SPIRE-MSS-NOT-000861

Correlation between interface force and CoG acceleration in the analysis of the SPIRE FPU model issue 7.3a.

The purpose of this technote is to show the correlation between the analysed interface force at the base of the instrument and the acceleration of the CoG and a point on the top (+X) edge of the SPIRE optical bench (SOB). This technote is a first cut and is to be used only as an indication of the feasibility to use accelerometers mounted on the top edge of the SOB to monitor I/F forces. This correlation is vital for the notching on interface forces during the random vibration test. It is for now only verified in X and Y direction since the detailed design of some components inside the instrument may change. X is in plane of the SOB, Y is out of plane of the SOB.

- The mass of the instrument in the FEA is 42.3 kg
- First mode at 135 Hz, Y-direction, effective mass 31.5 kg
- Second mode at 155 Hz, Z- direction, effective mass 32.9 kg
- Third mode at 185 Hz in X-direction, effective mass 18.3 kg

Input at 135 Hz in Y is 0.0064 g^2/Hz
Input at 185 Hz in X is 0.018 g^2/Hz

Responses: (See for graphs the annex)

135 Hz, Y-response

Grid at CoG location (SOB) 6.4 g-rms
I/F force 1661 N-rms
31.5*6.4*9.807=1990 N

185 Hz, X response

Grid at CoG location (SOB) 5.9 g-rms
I/F force 2375 N-rms
18.3*5.9*9.807 = 1065 N

The response of the SOB is in X-direction way off, with regard to I/F force and acceleration. But looking at Figure 5, scaling is sufficient for monitoring during testing. The acceleration follows the I/F force nicely but 'at a distant' this is easily compensated by including a 'force correction factor' of 2.2.

Checking figure 6 an accelerometer mounted on the top of the SOB is sufficient to monitor the I/F force in Y-direction. For this a 'force correction factor' of 0.83 should do the trick.

PS could have scaled the acceleration to make it easier to compare I/F force with acclerations (figure 5&6), but that would only confuse things I think. So I did not.

Conclusion:

For the x and y excitation accelerometers mounted on the top of the SOB are sufficient to monitor the I/F force during random vibration testing (and sine for that matter) using a force correction factors. Due to the configuration of the instrument, it is expected that the z-responses have similar behaviour compared to x-responses.

Annex 'the usual graphs'

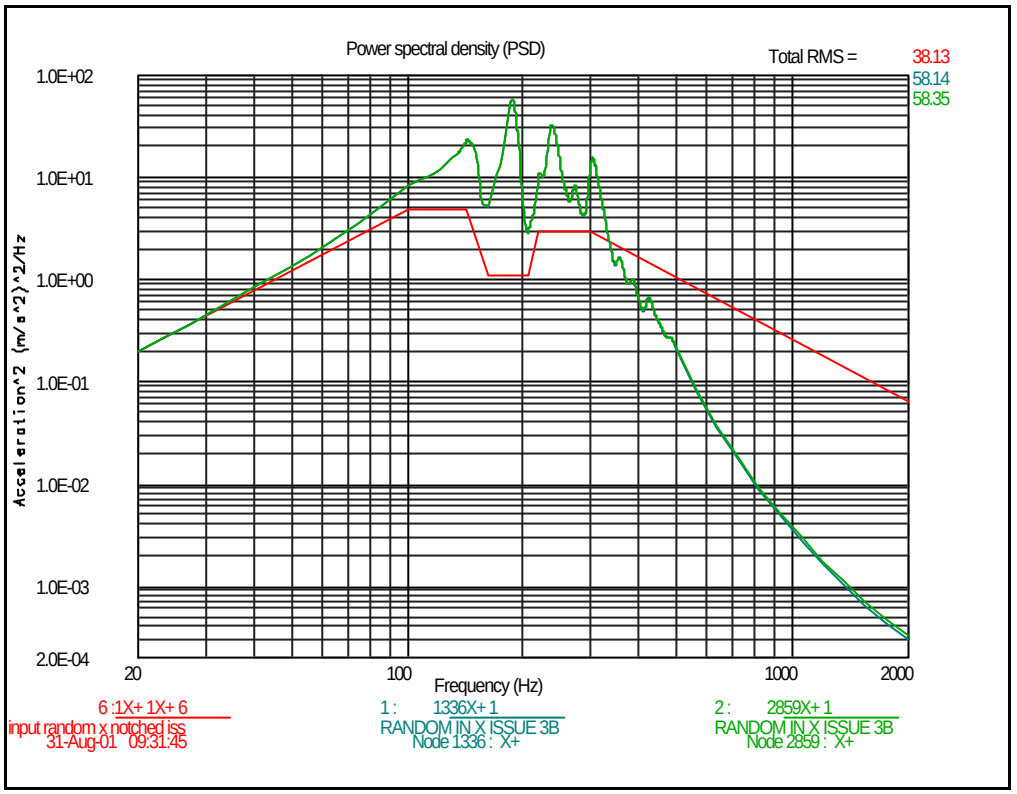

Figure 1: Random response notched x-excitation, blue top of SOB green SOB at Cog

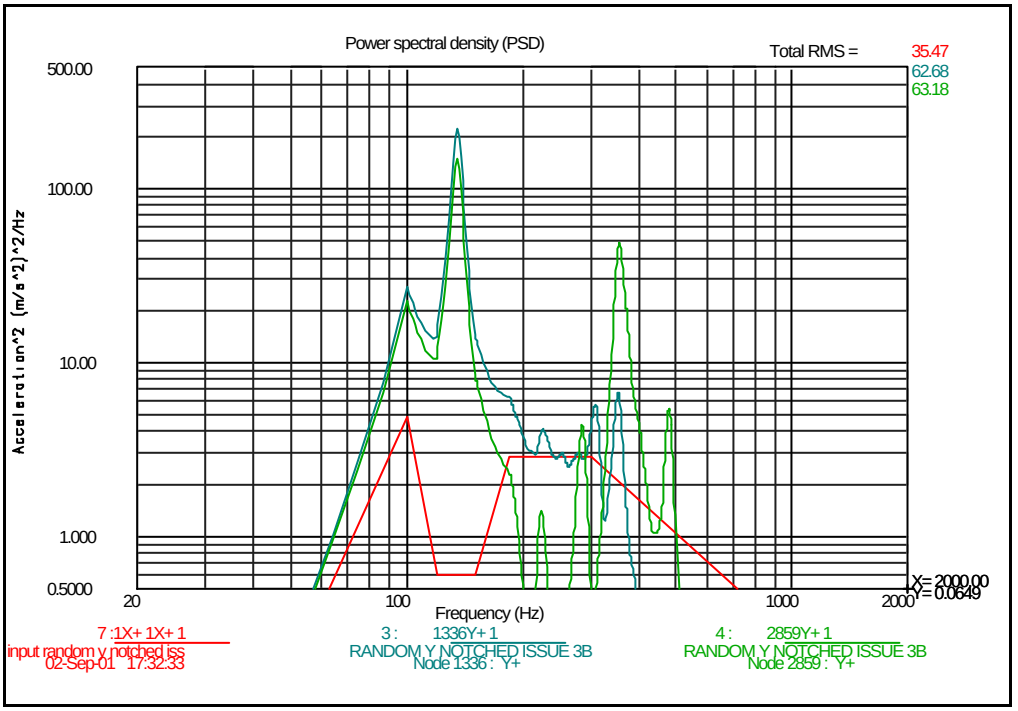

Figure 2: Random response notched Y-excitation, blue top of SOB green SOB at Cog

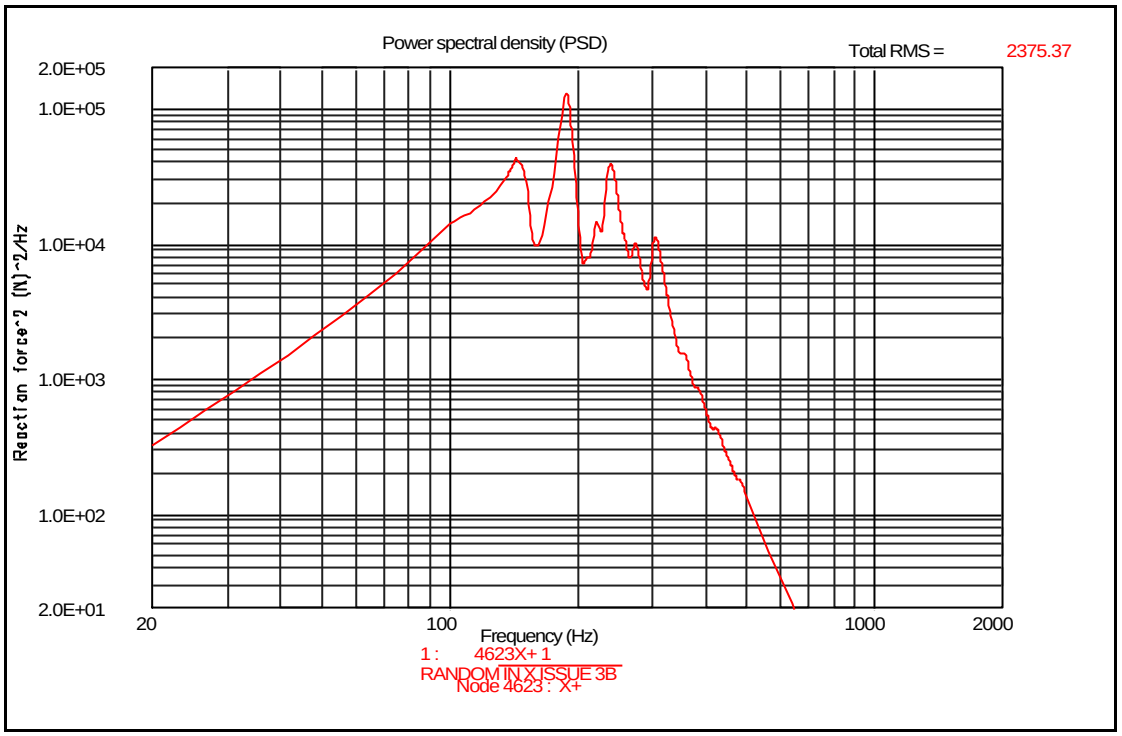

Figure 3: Random response notched X-excitation, interface force at base

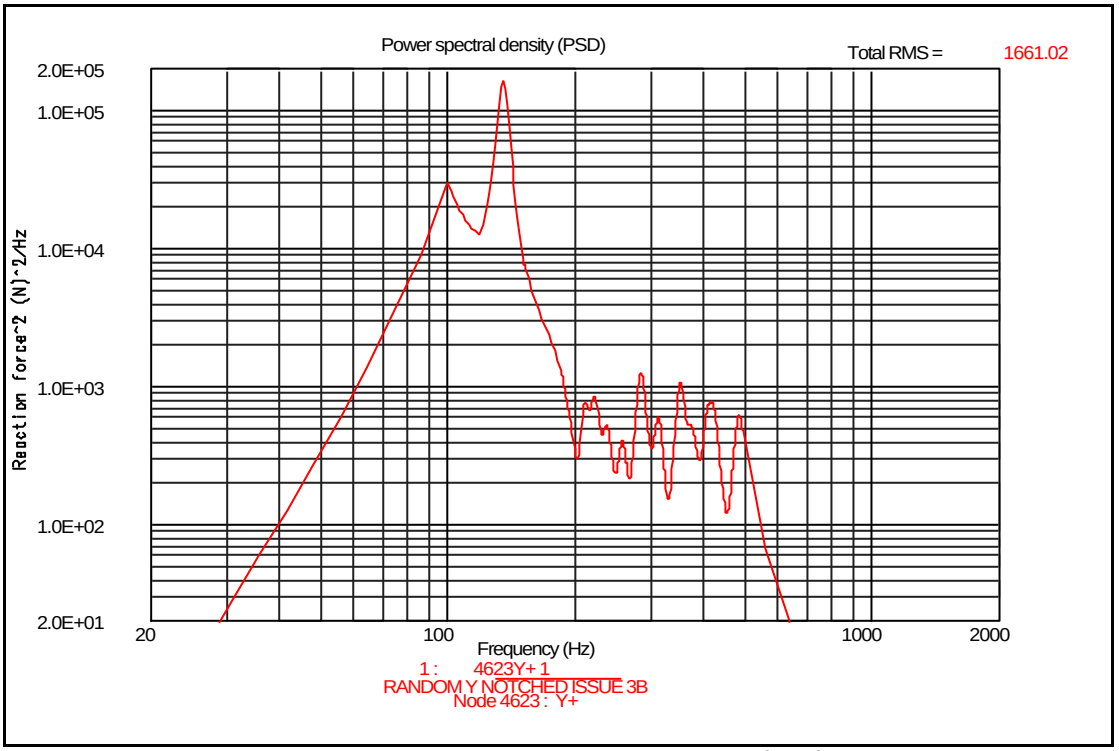

Figure 4: Random response notched Y-excitation, interface force at base

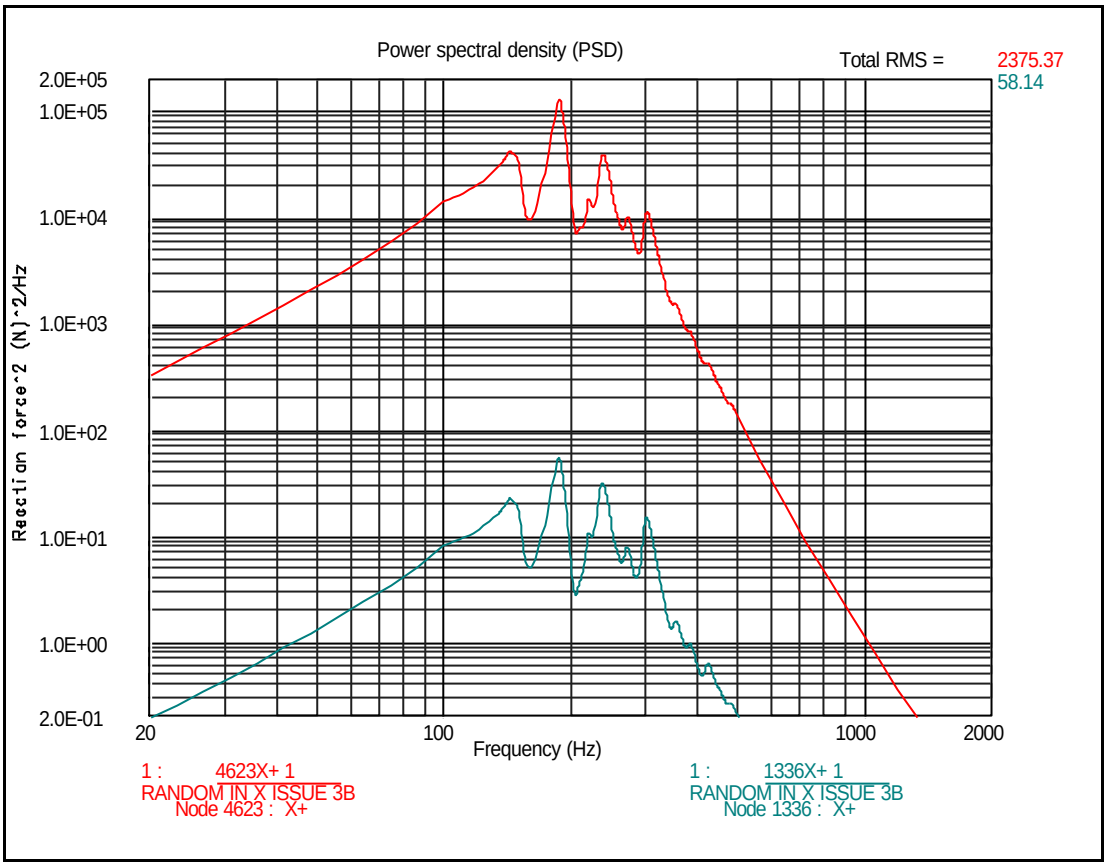

Figure 6: Random response notched X-excitation, interface force at base and accel on SOB

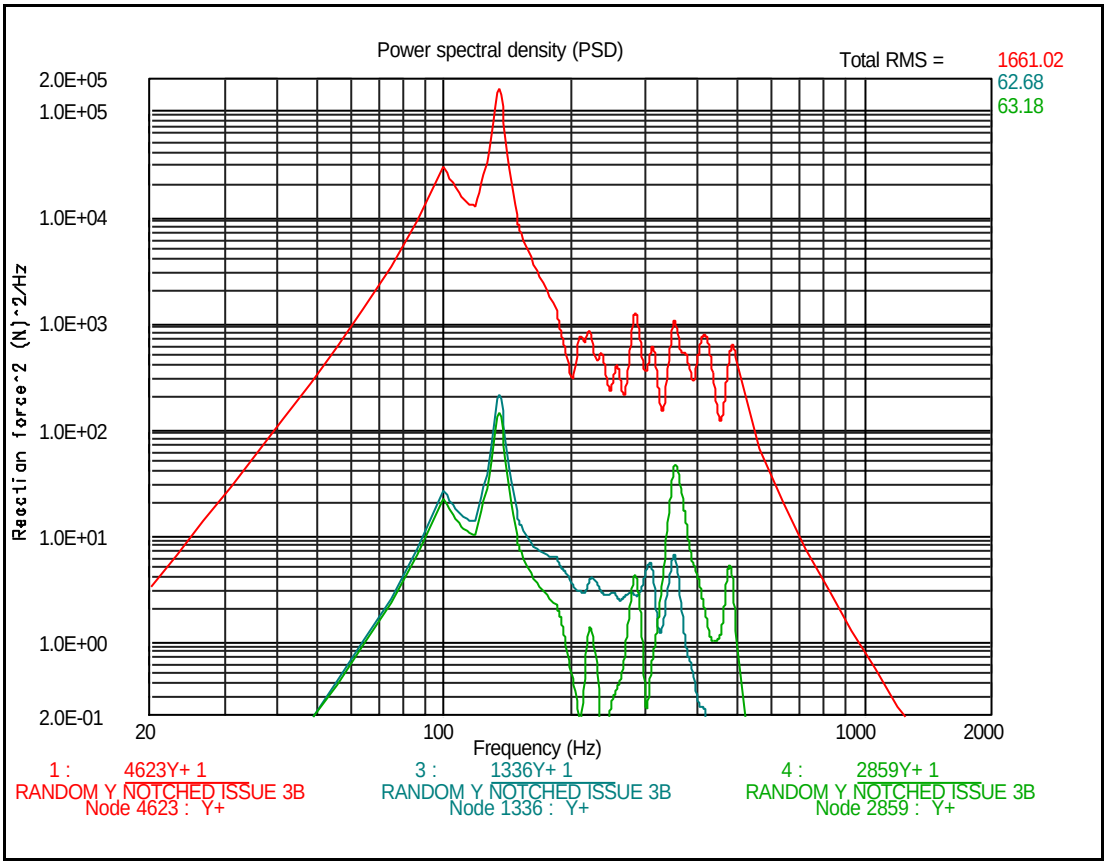

Figure 6: Random response notched Y-excitation, interface force at base and accel on SOB, blue top SOB and green at CoG on SOB