

## Triaxial vs. Single Axis Sensors

### The Benefits of Using Triaxial Array Accelerometers

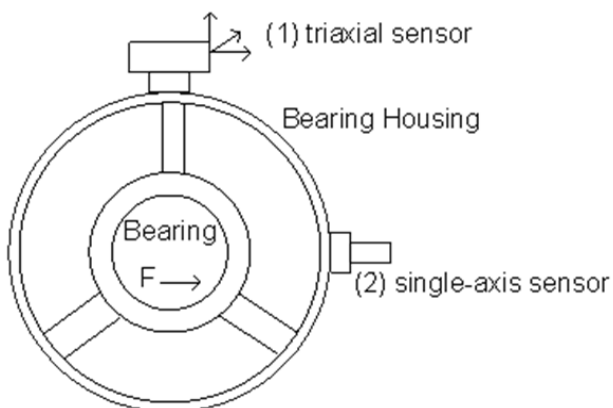
The question has arisen whether the transverse channel of a triaxial accelerometer provides equivalent measurements to a single axis accelerometer oriented in the same direction.

It should be recognized that different locations on a bearing housing will provide different structural transmission paths for vibration generated from the bearing itself. Each different transmission path might indeed have different frequency response characteristics, as well. Consider the diagram below.

The horizontal measurement at the triaxial sensor depends on the input force at the bearing ( $F$ ), and the frequency response of the structural transmission path between the bearing and the location (1) of the triaxial sensor. The measurement at the single axis sensor depends on the same input force ( $F$ ) but transmitted through a different structural path to the location (2) of the single-axis sensor.

For sufficiently low frequencies comparable with typical machinery rotation rates, or sufficiently tight, solid bearing housings, the frequency response of the two paths will be extremely close. When considering high frequency vibration (greater than, say, 1 kHz, for example, but depending on the mass, stiffness, and geometry of the machine casing) the response might be different, and the two locations might measure different amplitudes.

Such high frequency vibration produced by such faults as deteriorating rolling element bearings or high speed gear meshes is transmitted acoustically through the structure in stress waves, as opposed to overall translation (in phase) of the entire machine. Consequentially, subsequent interpretation of these components in terms of the directionality of the underlying forces can be extremely complicated. Such vibration tends to be omni directional as the stress waves are scattered at structural interfaces.



For measurement of machinery vibration for purposes of diagnostic trending, the difference in frequency response is usually not relevant. Both measurements are repeatable, so any increasing trend will still be detected.

If the bearing housing dimensions are large relative to the overall size of the machine, then the rotational components of motion might also have



an effect on the difference between the two measurements. For example, if the machine is rocking on its foundation, then the horizontal component of motion is actually higher at the triaxial location (1) than the single axis location (2), although both measurements provide a repeatable indication of the force generated at the bearing.

Although both locations provide horizontal measurements from the same bearing housing, the triaxial sensor is really measuring motion tangential to the axis of rotation, while the single axis measures radial motion. In the case of a soft foot or rotation of the bearing housing, the motion would not be detected by the horizontal measurement at location (2), but would be pronounced horizontally at the triax location (1). Many mechanical forces generated in typical machinery result in such tangential motions of the casing. The triax represents a better tool to measure tangential vibration than the single axis sensor.

In a predictive maintenance program where many machines are monitored on a regular basis, triaxial data collection offers a significant cost and labor saving benefit, especially when data can be collected simultaneously from all three channels. Only one sensor attachment and measurement cycle is necessary at each bearing monitored. Only one surface preparation at each bearing is necessary. Collecting three-axis data from each location with no additional labor gives analysts a much more complete set of data from which to diagnose machinery faults than if a smaller set of selected single axis measurements were made (see “Triaxial Vibration Spectral Data, An Important Ingredient for Proper Diagnosis, by Bill Watts).

In summary, while high frequency response might be different between a shear measurement made using a triaxial accelerometer and a radial measurement in the same direction made using single axis accelerometer, the benefits to using a triax include cost savings, convenience, and improved tangential sensitivity.



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