Wilcoxon
SENSING TECHNOLOGIES

Understanding the accelerometer noise specification

Accelerometer manufacturers use many different terms to specify the ability of sensors to measure low amplitude vibration signals. The most common terms for this important characteristic are:

- Spectral noise
- Broadband noise
- Resolution

Each of these terms has a different meaning, and we can't compare any one of them directly to another.

Noise

Noise is an unwanted signal output that does not represent true vibration. Lower noise allows smaller vibration signals to be read by an analyzer.

Accelerometer amplifiers, like all electronic amplifiers, have some noise. This noise is produced by the electronic components in the amplifier. It is not possible to make an electronic amplifier with zero noise.

An amplifier with the lowest noise is not necessarily the best amplifier for industrial applications. For example, the circuits that provide protection from high voltage and accidental reverse polarity powering also add noise to the circuit. If the manufacturer removes these protection devices from the circuit, the noise will be reduced – but the resulting accelerometer will also be much more easily damaged.

One common characteristic of all internally amplified accelerometers is that noise is higher at low frequencies. Unfortunately, low vibration frequencies are also where acceleration tends to be the lowest amplitude. For this reason, it's important that industrial accelerometers have low noise at low frequencies. For virtually all industrial accelerometers, noise is very rarely an important consideration at frequencies above 1,000 Hz.

Spectral noise

Most Wilcoxon accelerometer specification sheets provide information on the maximum specified noise for various low frequencies. Using model 786A as an example, the "Electrical noise" specification at 10 Hz shows *spectral noise* of 10 µg/√Hz. This complex term (µg/√Hz) converts the noise at a given frequency to the equivalent signal output in g. (1 g of acceleration equals approximately 9.8 m/sec^2.)

The term µg/√Hz describes the amount of noise that is present within a given bandwidth. In this calculation, the noise level is converted to the equivalent level of vibration (g) that would be measured by the analyzer. This allows comparison with actual vibration signals that need to be analyzed. For example, with a noise level of 10 μg, a real vibration signal of 30 μg is about 30 times greater than the noise.

This is very useful information. In this same example, this means that if we look at a 1 Hz wide window, at a frequency of 10 Hz, the signal output due to noise will be less than 10 μg.

Broadband noise

Broadband noise makes this same calculation. However, instead of looking at the different noise levels present at different frequencies, broadband noise is calculated over a very broad bandwidth. Wilcoxon generally specifies this bandwidth as 2.5 to 25,000 Hz.

This is not as useful a way to measure noise. Most industrial monitoring systems do not look at vibration over 5,000 or 10,000 Hz; calculating broadband noise over a bandwidth that includes frequencies up to 25,000 Hz can hide noise problems at the important frequencies that are actually being analyzed.

Some accelerometer designs have a very high noise at frequencies below 100 Hz, and have very low noise at 20,000 to 25,000 Hz. This type of accelerometer may have a broadband noise specification that is lower than an industrial accelerometer when, in actuality, the industrial accelerometer is lower in noise over a bandwidth of 1 to 10,000 Hz.

Wilcoxon industrial accelerometers are designed to have the lowest possible noise at the frequencies actually being monitored. This is why specification sheets show both the ‘broadband’ (including the bandwidth) and ‘spectral’ noise specifications. Other manufacturers may not have good noise specifications at the frequencies being monitored, and so only specify the broadband noise.

Resolution

Resolution is a confusing term that’s been defined in several different ways. It’s been defined as the lowest level of signal that can be measured, or the lowest level of valid measurement. The lowest level that can be measured depends on many factors, including the signal-to-noise ratio required by the data collector or analyzer being used.

Most people using this term are using broadband noise as the basis with which they calculate resolution – which, as we have seen, does not accurately reflect the different noise levels present at different frequencies.

Conclusion

Wilcoxon designs its amplifiers to have very low noise at low vibration frequencies. This is where minimizing noise is most important in industrial applications. The most useful measure of noise is *spectral noise*, which provides important information about the noise level at specific frequencies to be monitored.

It is not practical to compare one type of noise measurement to another (spectral, broadband, resolution), and the term resolution is only useful when the mathematical definition is provided. In most cases, “resolution” is just another way of saying “broadband noise.”