Acceleration Noise Density - Technical Note

This technical note gives some insight on accelerometer noise density figures and how to practically use them to estimate the related resolution over a bandwidth of interest.

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1 Introduction

There are several noise sources within the acceleration measurement chain. These consist of noise that originates from the transducer element's electrical and mechanical properties. Other factors include the electronics, be they internal electronics (IEPE, current loop driver, etc.) or external amplifiers, signal conditioners, ADC front-end, and the ADC itself (quantization noise).

In this document, we will consider the noise that originates from the accelerometer and its internal conditioning circuit and how it should be considered depending on the frequency bandwidth of interest.

Accelerometer datasheets provide a "noise threshold" or "resolution" in equivalent g's. Information about the bandwidth on which this value was measured or calculated should also be mentioned.
Usually, the resolution value is given for the full bandwidth of the accelerometer, as the manufacturer is not necessarily aware of the user bandwidth of interest.
Users usually select this bandwidth of interest, either directly (by looking at their full acquisition chain and/or selecting filters), or indirectly (e.g. by selecting a given standard on their acquisition device, as for machine condition monitoring).

In order to be able to estimate the resolution of a given accelerometer in the user bandwidth of interest, noise spectral density figures should also be provided. The noise spectral density information provides noise information as a function of frequency.

2 Example

Figure 1 shows the acceleration spectral density for a standard 100 mV/g industrial IEPE accelerometer (blue curve) and Micromega Dynamics MEMs-based condition monitoring accelerometer (orange curve). The trends of those curves are typical: the one of the IEPE accelerometer is higher at low frequency and decreases with frequency, as a kind of "1/f" noise, while the one of the MEMs-based accelerometers is rather flat, as a "white" noise.

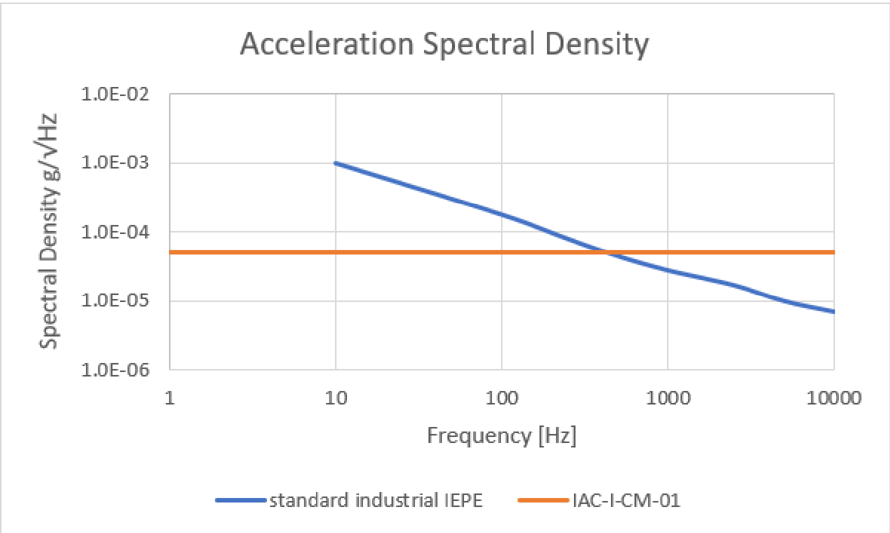

Figure 1: Acceleration Spectral Density for two different accelerometers

Now, imagine you want to have an idea of the resolution of the accelerometer over the 10 to 1000 Hz bandwidth. You have then to integrate the noise spectral density over this bandwidth.

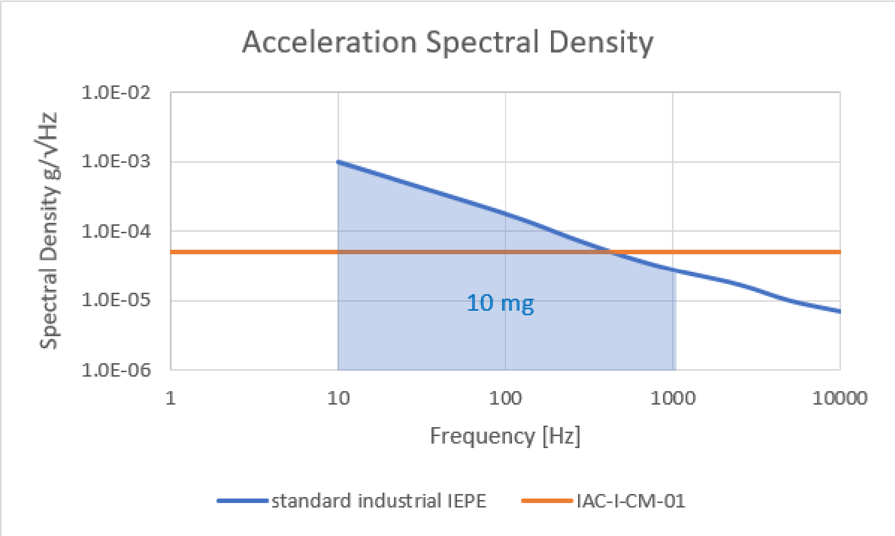

Figure 2: Resolution of the IEPE accelerometer over the 10-1000Hz bandwidth

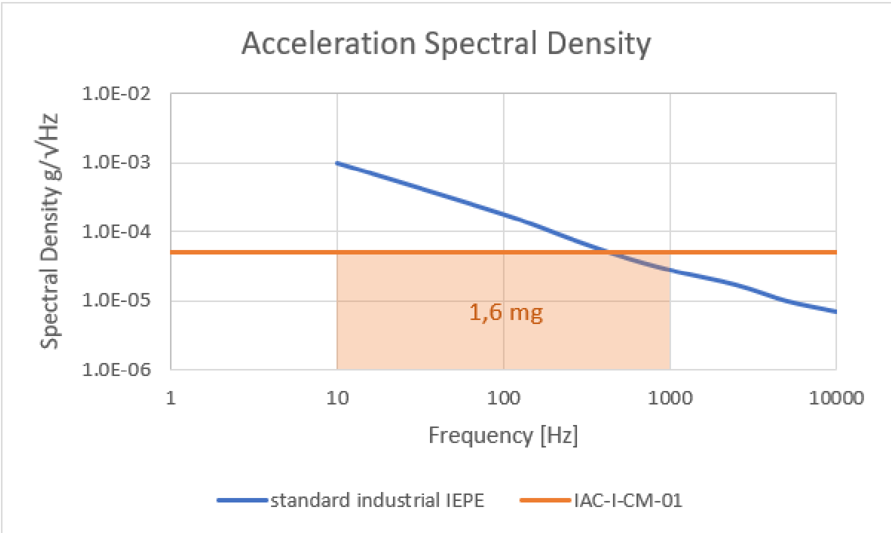

Figure 3: Resolution of the MEMS-based accelerometer over the 10-1000Hz bandwidth

3 TIP

A quick way to determine if the accelerometer selected has a low enough noise floor, use the rule-of-thumb: the lowest g level to be measured should be 10 times the “threshold level” or “resolution” in your bandwidth of interest.

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