Bulletin 911201

RECORDING and ANALYSIS
Of
SPECTRAL DATA FROM LASER DOPPLER VIBROMETERS
Using
THE CAT SYSTEM WITH SPECIAL SOFTWARE

APPLICATION

It is required to record and analyze shock and/or vibration data from very high g and frequency tests (PYROSHOCK) or tests involving products which are difficult to instrument because of their mass or size. For these applications, a non contacting laser doppler vibrometer (LDV) may be used as a sensor.

Problem: The LDV provides an excellent means to monitor both shock and vibration without the need for contact. Because of this feature, it has found growing application in applications fields such as pyroshock. However, the LDV outputs velocity vs time data, which is not in the form (g's) necessary for spectral assessment programs such as PSD and SRS. The principal method of converting velocity data to g's is to record it on tape, perform differentiation, then play it back through an analyzer. This takes time and most always degrades the data which results in poor analysis output.

Solution: The problems with recording and later differentiation have been overcome by a technique perfected by GHI. This is the conversion, by computer, of velocity spectral estimates into acceleration spectral estimates. The direct conversion by mathematical routines has none of the problems associated with tape recording and differentiation.

PYROSHOCK EXAMPLE

A Polytec AG LDV was used in combination with a typical shock accelerometer to capture a pyro induced event. The accelerometer was mounted on an aluminum block onto which the laser was focused. The resulting waveforms were captured by a CAT System. SRS analysis was then performed on both channels. The accelerometer data was processed by the standard SRS software while the LDV data was processed by special SRS software. The resulting SRS plots are shown on the opposite side of this page.

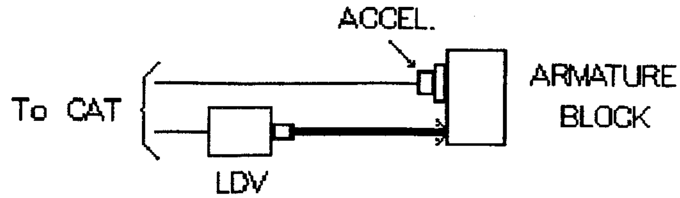
Benefits: LDV's, plus the GHI CAT with Special SRS or FFT Software result in more accurate analysis of both pyroshock events and vibration. The process of converting velocity spectral estimates to acceleration, on the fly, reduces the time from test to report drastically.

916 NORTH WESTERN AVENUE
SUITE 201 • SAN PEDRO CA 90732
(310) 548-6544

update

The illustrations on this page are from test reports produced by the GHI CAT running optional SRS Software.

Figure 1. (Right) Schematic of LDV and accelerometer setup. The accelerometer was mounted on an aluminum block attached to the shock armature. At the same time, the LDV beam was aimed at the block adjacent to the location of the accelerometer. The armature was excited by a pyro charge and the resulting armature response was detected by both the accelerometer and the LDV.



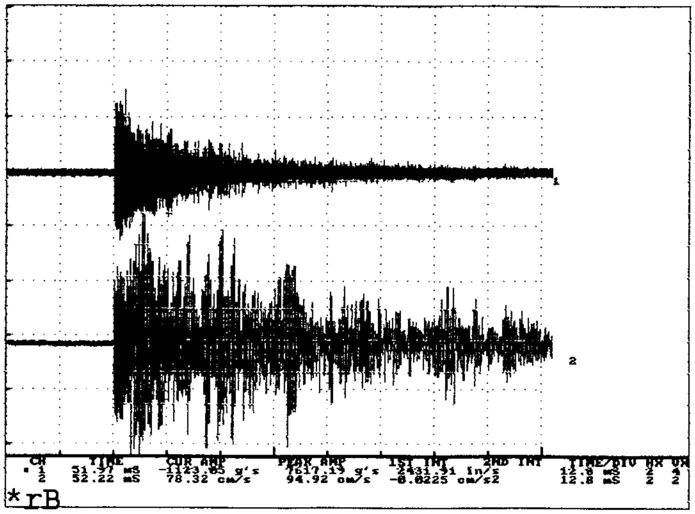
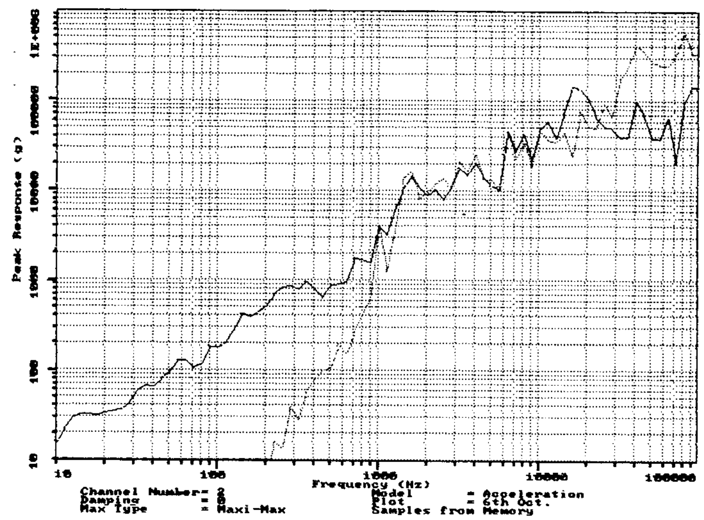


Figure 2. (Left) This figure illustrates the digitized time domain record of a pyroshock event. The top trace is acceleration from the shock accelerometer while the lower trace is velocity from the LDV. The peak acceleration as seen by the accelerometer was 7,617 g's. The peak velocity from the LDV was 94.92 cm/sec. Both signals are plotted on the same time base (12.8 msec/div). It appears that all useful information for SRS analysis is contained within 40 msec for the accelerometer. However, for the LDV, there is useful signal out to 100 msec. This is partially explained by the resolution capability of the LDV, which is in the range of nanometers.

Figure 3. (Right) This plot shows the absolute acceleration SRS's for both the accelerometer (solid line) and the LDV (dashed line). The LDV SRS was computed from velocity data. Both SRS's were calculated using zero (0) SDOF damping. The accelerometer SRS shows two typical problems. 1) The low frequency ramp up from 10 to 1000 Hz, caused by low frequency problems of the accelerometer and charge amplifier combination, and 2) the resonant peak at 18 Khz caused by the damping of the accelerometer. The 6 dB/octave ramp up to 1000 Hz for the accelerometer should be 12 dB/octave and reflects distortion in the analysis data that is not "real." The LDV produces a more correct ramp up. The degree of correlation between 1000 Hz and 12,000 Hz is excellent, indicating very close agreement between the two sensors within these limits as well as the validity of the velocity to acceleration conversion process used by GHI. The elastic mode resonance of the accelerometer block is seen on the LDV SRS as peaks at 40 and 80 KHz.



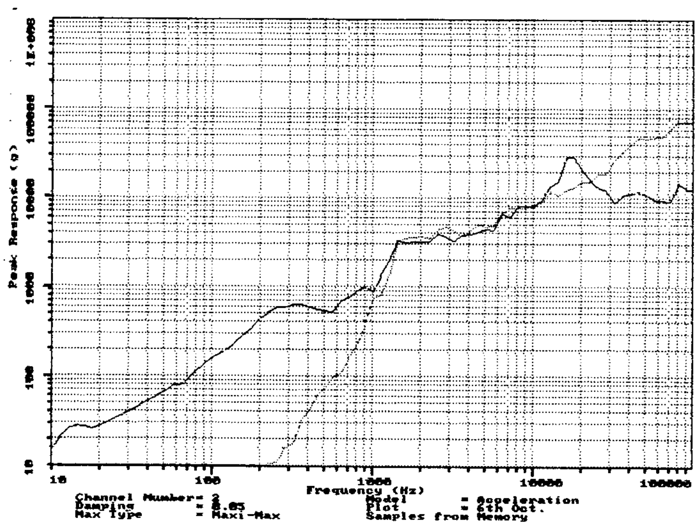


Figure 4. (Left) This plot shows the SRS's from both the accelerometer (solid line) and the LDV (dashed line) when a normal damping ratio of 0.05 was used. The degree of correlation between 1000 and 12,000 Hz is very good while the deviations of the accelerometer SRS outside of these limits described in Figure 3 is again apparent.

For additional information on the CAT System, GHI SRS Software with velocity correction, or the Polytec AG LDV used for these tests, please contact your local GHI representative or GHI Systems directly.