditions are accepted, (3) the plating processes can be adequately controlled to eliminate the conditions that cause tin whiskers, and (4) the plating suppliers agree to integrate the appropriate control mechanisms in their plating processes.