Abstract
Determine a specific m and Q value for a product

Question
How can I determine a specific m and Q value for a product for use in calculating the Fatigue Damage Spectrum (FDS)?

Answer
Vibration Research’s Fatigue Damage Spectrum (FDS) software is a tool which utilizes weighted time history files representative of the end-use environment of a product to create a FDS. From the FDS a Random Power Spectral Density (PSD) can be calculated creating a random profile that is the damage equivalent to the end-use environment of the product. In order to accurately calculate the FDS the m and Q values of the device under test (DUT) must be entered. For analysis, or investigative purposes there are general values that can be entered (m = 6 to 8, Q = 10), but for a more in depth analysis, and more precise calculation an m and Q value can be determined for a product.

To determine a more specific value for Q, a simple sine sweep through the operating range of the DUT will provide the primary resonance. The Q value used for the FDS should be the Q of the primary resonance. The Q value has a much lesser effect on the FDS than m. A higher Q value will use narrower filters resulting in sharper peaks, while the lower Q will result in a wider filter, a smoother spectrum, but less detail.

The m value plays a more significant role in the FDS calculation, and the accuracy of the m value can significantly improve the accuracy of the FDS generated. The process to determine the m is more involved than that of determining Q. In order to accurately determine m the S-N graph (Stress to Number of Cycles) must be created (Wöhler, 1870). One method to determine the S-N graph is to repeatedly test a product to failure at varying G_{RMS} levels, recording the amount of time required to achieve failure. When enough failure runs have been recorded, it is possible to back calculate a strong approximation of the S-N curve by plotting the data points on a log-log graph, and then plot the power law model of the data. The slope of the power law model is equal to b. From b it is possible to calculate the value of m.

\[ m = -\frac{1}{b} \cdot SF \]

In the formula, SF is based on the recommendations of MIL-STD-810G:

Vibration Research has a m calculation tool that will plot the G_{RMS} vs. time to failure data, determine the slope of the S-N curve, and calculate the m based on the input data available on our website:

FDS Calculator
References
