## Working Paper, Open Source Information for Cu-wire Interconnect Evaluation Discussions Jun 2018

1. AEC Q006 (currently at Rev A) is the current best practice for evaluating/qualifying solid state devices with Cu-wire interconnect in high reliability (non-commercial) applications

a. Pre and Post environment testing requires destructive (DPA) and non destructive analysis along with successful Electrical/ATE functional/parametric testing.

b. Pre and Post environmental test include, ball bond pull/shear and stitch/wedge bond pull performed seperately on different wiress, CSAM images, cross-sections of ball/wedge bonds - Electrical/ATE functional/parametric test results before/after stress tests

c. Reject/accept is agreed to by the user and manufacturer. Criteria includes items such as, shear/pull values, for the ball bonds, and pull values for the stitch bonds to include mean, min, max, standard deviation, specification limits and statistical analysis of the results, and cross sectioning through ball and stitch sites with an analysis of "common sense" reject conditions.

2. JEDEC JESD22-B116B (ball shear) and JESD47 have been updated to reflect criteria for Cu-wire construction, may be a fee for non-member down loading as of Jan 2018.

3. A joint JEDEC JC13.7 and JC 14.1 working group is forming to develop Cu-wire interconnect specific pull methodology and minimum pull criteria to be used a basis for updating MIL-STD-883 for high reliability applications and creating a JEDEC "industry" standard. To start in the fall of 2018

4. The joint JEDEC JC13 and JC14 Cu-wire pull working group will be open to JC13, JC14, and SAE CE12 members. Other participants with specific expertise may be considered and can contact the JEDEC JC13.7 chair, the SAE CE12, chair or the JC14.1 chair for consideration to support the working group.

5. The Joint JC13.7-SAE Cu-wire interconnect task group is looking to start work on developing a JEDEC publication with suggested best practices for evaluating devices with Cu-wire construction.

6. Some items for users to consider when looking at independently evaluating Cuwire products are:

a. How can the AEC Q006 be applied to other applications requiring a higher level of reliability?

b. How to develop criteria to go along with the requirements of the AEC Q006 and/or user application requirements?

7. Some examples of literature to consider when looking at Cu-wire interconnect devices are below, also see the notes in item 9 for getting copies:

a. The Automotive Electronics Council (AEC) Q006, rev A.

b. The 2018 AEC committee papers/presentations, previous years might be available on request, no guarantee.

c. JEDEC JESD22B116B, Wire Bond Shear Method

d. CMSE presentations, 2017 and 2018, from TI and others

e. John Timms 2014 presentation, "Copper Wire Concerns – Industry Standards Required"

f. NXP ISTFA 2013 paper, "Planar Analysis of Copper-Aluminum Intermetallics"
g. Spansion paper(s), "Evolution and investigation of copper and gold ball bonds in extended reliability stressing, Gold Bulletin, 2014"
h. Microsemi Sep 2013 paper, "Converting High Volume IC Manufacturing to Cu wire packaging"
i. Xilinx presentation "Cu Wire Implementation", Krimo Semmoud, May 2015
j. IMAP 2014 HiRel presentation, "A Case Study of the Reliability of Copper Bond Wires In Plastic Encapsulated Integrated Circuits"
k. 2014 STMicroelectronics presentation, "Description of the new method for decapsulation of devices with technologies M0-5/M0-7 with Copper wire", note dont use ultrasonic clean at the end, this was an error.

- 8. Others literature which may require more digging:
  - "The Systematic and Random Interfacial Oxidation Mechanisms of Copper Wirebonds to Aluminum Bond Pads", A.J. Griffin, Jr. (Texas Instruments, Inc.), April 2012, Automotive Electronics Council Reliability Workshop 2012
  - NXP, "Reliability Knowledge Framework & Application to Cu-wire specific Failure Mechanisms", René Rongen, Arjan van IJzerloo, Orla O'Halloran (NXP Semiconductors), April 2012, Automotive Electronics Council Reliability Workshop 2012
  - The iNEMI paper the cu-wire Phase 2 project presented in 2013 at EPTC and is available through IEEE. Titled "Copper Wire Bonded Package Characterizations and reliability for QFN Package from iNEMI Collaborative Project", by Masahiro Tsuriya.
  - Freescale paper, "Copper versus Pallidium Coated Copper Wire Process and reliability Differences", 63d ECTC 2014 #815, Chu-Chung (Stephen) Lee

- NXP paper, "Lifetime Prediction of Cu-Al wire Bonded contacts for Different Mold Compounds"
- ESTC Sep 2012 paper, "Early Fatigue failures in Cu wire bonds inside packages with low CTE Green Mold Compounds": http://www.cedm.be/library/publications

9. Notes for getting the primary literature in item 7 above:

a. The AEC Q006 and 2018 committee/workshop papers are available for free at the Automotive Electronics Council (AEC) web page.

b. The JESD22B116B, Cu and Au wire shear method are on the public JEDEC page, downloads. Currently a JEDEC water mark and a name stamp are on the downloads, there may be a fee.

c. A very informative TI paper was presented last year at the CMSE and at SAE meetings. Contact Tom Green to get CMSE papers form 2017 and the recent 2018.

d. John Timms (Continental) has presented a paper at AEC and SAE meetings. This presentation is available to SAE CE12 members on the SAE web page. . Contact Jeff Jarvis or Sultan Lilani for liaison membership.

e. The NXP paper is available at a few online sites including the IEEE (a fee) also at or the Researchgate web page (request to the author).

f. Spansion paper(s), go to this link at Researchgate (https://www.researchgate.net/publication/272014994\_Evolution\_and\_investigation\_ of\_copper\_and\_gold\_ball\_bonds\_in\_extended\_reliability\_stressing), or to Springer at (https://link.springer.com/article/10.1007/s13404-014-0135-z). Title of one (and there are more) is "Evolution and investigation of copper and gold ball bonds in extended reliability stressing", you should be able to search for it at these sites in your favorite browser.

g. The Microsemi paper is available at the SMTA website. Go to the SMTA page at (https://www.smta.org/knowledge/knowledge.cfm), and in the search box on the right, search under the presentation title, "Converting High Volume IC Manufacturing to Cu wire packaging". Once the search is done, scroll down a little until you see this paper, it should be in the top 10 hits. You can also just search in your browser under this title.

h. The Xilinx presentation is available to SAE members on the SAE CE12 web site.

i. The iMAPS paper is available to iMAPS members at no cost or a \$20 fee for non-members.

j. The STMicro presentation is available at the SAE CE12 webpage.