TECHtips

Electronics Manufacturing Insights from ACI Technologies, Inc.

# Tin Whisker Risk Assessment Improves Reliability

High quality, critical electronic assemblies sometimes require a tin whisker risk assessment, even if the analysis proves the risk is negligible. Defense and high reliability segments have historically executed these assessments since the reliability requirements are obvious. Many commercial companies do not perform a tin whisker risk analysis since this failure from tin whiskers can be less obvious in their products. To manage this risk, several steps are in order. First, recognize the problem is real. Second, assess the risk and third — if required — mitigate or reduce the effects of tin whiskers to acceptable levels.

The problem is real and the exposure growing. With Asia and Europe already mandating lead-free electronics, the United States will inevitably follow suit. American manufacturers must currently build lead-free electronics to ship product to Asia and Europe. With lead-free comes more pure tin electroplated onto component terminations, and with tin comes tin whiskers. There is a risk for electrical failure caused by tin whiskers acting as randomly inserted conductors in assemblies. For commercial companies, reducing these failures can lower warranty costs and field service repairs.

Tin whisker information is abundant, and the subject is an area of active research. NASA operates a site which is an excellent resource and offers a solid treatment of the subject with ample pictures of the phenomenon. The site for NASA Goddard Space Flight Center is at https://nepp.nasa.gov/whisker/. Even so, a quick review of the tin whisker problem is warranted.

A tin whisker is a crystalline filament of white tin which grows from tin. It is electrically conductive. If filaments like this grow in an electronic assembly or circuit board, this whisker can continue to lengthen to become a path for current causing shorts or erratic behavior. Tin whiskers have been implicated in the recent Toyota gas pedal recall and other problems including a heart pacemaker (see the NASA website for more examples). The whisker can be destroyed in the process of carrying the current, often leaving little evidence for trouble shooting. The tin whisker does not need voltage to grow, which means the filaments can grow when the product is in storage.

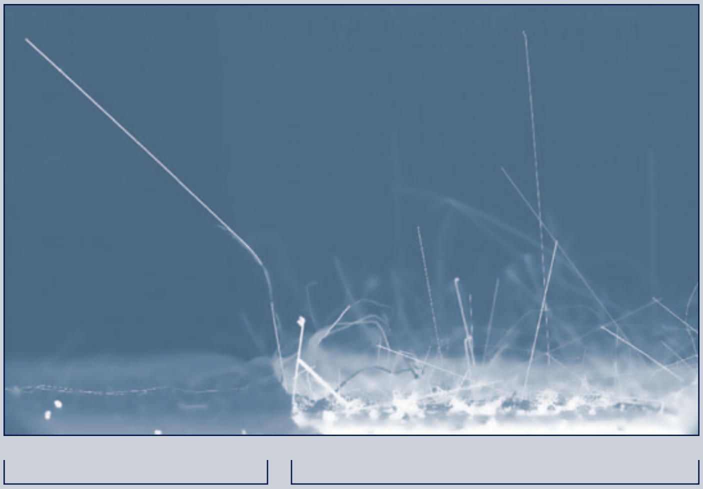


*Figure 1-1: The containment of tin whiskers by conformal coating.*

There is a method or algorithm with established currency that breaks down the different tin whisker risks common to an electronic assembly. This method, commonly called the “Tin Whisker Risk Algorithm” or “Pinsky Algorithm (after the Raytheon engineer who compiled it),” surveys a dozen distinct aspects of how the tin in a lead-free electronic assembly will affect the assembly reliability. Some of these are conductor spacing, lead content, tin thickness, and conformal coats. Numerical values are attached to each aspect and summed up to give a final figure. Along with providing an assessment of total risk, the twelve aspects of tin whisker risk can be individually studied by designers to drive out risk in the design phase. The highly recommended algorithm is available online. Once the product is finished, modifications are expensive; conformal coating may be the most sensible remedy to lower tin whisker risk (Figure 1).

Products are manufactured by one organization and sold to another. For these transactions to proceed smoothly, standards are developed for those designing and building products and those purchasing those products. GEIA-STD-0005-2, “Standard for Mitigating the Effects of Tin

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Whiskers in Aerospace and High Performance Electronic Systems" provides a framework for communication and agreement on the processes employed to control and mitigate the use of lead-free solder in these applications.

The mentioned GEIA standard describes five levels of control for lead-free solder, Level 1, Level 2A, 2B, 2C and Level 3. Level 1 has essentially no control on tin finish; Level 2 has three sub levels with some controls on tin finishes; and Level 3 has a prohibition of any tin finished components. The customer can specify the control level desired, and the document contains the details to be followed by the manufacturer.

## Summary

The physics of tin whiskers do not differentiate between military and commercial products. The tin whisker driven failures that manufacturers of high reliability and military equipment so vigorously try to prevent will plague commercial manufacturers if similar preventative steps are not taken.

Commercial manufacturers can utilize the same effective techniques developed by the military manufacturer to manage and mitigate the tin whisker risk of a commercial product. This will usually require only a modest amount of effort.

Recognize that with the reduction of lead and the increase in lead-free assemblies, the opportunities for tin whisker problems increase. Once it is determined that a risk assessment of a product is required, the assessment of an assembly can proceed, piece by piece. These individual tin whisker risks can be summed to provide a risk level for the assembly and the Pinsky algorithm is a common tool to generate a risk number. Based on the cumulative risk level, specific mitigation or risk reduction and tin control techniques can be employed to drive the risk to an acceptable level.

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