GHI SYSTEMS

Typical ESSM Shock Test Data and Analysis Using SRS

BACKGROUND A 2.5" format hard disk drive was placed on a GHI Environmental Shock Simulation Machine, ESSM. The orientation of the drive was set by grippers on the ESSM such that a particular corner of the drive would impact a solid stainless steel impact anvil at a desired orientation. The drive was instrumented with an accelerometer, the output of which was captured with a GHI WinCAT data analysis system with both time domain and SRS capability. Figure 1 shows the captured time domain acceleration waveform and velocimeter readout.

Certain data can be read from the analysis of time history data, such as peak amplitude, velocity change, duration, offsets, etc. Figure 2 shows the SRS analysis of this same waveform. It validates the values that were determined from the time domain data but additionally identifies the resonant frequencies of product resonances excited by the impact shock.

The drop height was approximately 10 inches, and the impact velocity, read from the GHI velocimeter is displayed on the plot seen in Figure 1 equal to 80.36"/sec..

ANALYSIS & COMMENTS The shock is very much like a "pyro shock" although it does have a velocity integral, while a true pyro shock does not. The velocity change is due to the fast rising narrow shock itself plus the "case resonance" waveform component above "0" baseline which is superimposed on it. Resonance was found to be 15.6 kHz using the SRS. SRS is the best method to use to analyze this type of data because of the nature of the time history of the shock.

The resulting SRS is seen in Figure 2. Note that it "up-ramps" like a velocity shock, rolls over at its peak, then rolls back to exit the plot at the ZPA amplitude. Most of the values verified by the SRS are read from the time domain. From the time domain, the peak amplitude of the shock is 2 kg, but damping gain of 1.8 times produces an SRS peak t of 3.6 kg (damping gain of 10x effected by single cycle). The ZPA, by definition, must be equal to the peak time domain amplitude and is equal to 2 kg. The peak at which the SRS reaches 3.6 k g's should be equal to the equivalent frequency (1/t) from the start of acceleration and where it reaches a first major minimum, which is roughly 136 microsec. This produces a peak frequency plateau near 7428 Hz. The ring down of the shock is product resonance superimposed on the impact shock and is comprised of many equal-width oscillations which die off in amplitude exponentially. It's frequency is read from the SRS as the little dimple near the peak at 15.613 kHz.

This resonance damps down during the residual spectrum (which occurs after the end of the principal shock loading) and is superimposed on the SRS of the principal shock. In fact, it reaches a higher destructive amplitude than the principal shock SRS (4058 g's versus 3600 g's) and must be considered potentially more damaging than the principal shock. This can be studied by changing the SRS computation damping ratio and seeing what the real peak amplitude of the resonance motion is. When the plot is extended to the right margin (100 kHz) the intersection with the ZPA can be read. Some of this information can be read from the time domain.

CONCLUSIONS In summation, from the SRS and time domain, we can read:

Peak shock amplitude = 2 k g's. Confirmed by SRS max = 3.6 k g's. (Due to gain of SRS)

Equivalent shock velocity change and duration = 107"/sec, 256 usec.

X-Y product plane case resonance = 15.6 kHz.

SRS max at resonance: 4.05 kg's.

Classification of shock: Velocity shock with residual spectrum damped ring-down.

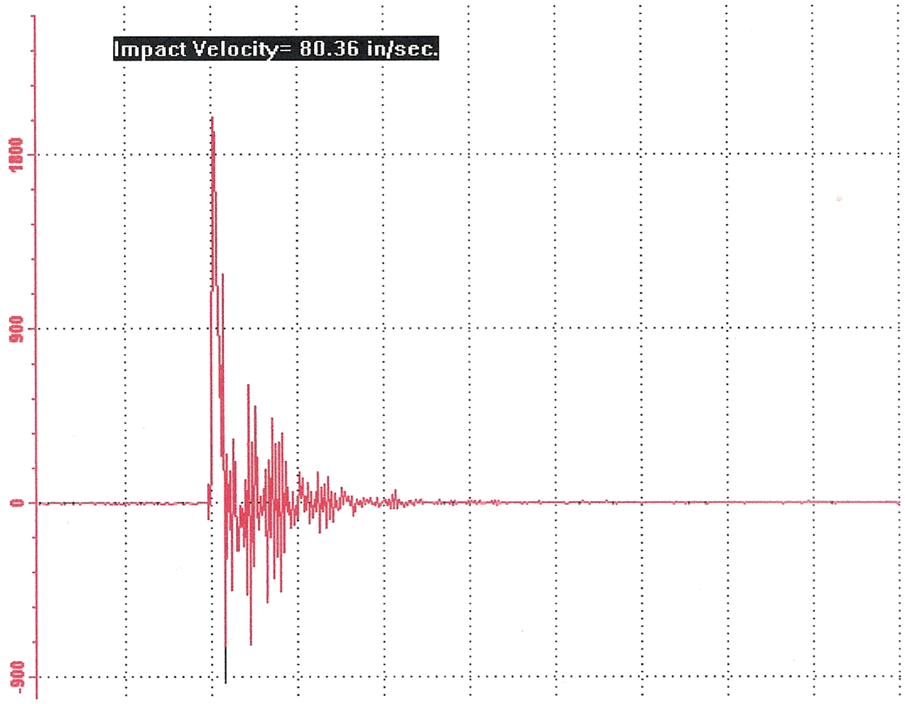

Figure 1. Time history captured with GHI WinCAT system. Peak amplitude reading was 2 Kg. Duration of principal = 256 usec. dV velocity change = 107 In/sec..

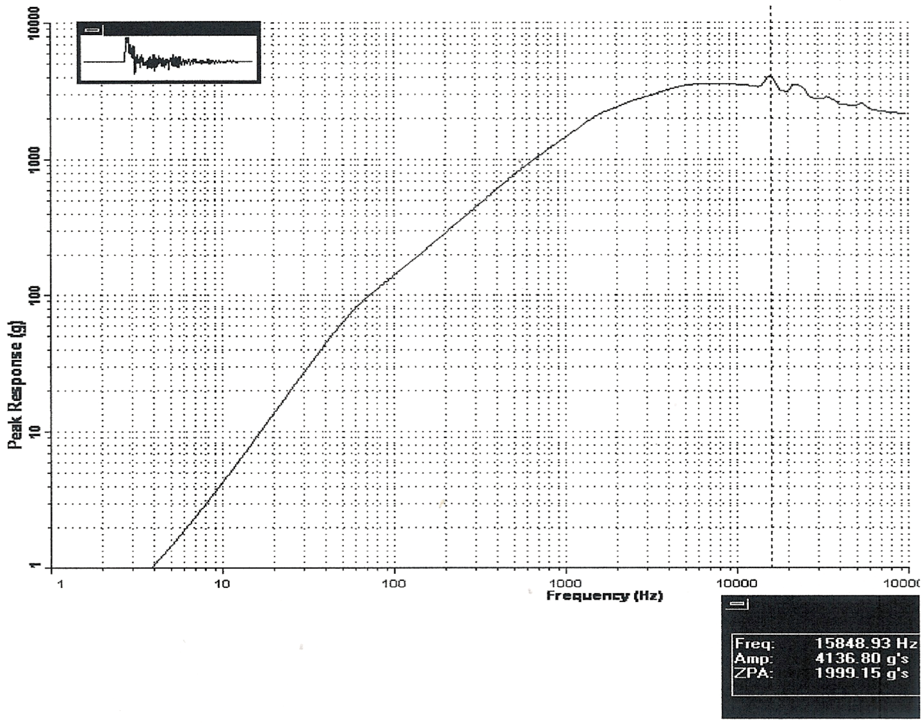

Figure 2. SRS of shock seen in Figure 1. This validates the time history readings but also shows "case resonance" @ 15.8 KHz.