# Tech note - measurement locations

Understanding the importance of taking vibration measurements at all locations where rotating components interface with the machinery frame.

A general statement can be made as to vibration measurement locations. “Make vibration measurements at all locations where the rotating components interface to the machine frame.” Additional measurements at the attachment mounting locations may be useful on machines that present particular problems related to structural response such as resonance in the structural support system for a rotating machine or in the pipe system attached to a pump.

## ISO 10816-1 guidelines

General guidance as to mounting locations for vibration sensors is described in ISO 10816-1:1995 Mechanical vibration – Evaluation of machine vibration by measurements on non-rotating parts, Part 1: General Guidelines. The guidance contained in section 3.2 Measuring Positions states:

*Measurements should be taken on the bearings, bearing support housing, or other structural parts which significantly respond to the dynamic forces and characterize the overall vibration of the machine.*

*To define the vibrational behavior at each measuring position, it is necessary to take measurements in three mutually perpendicular directions. The full complement of measurements (at each support and in three mutually perpendicular directions) is generally only required for acceptance testing. The requirement for operational monitoring is usually met by performing one or both measurements in the radial direction (i.e. normally in the horizontal-transverse and/or vertical directions). These can be supplemented by a measurement of axial vibration. The latter is normally of prime significance at thrust bearing locations where direct axial dynamic forces are transmitted.*

## Understanding standards

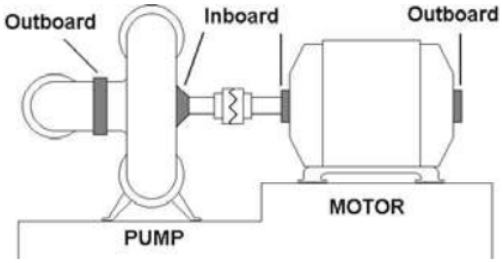
The guidance basically states that a complete set of measurements for rotating shaft vibration consists of two radial readings at a bearing position in directions 90º apart and an axial direction reading. This is also the same advice given by most manufacturers of vibration analysis equipment and purveyors of vibration training courses.

## Mounting considerations

Two of the greatest problems facing vibration analysts are how many sensors to mount and where to place them. As a general rule, if only one sensor can be permanently mounted, it should be placed at the thrust bearing since faulty bearings will transmit vibrations in the axial as well as radial directions. While the vibration energy is lower in the axial direction, it is still available for analysis.

Other factors to consider are where additional sensors should be placed, and what the optimum number of sensors to use is. Since the axial reading will be on one piece of equipment, the second sensor should be mounted in the radial direction on the other piece of equipment. For a typical equipment set of one driver and one driven element (i.e. motor driving a pump) there will usually be four total bearings with one of them acting as a thrust bearing. This means a total of five sensors would be the usual optimum number of sensors.

Refer to the motor-pump unit drawing as an example. There are four bearing positions, two on the pump and two on the motor. The inboard pump bearing serves the function of taking up axial thrust as well as radial force. In this case the optimum number of sensors would be five (5): a sensor in the horizontal position at each of the four (4) bearings and one (1) in the axial direction at the inboard pump bearing.

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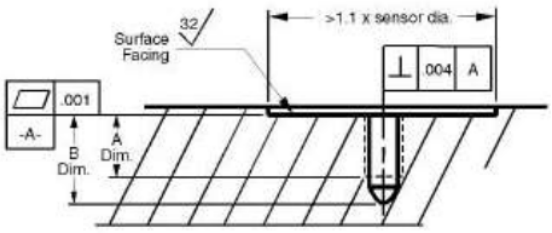
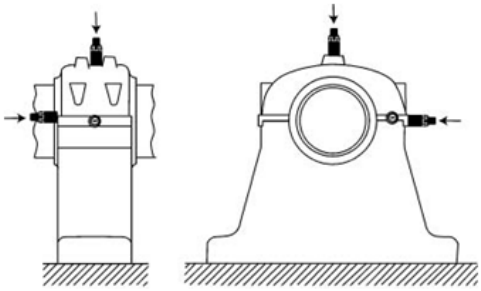
## Surface preparation



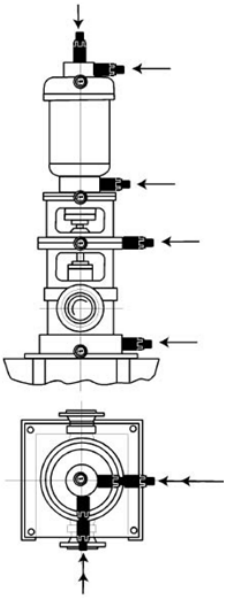

The illustrations in this tech note show some examples of mounting locations to achieve a full complement of measurements at each bearing position if a user were to mount permanent accelerometers for each measurement position. Also illustrated is the surface preparation necessary to properly mount industrial transducers on machines. The spot-facing and pilot hole drilling can be accomplished in the same operation by using Wilcoxon's spot-face tool, ST101. It will face off a 1.25 inch diameter spot while drilling the pilot hole for a 1/4-28 tap.

Many users wonder if accelerometers need to be installed all three axes at each bearing location. ISO standards specify that only one or two measurements at a bearing position are necessary for operational needs.

## Pedestal bearings



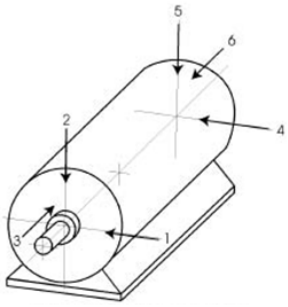
In the pedestal bearing illustration, the bearing support structure has the highest stiffness in the vertical direction. Consequently, if a user wishes to measure the highest levels of vibration experienced on this bearing, the horizontal (radial) direction will yield the highest reading since the horizontal direction has lower stiffness than the vertical. In general, one sensor should be used at every bearing position and it should be mounted in the direction of least support stiffness.



## Vertically mounted equipment

For vertically mounted equipment such as vertical pumps, any horizontal direction would seem to present equal stiffness and, hence, equal vibration levels. However, equipment support structures may in fact, have higher stiffness in one direction versus another. In those cases the sensor should be mounted in the direction of least stiffness to measure the highest vibration levels.

## Axial measurements




Another area of confusion is axial measurements. If measurements are being taken at each bearing position, are axial measurements at all necessary? While not absolutely necessary, at least one axial measurement should be taken at the bearing position where there is a thrust bearing or a bearing that can act to accept an axial load. Some vibration problems will exhibit symptoms better in the axial direction than in the radial direction. This vibration energy can be measured best at the bearing location where axial loading will transmit to the bearing case.

## Maintenance history

Some additional guidance as to monitoring locations can come from the actual maintenance history of the machine. If the equipment or similar types of machinery have a history of some particular fault mode, that fault mode should be used for guidance as to where to mount vibration sensors. For example, if a particular model of pump usually has problems with the bearing at the driven end of the pump, it would be a good idea to monitor the driven end of the pump in the radial direction. If a user were to only have the ability to mount one permanent sensor, then the user should tend toward mounting that one sensor in a location most likely to indicate the most probable failure mode of the pump.

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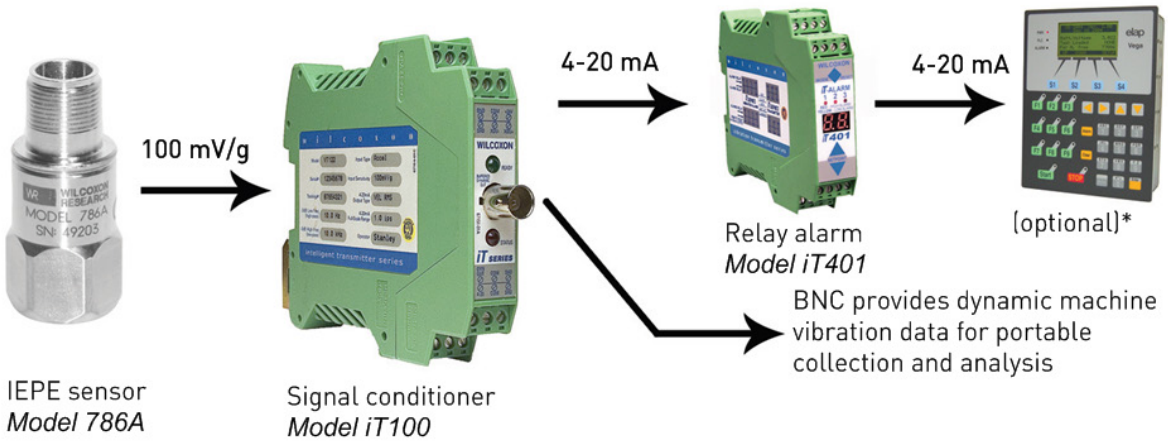


## Importance of vibration monitoring

Vibration sensors coupled with panel mounted transmitters offer industrial plants the opportunity to include machinery vibration with other operating parameters measured by PLC and DCS systems. Unlike flow, pressure, or temperature, however, vibration is not usually related directly to the production process. Vibrating screens and mixers are exceptions to that statement; their operation must be at a certain level or the process can be directly affected.Plant personnel must decide what limits to place on vibration. Often, data is available from historical vibration records to indicate the levels of vibration that are acceptable and unacceptable. In the absence of such historical guidance, ISO 10816 can provide useful information to aid in selecting proper settings for vibration limits. This guide adds some additional information to aid users in their quest for vibration limits. Here we have introduced the concepts of base-lining, rate of increase, and data weighting. Using ISO 10816 as a guide we have expanded on the number of vibration sensors to use and where to locate them on machinery.

Although it is primarily the responsibility of the plant maintenance personnel to determine whether to monitor vibration, where to locate sensors, an acceptable level of vibration, and when to institute corrective maintenance, this guide is designed to provide some additional data to aid in those decisions. It is not intended to replace the knowledge of experienced maintenance personnel. Operating and maintenance personnel are the people who generally know their machinery the best.

In any situation involving vibration monitoring the best guidance is to use common sense and good judgment. For more information or help with your application, email info@wilcoxon.com or call 1-800-WILCOXON.

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