SHOCK AND VIBRATION RESPONSE SPECTRA COURSE
Unit 7B. Overall GRMS Value of Power Spectral Density Function

By Tom Irvine

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Introduction

Random vibration may be represented in the frequency domain by a power spectral density function. The power spectral density amplitude is represented in units of (G^2/Hz). This is an abbreviated notation. The actual unit is (G_{RMS}^2/Hz).

GRMS from Power Spectral Density

The overall GRMS value is equal to the square root of the area under the power spectral density curve. The power spectral density function can be integrated using the trapezoidal rule. This approach is suitable if the power spectral density has a constant Δf frequency resolution.

GRMS from Time History

Recall that the GRMS value may also be calculated directly from the time domain using equation (1).

$$G_{RMS} = \sqrt{\frac{1}{N}\sum_{i=1}^{N} x_i^2} \tag{1}$$

Sample Time History

A flight accelerometer time history is shown in Figure 1. The data is from a suborbital rocket vehicle. The source energy was aerodynamic buffeting during powered flight. The overall level is 2.95 GRMS, as calculated using the maxfind.exe program.

Corresponding Power Spectral Density

The power spectral density is shown in Figure 2, as calculated using the poweri.exe program. The vibration is clearly random, although it is not white noise. The square root of the area under the curve is 2.94 GRMS, as calculated using the psdtrap.exe program.
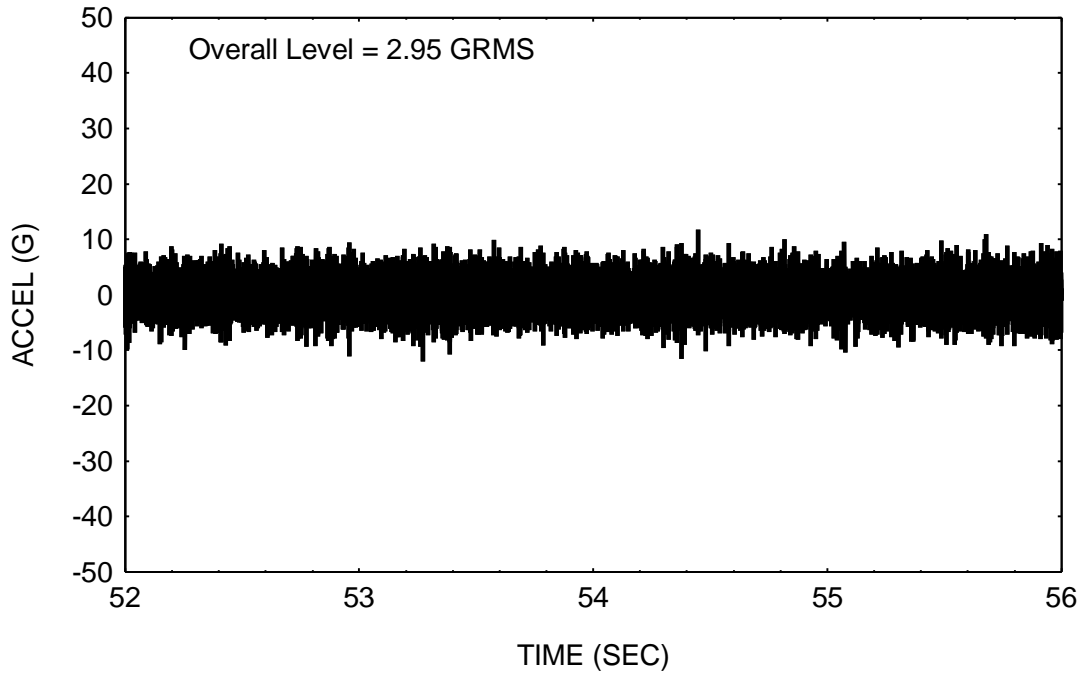
FLIGHT ACCELEROMETER DATA

Figure 1.

POWER SPECTRAL DENSITY FLIGHT ACCELEROMETER DATA
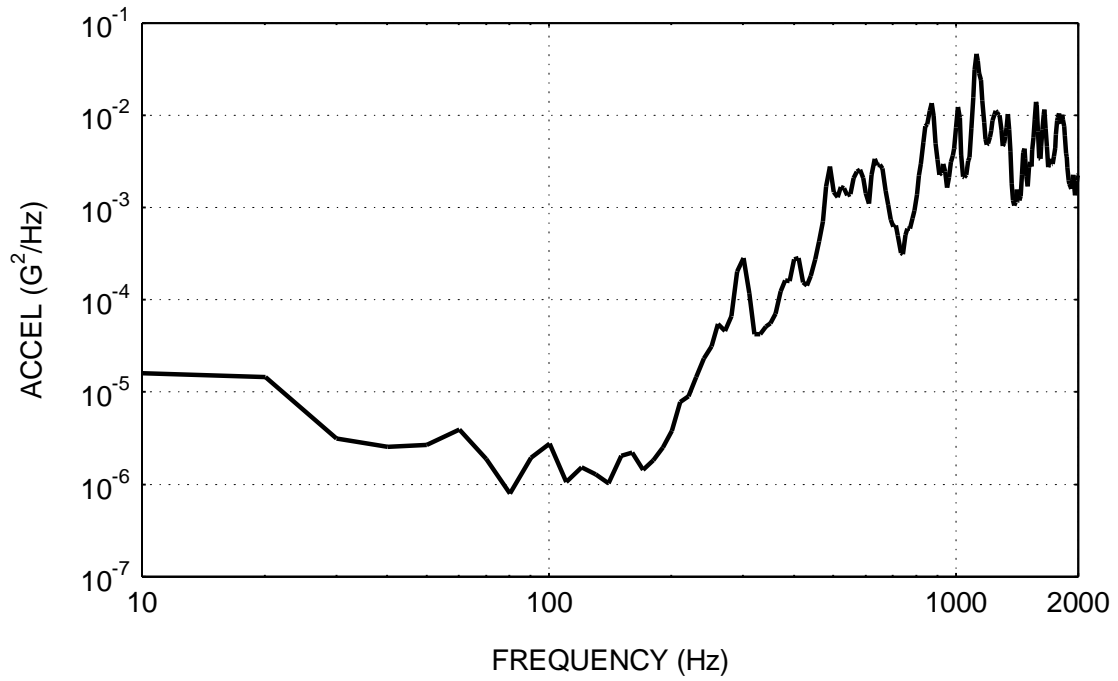Overall Level = 2.94 GRMS

Figure 2.

<u>Comparison</u>

Thus, the GRMS value from the time history equals the GRMS value from the power spectral density, ignoring the small numerical error.

<u>Homework</u>

Repeat the examples in this unit using data file: flight2.txt. This is actual flight accelerometer data.

Use a frequency resolution of $\Delta f = 10$ Hz. The data is somewhat nonstationary, but this is not a concern for this exercise.

What are the GRMS values of the time history and power spectral density?