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Comments on Test Methods & Criteria for Tin Whiskers in Surface Mount Passive Devices

A Statement issued by members of EIA/ECA Steering Committee S-1

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Electronic Components, Assemblies & Materials Association

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A Statement Issued by members of ECA/EIA Passive Components Group

The ECA passives component group had issued a white paper on tin whiskers last year (an updated version is available on the web site). It introduced facts which showed that the problem of tin whiskers was limited to some very specific applications (there have been anecdotal reports of weapon and satellite systems failing because of tin whiskers, but no scientific data exists in public domain to support that claim) and to the best of our knowledge, as of today the entire commercial electronics industry has never reported a failure due to tin whiskers. Nevertheless, to allay the fears of the electronic industry, JEDEC and iNEMI have come up with a set of test conditions for all components, surface mounted or leaded (including lead frames).

When one considers that the actual physics of whisker growth is not yet clear and mitigation techniques still debatable (more of an art than science), the test guidelines put forth by JEDEC and iNEMI are a good start. However, some of the tests and the judgment criteria need to be reviewed in light of the nature of majority of applications, industrial trends and the properties of whiskers itself. More importantly, the test conditions and judgment criteria being proposed are different for North America and other global electronic alliances, like JEITA (Japan) or IEC (Europe). This is bound to cause confusion in the industry, especially when one considers the integrated nature of the global economy and electronics manufacturing. However, the scope of this paper will be limited to North America. Also, we propose criteria, which we believe to be more practical without sacrificing reliability of components or the end product. We are attempting to highlight and understand the risks involved before making a judgment (or over react). ***At this point it is important to note that it is possible to grow whiskers on surface finishes which include lead (a few publications have provided evidence), and although the risks of whisker growth may be higher in pure tin finishes, it is not a new phenomenon***. For a good synopsis on possible causes of tin whiskers please refer to the summary presented by Galyon, Smetna and Vo ("Cause of Tin Whiskers Remain Elusive", available at http://smt.pennnet.com/Articles).

It is not the intent of this paper to delve into the details of test conditions or methods as proposed by each industry alliance, but we wish to point out that there are marked differences amongst the different groups. This is not to say that one or the other industry alliance group is being lax or strict, but it does show that the approach to risk management is different. However trivial the differences, this would be confusing and cumbersome to a global company with manufacturing sites all over the world. It is therefore recommended that the differences be ironed out and a unified set of test methods and criteria be adopted globally.

On the home front, let us review the industry/application classification of both JEDEC (JESD201) and iNEMI. Although both have different number classification (exactly opposite of each other), they agree that:

- For mission/life critical applications such as military, aerospace and medical, pure tin and high tin content alloys are not acceptable.
- For Business applications such as Telecom Infrastructure equipment, high-end servers, etc, the whisker length should be less than 45 or 40 um. HOWEVER, as both JEDEC and iNEMI mention, the key point to note here is that, ***the concern in such applications is breakage of whiskers*** (not short circuit of the actual component with whisker growth).
- For industrial and commercial products ***whisker breakage is not a major concern***, although JEDEC further breaks down ***commercial products as "no major concern with whiskers"***. However, the maximum whisker growth is limited to 67 um or 50 um (for RF applications above 6 GHz).

The following argument must be viewed in light of the above. ***It seems that for high reliability applications the major concern is not just the shorting of components with whiskers, but shorting or other problems caused by whiskers falling off***. Therefore, ***before settling down on whisker length by application, a clear relationship between whisker length and breakage strength (mode and mechanism) needs to be established***. In our opinion, the debate should focus on not just the growth of whiskers, but their robustness too.

Robustness

We propose that after further studies are conducted, at some point in the near future, the robustness of whiskers should be linked to the criticality of the application (the robustness itself could be linked to size). Some of our member companies have performed various shock, vibration and other tests of varying severity (as high as required by space launching agencies) on parts with grown whiskers, ***and have found no evidence of whiskers breaking***. If at all, ***such tests should be standardized and used, as criteria to define whether the parts may be used in critical applications are not***. If we just go by the current size guidelines, one may end up having a misconception that whiskers less than 40 or 45 um would not break off and on the contrary whiskers of length 67 um are more prone to breakage. At this stage it is more important to know whether the whiskers that have grown would break off or not. Each manufacturer could provide such data. Thus before we settle down on specifications, in the interim we propose the following size based criteria.

Size

We propose that whisker length be linked to case size, instead of application (for now it may be OK to exclude space and specialized military applications). For example, in case of SMD MLCCs, the 0402 package size (the pre-dominant case size along with 0603) has a minimum gap requirement between terminations of 300 um. This means that whisker on one end must exceed 150 um (in a straight line) for the part to short. Therefore allowing for enough and reasonable safety margin, we propose the following:

- Case size 0402 and larger, maximum allowable whisker length = 100 um
- Case size 0201, maximum allowable whisker length = 67 um
- Case size 01005, maximum allowable whisker length = 40 um

Of course, deviations to these specifications should be allowed when there is problem with spacing of adjacent parts (although the above specifications should cover almost all cases very well).

Then there are other issues like the significance of 4000 hr storage tests. It is true that whisker growth on shelf is unacceptable, but we need more studies on what happens to these whiskers during soldering. On the other hand, if a part's been soldered (thereby annealing tin), the risk of whisker growth is significantly mitigated (in non soldered areas) and the test may not be representative.

In no way is it our intention to downplay the whisker problem and its elimination or mitigation should be the ultimate goal of the industry. Also, in no way does it downplay the importance of a few manufacturers who have chosen to continue supplying tin-lead finish for special applications. The intent of this paper is to present all the facts (or lack of those) and provide a forum for an objective dialogue, which will allow the vast majority of the industry to go ahead and make well informed judgment. In the end this will benefit the consumers.

We would strongly recommend our readers to review our earlier bulletins (CB19) where we have listed guidelines on how to avoid whisker problems. Once again, for all the excitement it has created, for almost all commercial applications, tin whiskers is not a problem that will affect you and your products. It is more important at this point to eliminate harmful products like lead from the environment.

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