Experimental skewed ESS fixture: an interim report

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This is an interim status report on the development progress at Quanta Laboratories of skewed fixtures to simulate 3DoF for circuit card assemblies (CCAs) exposed to broadband random vibration with simultaneous application of 40°C/minute rate of change in product temperature. It is a follow-up to the article in the Aug./Sept. issue of TEST Engineering & Management.

In the earlier article the authors proposed to simulate 3DoF using a skewed fixture simulated by a conventional single axis electrodynamic shaker. This design was proposed as a reliable alternate until a better system can be developed. We pointed out in our earlier paper that this design had not been scientifically evaluated and proven to be the best approach to an ESS development or production process. Experimental evaluation is continuing at Quanta Labs. When actual evaluation testing revealed large variations (greater than two-to-one) in vibration levels across two popular 6DoF systems, we questioned whether currently available 6DoF systems can offer an acceptable solution.

Skewed fixtures are being designed using finite element analysis, then built and subjected to empirical surveys. In addition, specially designed CCA fixtures are being analyzed, mounted upon, and tested with the skewed fixtures as a vibration/thermal system. The skewed fixture shown in Figure 1, the first one tested, exhibited undesirable resonant frequencies in the 1300 to 1700 Hertz (Hz) range.

The authors' objective is to avoid significant resonant frequency peaks on the fixture combination such that the product (CCA) output avoids undesirable resonance in the 20 to 2000 Hz range. To achieve the desired results, several modifications were made to the original skewed fixture which improved the transmissibility. But we recognized that the CCA fixture also induced undesirable resonant frequencies that were changed with minor modifications. Steps were taken to improve undesirable resonance in the CCA and in the CCA holding fixture. This was verified by significant improvement shown in the test results. Improvements were also realized from modification of the original skewed fixture shown in Figure 1.

Currently, the authors are concentrating upon another project, wherein new designs are underway in magnesium, as follows:

- An adjustable CCA fixture for different width cards. Preliminary analysis showed good structural characteristics, high speed ducted airflow, and an improvement in induced resonant frequencies in the ESS vibration range. This can be accomplished using a combined vibration/thermal fixture with cards held horizontally.
- Preliminary concepts have been developed to design and build a skewed fixture hogged out of a one-piece ingot of magnesium. It is expected to eliminate virtually all welding. It can also eliminate flat plates, which ring and induce undesirable resonant frequencies in the ESS power spectral density range. This approach consists of the magnesium ingot machined into a pedestal type fixture. One concept for the top and bottom of the fixture is proposed to be as depicted in Figure 2. Tapered stiffeners can be machined out of the one-piece ingot to avoid the flat plate acoustic resonance syndrome (bell ringing). Although the machining will cost more, eliminating the high cost of difficult-to-get-at welds and weld preps is expected to compensate.

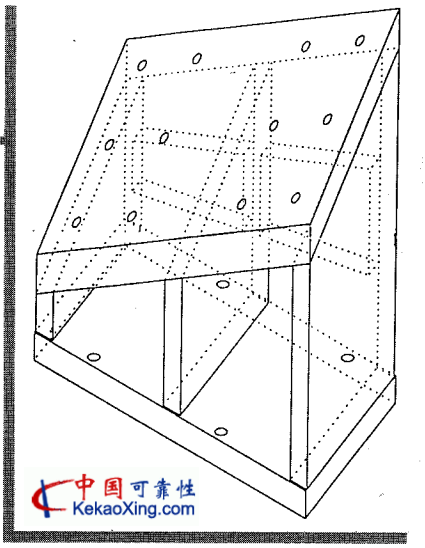

FIG. 1—Diagram of ESS skewed fixture; fixture is 5.5 inch x 10 inch; X = Y = 0.75Z.

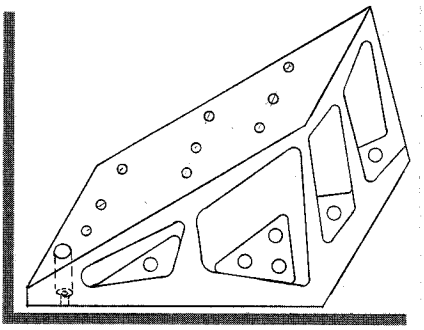

FIG. 2—Concept sketch of ESS skewed fixture.

Conclusions

Testing of prototypes has shown that the skewed fixture approach realized several advantages and disadvantages, but it does require additional evaluation. The authors believe skewed fixtures can provide a low-cost, reasonably effective, interim tool for ESS as a multiple-axis, one-setup, screen system. Design of skewed fixtures is not as simple as we first thought; it takes lots of analysis and experimentation. For new card and skewed fixtures, finite element analysis is being conducted up-front before fabrication begins.

Additional design, evaluation, build, and testing of UDLP-FMC fixtures at Quanta Laboratories is planned to be conducted and reported on in future articles. T