Shaft eccentricity measurements with the SKF Multilog On-line System DMx

By Marcel de Boer • SKF

What is eccentricity monitoring?

Shaft eccentricity is a measurement of the mechanical, thermal, or gravity bow of a rotor assembly at slow roll speeds as shown in **Figure 1**. This bow must be minimized prior to operation of a large machine train to prevent vibration and possible machine damage, caused by rotating parts of the rotor assembly contacting stationary parts of the machine case. This contact of rotating and stationary parts is referred to as "radial rub occurrence."

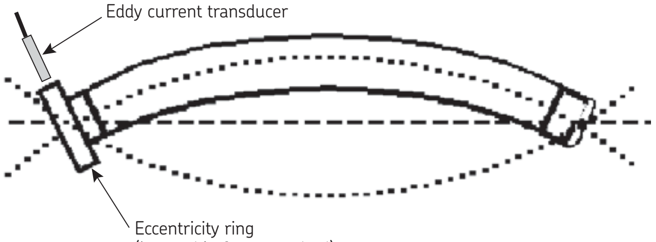


Figure 1.

The SKF Multilog On-line System DMx.

Why measure eccentricity?

Rotor bow

During normal machine operation, the rotor assembly is constantly rotating at high speed. This high-speed rotation equalizes the effects of gravity and thermal forces acting on the rotor assembly. However, as soon as the rotor assembly comes to rest, these forces no longer apply equally to all sides of the assembly. With the rotor assembly in a stationary position, gravity acts upon the rotor causing the center to bow, similar to how a thin piece of wood bows when placed between two mountings. As displayed in **Figure 2**, machine bearings support the rotor assembly span between them. This condition is normally a problem on a machine that has been stationary for some time (for example, as a result of machine outage).

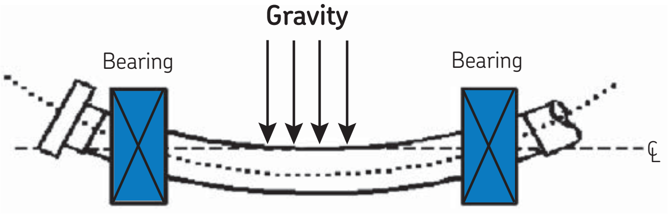


Figure 2.

Thermal forces act on a rotor assembly when the rotor is shut down from its operating condition. In a shutdown condition, heat is trapped in the upper machine casing, creating a thermal differential across the assembly (for example, the top of the rotor assembly becomes hotter than the bottom). As displayed in **Figure 3**, this temperature differential causes the rotor assembly to bow towards the greater heat source (upwards in this case). This example is similar to placing a torch or other heat source on one side of a piece of flat steel. The steel will bow toward the torch, or heat source.

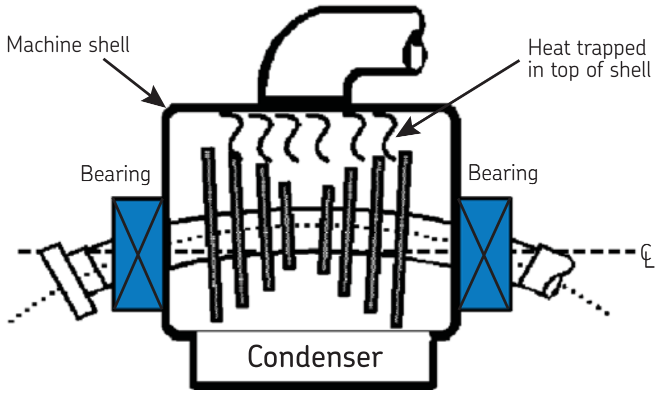


Figure 3.

The degree of the bow is reflected as mechanical eccentricity at the two shaft ends (see **Figure 1**).

A key Turbine Supervisory Instrumentation (TSI) measurement for monitoring shaft bow uses an eddy current probe targeted on a "eccentricity ring" to measure eccentricity.

Eccentricity with the SKF Multilog On-line System DMx

In the SKF Multilog DMx, the CMMA 9910 protection module is the signal-conditioning unit used for monitoring eccentricity. This application note provides a guide to the module's configuration for a typical eccentricity measurement, and should be used in conjunction with the SKF Multilog DMx user manuals.

The SKF Multilog DMx module simultaneously accepts up to four dynamic input signals and up to two speed inputs through its terminal strip connector. Each channel can be independently configured via programming for any kind of AC or DC voltage signal. In this document, only the eccentricity configuration is discussed.

Sensor input

When measuring eccentricity, a standard eddy current probe system with a 2 mm range (80 mils) is typical. The recommended sensor arrangement is to use a standard eddy current probe and cable with the internal digital driver of the SKF Multilog DMx. An external eddy current probe system (consisting of probe, cable and analog driver) must be powered externally with a CMMA 9910.

Sample "measurement channel properties" from SKF Multilog DMx Manager software are shown in **Figure 4** and **Figure 5**. In the "General" tab, Eccentricity is a TSI parameter in a "drop-down" list. Selecting it reveals a number parameters in the "measurement" tab applicable to eccentricity. In the example shown in **Figure 4**, the ECP type is set to "Direct ECP" in order to use the internal digital drivers.

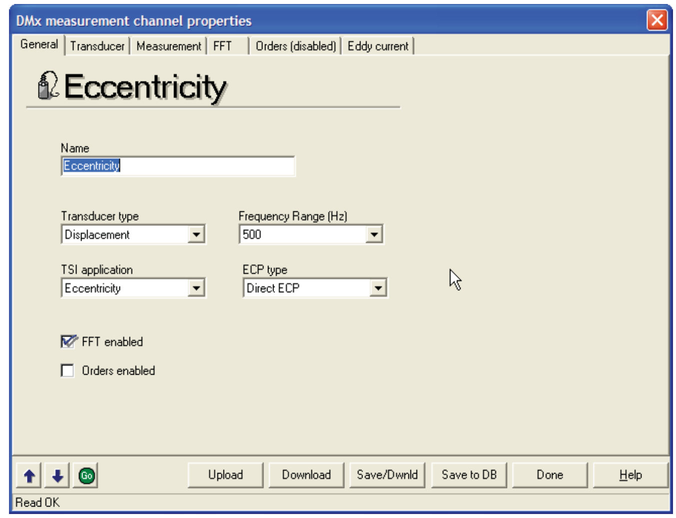


Figure 4.

The SKF Multilog DMx microprocessor performs probe "OK" checks. The limits for OK checks, together with the measurement engineering units, are set in the "Transducer" tab (see **Figure 5**).

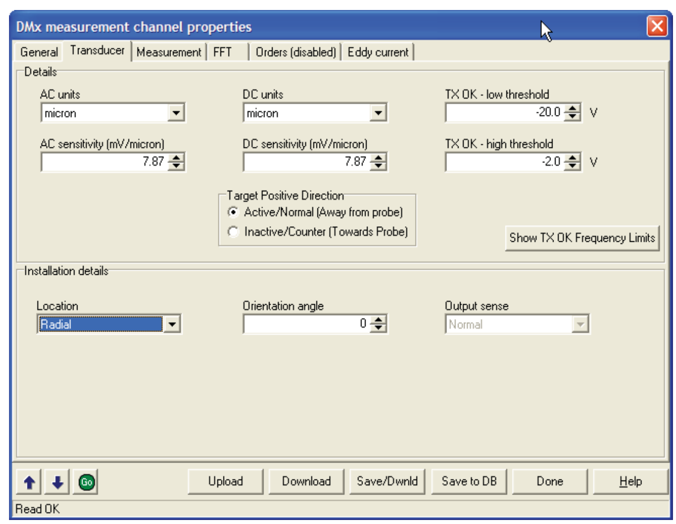


Figure 5.

Processing

The eccentricity measurement is only valuable as an indicator of possible rotor bow at slow speed (slow roll), and occurs at speeds below 600 RPM (10 Hz). Above this speed, either the rotor bow has been "rolled out" or the machine has wrecked itself. As the speed increases, the mechanical eccentricity at the shaft ends reduces to the level where it is indistinguishable from shaft radial vibration (as measured on the eccentricity ring). Hence, when measuring eccentricity, a software selectable low pass filter is applied that is between 5.0 and 20.0 Hz. This results in an operating area from 30 RPM (0.5 Hz) up to any speed between 300 RPM (5 Hz) and 1 200 RPM (20 Hz).

As described in **Figure 6** and **Figure 7**, processing will produce the results shown in **Figure 8**, in a live SKF Multilog DMx Manager display.

Processing configuration

Set-up of eccentricity processing in the SKF Multilog DMx is as follows, choosing between:

- A reading in micron measured as peak-peak ***per revolution*** or
- True peak-peak measurement

In **Figure 6**, a measurement over a single revolution is selected for speeds greater than 0.5 revolutions per minute. For this option, there must be an active speed channel (Keyphasor).

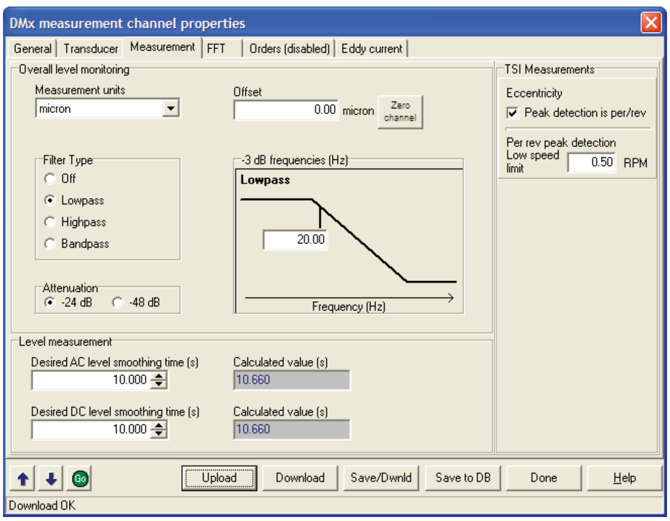


Figure 6.

If eccentricity is to be determined by true peak-peak measurement, then, first the "per/rev" needs to be deselected, and then an AC level smoothing time needs to be specified. The smoothing time is used to stabilize the reading at slow rotational speeds. A smoothing time of 10 seconds is typical – a smoothing time of only 1 second would produce fluctuations in the value which are not indicative of the mechanical eccentricity being measured.

Processed output selection

The measured eccentricity becomes a "Processed Channel" in the SKF Multilog DMx. This can be displayed "live" in SKF Multilog DMx Manager, transmitted to a process control system, and/or be sent to SKF @ptitude Analyst software for long-term trending. For eccentricity, normally the peak-peak output is used. **See Figure 7**.

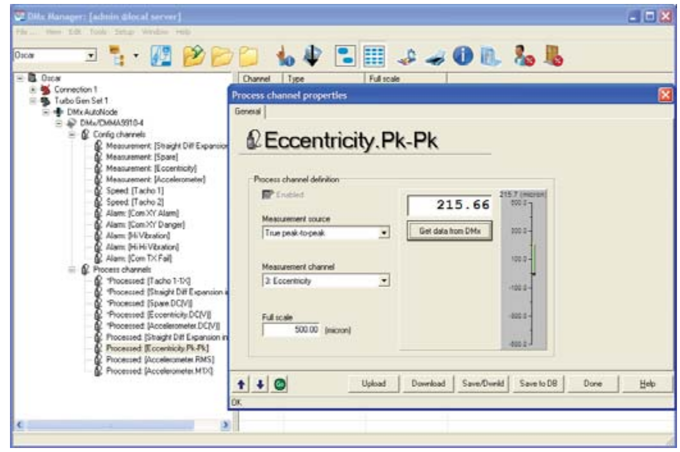


Figure 7.

Data Display

The processed data from the above selection is available for live display in the SKF Multilog DMx Manager software in a variety of formats. **Figure 8** shows a bar graph.

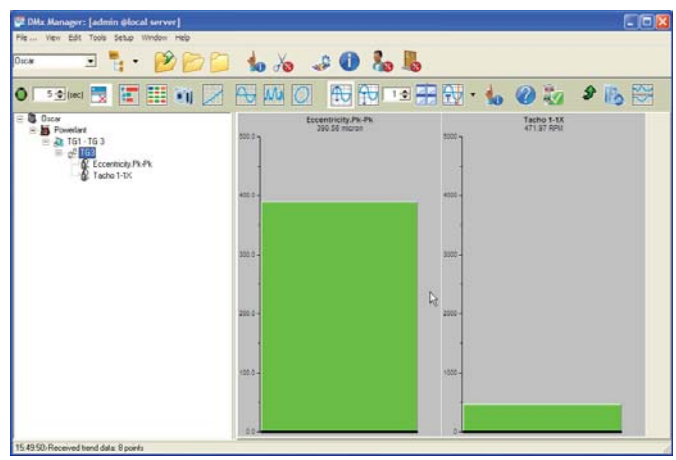


Figure 8.

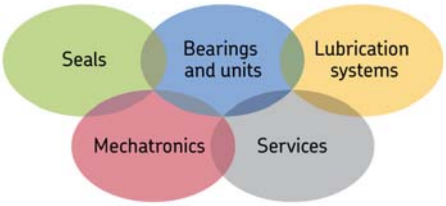
Alarm Outputs

The SKF Multilog DMx measures the input signals, processes them, and compares their level to programmed alarm set-points. The results of these comparisons display on the module's front panel LED.

If input signal levels exceed the programmed alarm set-points, the module's microprocessor can activate individual channel or common alarm functions.

The alarm status can be transmitted to the outside world in two ways:

- An alarm status value to the control system, via the RS-485 communication link (converted to a common protocol such as Modbus).
- Status change of any of the 5 opto-coupler outputs on the SKF Multilog DMx, which may in-turn be connected to an electro-mechanical relay.



The Power of Knowledge Engineering

Drawing on five areas of competence and application-specific expertise amassed over 100 years, SKF brings innovative solutions to OEMs and production facilities in every major industry worldwide. These five competence areas include bearings and units, seals, lubrication systems, mechatronics (combining mechanics and electronics into intelligent systems), and a wide range of services, from 3-D computer modelling to advanced condition monitoring and reliability and asset management systems. A global presence provides SKF customers uniform quality standards and worldwide product availability.

For additional information on SKF products, contact:

SKF USA Inc.
5271 Viewridge Court • San Diego, California 92123 USA
Telephone: +1 858-496-3400 • FAX: +1 858-496-3531

Web: www.skf.com/cm

Publication **CM3112 EN** • March 2009