Failure Analysis Report for Customer
XXXXXXXXXXX Inc.

07/10/2016

Report provided for customer review
1.0 Summary:

On April 9, 2016 All Flex was alerted to a quality issue related to flexible circuit XXXXXXX PN 12345 currently supplied by vendor YYYYYYYYY. Approximately 20% of flex assemblies shipped to customer exhibited performance issues with LIS2DH accelerometer. Customer analysis determined issue was due to internal electrical failure of component, rather than electrical problems with assembly or logic/programming problems with software. Samples of good and bad assemblies, and good and bad LIS2DH components were shipped to All Flex for failure analysis.

Root cause failure analysis was performed at All Flex. Customer provided All Flex with programming software for identification and troubleshooting of affected assemblies. Samples were inspected via visual and x-ray analysis. Flex assemblies were tested for functionality after simulation of post-assembly processing.

X-ray and visual inspection did not reveal failure mode of affected assemblies. Continued testing of post-assembly product did produce convincing evidence of possible root cause of issue. In discussion with customer, it was uncovered that the current supplier utilizes ultrasonic cleaning which may have an impact on certain components. To attempt to replicate the issue, All Flex assembled components on reworked, bare flex boards and analyzed whether the components were affected by Ultrasonic cleaning. Five flex assemblies were tested, verified working before Ultrasonic cleaned, and verified not working after Ultrasonic cleaned.

Results of failure analysis conclude that root cause of defect flex assemblies is Ultrasonic cleaning process.

Analysis completed by: XXX XXXXX
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2.0 Analysis:

2.1 Background Information

Customer-supplied information:
(Sent by XXXXXXXXXXXX, Quality Engineer at XXXXXXXX, 4/9/15)

“On a subset of devices, the z-axis of one of the accelerometers (perpendicular to the pcb plane), is flaky (has a crazy DC offset way out of line of the spec sheet). X and y axis and all other communication with the accelerometers worked with no problem. I don't think there's an electrical problem with the board, nor a logic problem with the software. It looks like an electrical problem internal to the accelerometer. Very odd. My only thought is that the z-axis vector is aligned with the pnp motion during placement. Any chance that could internally affect an accelerometer? 90% of the devices have no issue.

I think the boards are good, but the accelerometer is too small for me to solder by hand. If I sent a board back to you, could you replace the accelerometer to see if it makes a difference? I think that would help the debugging of the issue by positively eliminating the board and software as the problem.

“

2.2 Investigation

- Visual inspection did not reveal any defects / failure modes causing reported issue
- X-ray inspection did not reveal any defects / failure modes causing reported issue
  - All LIS2DH solder joints of affected flex assemblies met IPC Class 2 criteria for mechanical and electrical performance
  - No cracks, pits, voids found that would potentially cause electrical opens in circuitry
  - No solder shorts found that would cause electrical performance issues
  - X-ray resolution insufficient to effectively inspect internal mechanical / electrical connections of LIS2DH components on affected assemblies
- Testing performed on confirmed good flex assemblies to simulate post-assembly process steps to determine possible root cause of issue
  - Reflow process: flex assembly confirmed good after process
  - Handling / ESD: flex assembly confirmed good after test
  - Hand Cleaning and In-line cleaning: flex assembly confirmed good after process
  - Ultrasonic cleaning (part of rework process): flex assemblies confirmed malfunctioning after process
    - 5 flex assemblies tested with this process
    - After Ultrasonic clean and dry, flex assemblies tested and proved malfunctioning when placed in Ultrasonic basket
    - Failure modes affected various LIS2DH components differently, in x-, y-, and z-axis
2.3 Conclusions

Results of this failure analysis have determined that full power of Ultrasonic clean process exerted upon flex assemblies results in varying electrical performance defects of LIS2DH component. Ultrasonic clean process was most likely performed upon 10-20% of flex assemblies, which is common to use as part of an internal rework process performed post-assembly.

Based on the results of this analysis of non-conformance, XXXXXXX will implement modifications to the rework process in future. Rework process will be modified to disallow Ultrasonic cleaning of reworked flex assemblies.

** Additional **
All Flex recommends the implementation of a post-assembly electrical test to ensure zero-defects due to the soldering and cleaning process.
3.0  Graphic Support Data

Figure 1: Flex assembly

Figure 2: LIS2DH package information

2.6.2  Zero-g level

Zero-g level offset (TyOff) describes the deviation of an actual output signal from the ideal output signal if no acceleration is present. A sensor in a steady state on a horizontal surface will measure 0 g in X axis and 0 g in Y axis whereas the Z axis will measure 1 g. The output is ideally in the middle of the dynamic range of the sensor (content of OUT registers 00h, data expressed as 2's complement number). A deviation from ideal value in this case is called Zero-g offset. Offset is to some extent a result of stress to MEMS sensor and therefore the offset can slightly change after mounting the sensor onto a printed circuit board or exposing it to extensive mechanical stress. Offset changes little over temperature, see “Zero-g level change vs. temperature”. The Zero-g level tolerance (TyOff) describes the standard deviation of the range of Zero-g levels of a population of sensors.

Figure 3: Excerpt from LIS2DH data sheet, page 16
3.0 Graphic Support Data (continued)

Figure 4: Common Ultrasonic Cleaner used in rework process at All Flex.

Figure 5: Operational parameters of Ultrasonic cleaner