Copper Bond Wire FAQ

Technical FAQ:

1. **Will Lattice perform a full re-qualification of every device/package combination to be offered with Cu-wire?**

   Lattice uses Family Qualification Methods as defined in JEDEC JESD47 to identify representative qualification vehicles for the reliability evaluation. Per JEDEC JESD47 "Stress-Test-Driven Qualification of Integrated Circuits", Lattice uses representative devices to qualify families of similar components utilizing the same fabrication process, design rules, and similar circuits. The Cu-wire family qualifications applied to package families where the construction is the same and only the size and number of leads differs. Lattice has considered interactive effects of the silicon and package in applying family designations. Lattice uses a Failure Modes Effects Analysis (FMEA) method for qualification plan generation.

2. **Do your assembly vendors have extensive experience for mass production of Cu-wire products? Do they have a track record manufacturing consumer, commercial and industrial grade products?**

   Lattice assembly partners are running Cu-wire processes in very high volumes. Typical run rates are approaching a billion units per year using this technology.

3. **In the future, will Lattice restrict manufacturing to only Cu-wire material set for the device/package combinations listed in the Product Change Notification (PCN)?**

   This PCN is intended to release Cu-wire versions of our devices as an Alternate Qualified Material Set (AQMS). To ensure manufacturing flexibility, Lattice reserves the right to utilize Cu-wire or Au-wire material sets at any time.

4. **What if I want to stay on Au-wire material set ?**

   Please refer to Question "3" under Business FAQ on Page 4.

5. **I heard that Cu-wire bonding is not as reliable as Au-wire bonding. Is this true? Are there concerns for long term reliability? I heard Cu-wire corrodes over time. How are you handling this?**

   Lattice has carefully studied the current state of Cu-wire reliability. The Cu-wire process requires alternate materials and tighter process control than Au-wire to achieve industry requirements for

product reliability. All Cu-wire products will use the required ultra-low halogen materials needed. Lattice has also specified tighter process controls at all our assembly vendors. The reliability stress testing completed demonstrates these materials and controls are effective. Full process control and reliability data are available for our Cu-wire product offerings.

6. **Are there any performance differences in devices using Cu-wire?**

While copper has a slightly higher conductivity than gold, the difference will not impact device performance. To be certain, Lattice has completed select re-characterization (including SERDES characterization where applicable) of devices to demonstrate equivalent performance. This characterization information is available through the PCN.

7. **Is the Cu-wire manufacturing process more susceptible to wire lean, sway or sweep issues?**

Cu-wire is more rigid than Au-wire. Comparisons using 0.8mil diameter wire of 160mil wire length show that sweep for Cu-wire is 2.5%, while for Au-wire the sweep is 3.7%. These results confirm wire lean, sway and sweep are better controlled with Cu-wire.

8. **How do you ensure you do not get bond pad cratering due to higher Cu-wire bond stress?**

For each device/package combination, Lattice worked with our assembly vendors to perform Design of Experiment (DOE) testing to find the optimum bonding parameters. The process window for Cu-wire bonding was then specified in the process control requirements.

9. **Cu-wire bonding has a different process window than Au-wire. What did Lattice do to ensure the Cu-wire process remains in control?**

A complete Design of Experiment (DOE) was performed for each device/package combination before the start of manufacturing. This established the acceptable process window for manufacturing each product. The process window requirements were then added to the Assembly Process Control Plan at the assembly vendor, and included in the Lattice External Supplier Control Requirements.

10. **Are there any differences in manufacturing rates between Cu-wire and Au-wire?**

Cu-wire bonding has a slightly slower throughput rate than Au-wire bonding due to the additional process controls required. Lattice assembly partners have sufficient dedicated Cu-wire bonder capacity for current and future requirements. Additionally, the Cu-wire material set is an Alternate Qualified Material Set, so Lattice can continue to use the Au-wire material set as necessary to meet customer demand.

11. **How do you control the manufacturing process to ensure reliable second bond strength?**

    Second bond formation was a critical element in the Design of Experiment (DOE) investigation of Cu-wire process parameters. For metal lead frame products, bare Cu-wire has a sufficient process window for manufacturing. For substrate products, Lattice will use Palladium-coated Cu-wire to ensure a sufficient process window for manufacturing.

12. **In-line process control measurements for first wire bond often show acceptable results, but the bond can then degrade in heat and humidity stress conditions. What has Lattice done to ensure long term reliability of the Cu-wire bond to the device?**

    Reliability of the bond between the Cu-wire and the device bond pad is determined by the correct bonding parameters (power, pressure, heat, vibration, time) during bond formation, and the correct properties of the package materials. These were key elements in the Design of Experiment (DOE) used to define the acceptable process window for manufacturing. Additionally, the reliability qualification included specific testing under extreme temperature and moisture stress to demonstrate that the first wire bond is reliable.

13. **Will bond pad modification be necessary as Cu-wire is harder than Au-wire?**

    Lattice will not need to modify any bond pad structures for qualifying the cu-wire material set. The Design of Experiment (DOE) examined pad structure as a key element, and an acceptable process window exists for our current bond pad structures.

14. **How do you manage the relatively limited shelf life of Cu-wire on the bonding machines?**

    Specific shelf life requirements for storage and floor usage of Cu-wire have been implemented at Lattice assembly suppliers. These requirements include incoming inspection, storage, floor usage life, and material handling. The material management requirements were added to the Assembly Process Control Plan at the assembly vendor, and included in the Lattice External Supplier Control Requirements.

15. **Will Lattice be changing any other elements of the Bill of Materials in addition to the Cu-wire ?**

    In addition to the wire, the mold compound must also change to a material with ultra-low halogen content and balanced pH. These parameters reduce the risk of bond failure. In some cases, the die attach material will change along with the mold compound. The PCN lists all the changes implemented in the Bill of Materials for Cu-wire processing.

16. **Do I need to take any special precautions during board assembly, such as reflow process, reflow temperature, solder material, flux, cleaning processes, or post assembly shelf life?**

    The stability of Cu-wire bonds with thermal aging is better than that of Au-wire bonds. Therefore, there are no thermal concerns with reflow temperature or reflow cycles. All devices will meet JEDEC J-STD-020 and J-STD-33 requirements. Lattice is using industry standard plastic mold and die attach materials that were developed to work with Cu-wire. These eliminate the corrosion issues observed on the very early Cu-wire material sets.

17. **Are there special end use environmental concerns, such as thermal sensitivity, vibration, shock or other risk?**

    The stability of Cu-wire bonds with thermal aging is better than that of Au-wire bonds. Therefore, there are no thermal concerns with operation in environments that do not exceed the rated junction temperature for the device. Lattice is developing Cu-wire only for plastic molded packages, so there is no risk of vibration or shock failure.

Business FAQ:

1. **Is Cu-wire material new at Lattice?**

   All our 40nm products (iCE40™) are currently manufactured using Cu-wire. With this PCN, we are in the process of extending this alternate qualified material set to other Lattice families.

2. **What are the economics of Cu-wire bonding? Will the Cu-wire devices have a lower price than the Au-wire devices?**

   There will not be any price reductions associated with this PCN. Lattice's ability to maintain existing prices requires customers to qualify the Cu-wire material set. Customers who decide not to accept the Cu-wire material set should expect to see price increases over time.

3. **Can I still buy Au-wire devices?**

   Devices that are shipping with the Au-wire material set today will continue to be available to customers via a custom Ordering Part Number (OPN). The custom OPN for the Au-wire material set will use the three character suffix "AU1" appended to the standard OPN as shown below:

   Standard OPN: LCMXO2-1200ZE-1TG144C

   Au-wire OPN: LCMXO2-1200ZE-1TG144CAU1

   See question "2" under Business FAQ for long term pricing trends for Au-wire devices.

4. **How do I order Cu-wire devices?**

   Cu-wire devices for PCN evaluation can be obtained by submitting a sample request through your local Sales Representative within 30 days from date of PCN notification. Please specify the custom OPN associated with the specific assembly location while requesting samples. Please refer to the PCN for custom OPN information for sample support.

5. **Will samples be available for all device/package combinations undergoing Cu-wire qualification at the time of PCN notice?**

   Customers requiring samples for evaluation should submit a sample request to their Lattice Sales Representative within 30 days from the date of PCN notification. Samples will be available for most of the high volume device/package combinations at the time of PCN notice.

   If Lattice is unable to fulfill the sample request immediately, Lattice will schedule to build the samples for the customer. Lattice will provide the customer 90 days from the receipt of samples to complete their evaluation.

6. **How long will I have to validate the new Cu-wire devices in my end product?**

   Customers will have 90 days from the PCN notification date to complete their evaluations. If customers request samples to complete their evaluation, they will have 90 days from the date of receipt of samples to evaluate the Cu-wire devices. Customers who do not want to receive the Cu-wire devices until they complete their evaluation must initiate a change order request prior to the PCN Expiration Date to convert their backlog to the Au-wire custom OPN (Example in Question "3" under Business FAQ on Page 4).

7. **When could I begin getting Cu-wire material?**

   Unless a customer needs additional time to evaluate the Cu-wire samples, Lattice plans to ship Cu-wire material as early as 90 days after the PCN notification date.

8. **How will Lattice guarantee that I do not receive Cu-wire bond devices before I complete my evaluation?**

   Case 1: Customer will complete evaluation prior to the PCN Expiration date (90 days after PCN notice).

   No action is required as Cu-wire material will ship no earlier than 90 days after the PCN notice date.

   Case 2: Customer will complete evaluation after the PCN Expiration date

   Any customer who does not want to receive the Cu-wire devices until they complete their evaluation must initiate a change order request prior to the PCN Expiration Date to convert their backlog to the Au-wire custom OPN. The custom OPN for the Au-wire material sets will use the three character suffix

"AU1" appended to the standard OPN as shown in the example below. After the customer completes evaluation of the Cu-wire material set, any backlog with the "AU1" custom OPNs must be converted back to the standard OPN.

Standard OPN: LCMXO2-1200ZE-1TG144C

Au-wire OPN: LCMXO2-1200ZE-1TG144CAU1

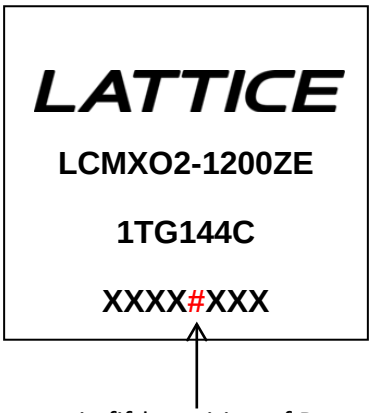
If customers want to restrict their existing custom OPNs to Au-wire material sets, they must initiate a request for a new custom OPN that will replace their existing custom OPN. After the customer completes evaluation of the Cu-wire material set, any backlog with the new custom OPNs must be converted back to the original custom OPN.

9. I understand that Lattice will be qualifying the entire set of Cu-wire devices across different assembly sites at different times. How will I be notified?

Lattice will provide a single, comprehensive PCN outlining our complete plan for qualification of the Cu-wire material sets across multiple assembly sites. Lattice will provide periodic revisions to the PCN as different product families/assembly sites become qualified.

10. Is there a way to identify Au-wire vs. Cu-wire devices by looking at the physical device?

Devices with Cu-wire material sets can be identified by a numeric value in the fifth position of the datecode marked on the topside of the devices. An alpha character in the fifth position indicates a gold bond wire (Au-wire) material set. This datecode is also marked on the label on the outside of the inventory box as well as on the anti-static, moisture barrier bag within. See device topside marking example below.



Numeric Character in fifth position of Datecode indicates Cu-wire material set
Alpha Character in fifth position of Datecode indicates Au-wire material set

11. Will Lattice provide any qualification or characterization reliability data?

Lattice will be providing qualification and characterization data. Please refer to the PCN for information on how to access this data. Manufacturability and Construction Analysis reports will be available on request through your local Sales Representative.