Straight differential expansion measurements with the SKF Multilog On-line System DMx

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Turbine Supervisory Instrumentation

The SKF Multilog On-line System DMx machinery protection system is specifically designed to perform critical measurements which are used in the control of large steam turbine generator trains. One of the most important measurements is that of differential expansion. The general concept is discussed in the SKF Reliability Systems application note, publication CM3073 EN.

There are many configurations for measuring differential expansion. This application note discusses the common sensor configuration of straight differential expansion. The sensor orientation is considered, together with the appropriate SKF Multilog DMx configuration example.

The straight differential expansion configuration is the most basic of all configurations. As shown in **Figure 1**, a single eddy current sensor views a straight collar in the axial direction. In most instances, existing collars integral to the rotor assembly denote the areas where the measurement is to be performed.

These locations are typically located as far from the thrust assembly as possible, as this is the location where the maximum rotor growth can be observed.

The SKF Multilog On-line System DMx.

The maximum amount of differential expansion capable of being measured is in direct proportion to the sensor's linear range. Due to the large measurement ranges required to monitor differential expansion (typically 12 mm or 500 mil), extended range eddy current sensors are utilized.

Customized bracket design is also typical for these measurements. Note in the orientation shown in **Figure 1** the probe sees an increasing voltage as the rotor moves away from the probe.

In some instances this straight configuration is utilized to perform measurements up to 1000 mils, the sensor being mounted internal to the low pressure shell of the machine.

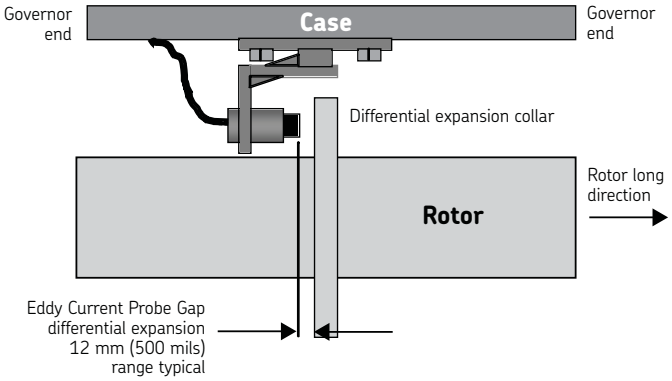


Figure 1. Straight differential expansion configuration.

If possible, this configuration should be avoided, due to the cost of cable routing and the low life expectancy of an eddy current sensor subjected to this environment. In addition, other physical limitations such as target area size often restrict the use of such probes, as they have a larger tip diameter (>25 mm).

An ideal choice of sensor for straight differential expansion is the model CMSS 62, which has an 19 mm tip diameter, and a measurement range of 12.5 mm when used in combination with a CMSS 900 extension cable and digital eddy current probe driver integral to the SKF Multilog DMx.

Figure 2. The 19 mm SKF CMSS 62 Eddy Current Probe.

The "K" position

The probe must be calibrated like any other eddy current probe, with the rotor blocked into the "cold set" position (often referred to as the "K position" or "green mark" position). In this position, the rotor is typically set hard against the active thrust shoe, and this provides the cold set for the differential expansion measurement. The zero point should be within the linear range of the probe, and this is determined by a probe calibration, which should be prepared against target material like any other eddy current probe installation.

Pendulum probes

In some shaft designs, the available target area for a non-contacting probe is insufficient. In this case a pendulum probe may be used. This is a simple mechanical arrangement which uses either a physical contact with the shaft, or a magnetic tip. Mounted externally to the casing, the tip follows the movement of the shaft and the pendulum translates this away from the target area to where a regular displacement probe may measure the adjusted movement. Conditioning electronics then provide a direct differential expansion measurement output typically as a 4-20 mA signal. The concept is illustrated in **Figure 3** and shown in **Figure 4**. A typical pendulum probe is the Model DP241 from Vibro-Meter, which measures ±15 mm (±600 mils).

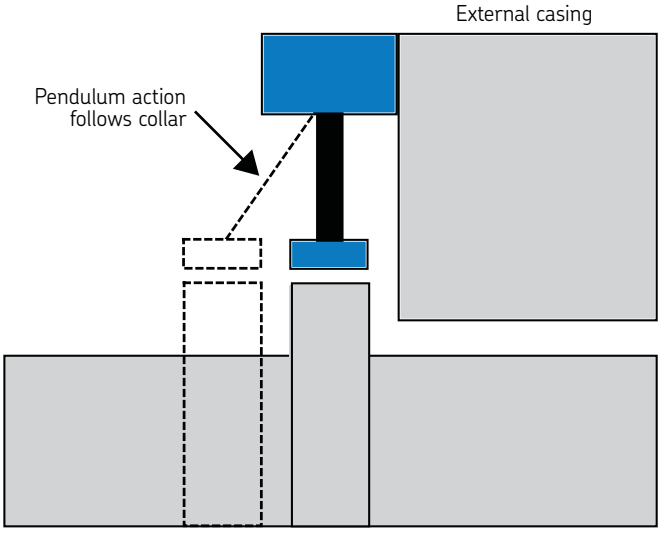


Figure 3. Pendulum probes.
Figure 4. Pendulum probe installation.

Configuring the SKF Multilog On-line System DMx module

For straight differential expansion, the SKF Multilog DMx (CMMA 9910) set-up procedure is identical to that of a thrust channel, with the exception that a long range probe is used. Long range probes have lower sensitivities than 'normal' probes, owing to the available voltage being spread over a longer range. In addition, some long range probe designs may operate on a positive polarity voltage.

A single SKF Multilog DMx channel is required. The following figures show the SKF Multilog DMx Manager setup typical for a 19 mm diameter probe using the integral digital driver of the SKF Multilog DMx.

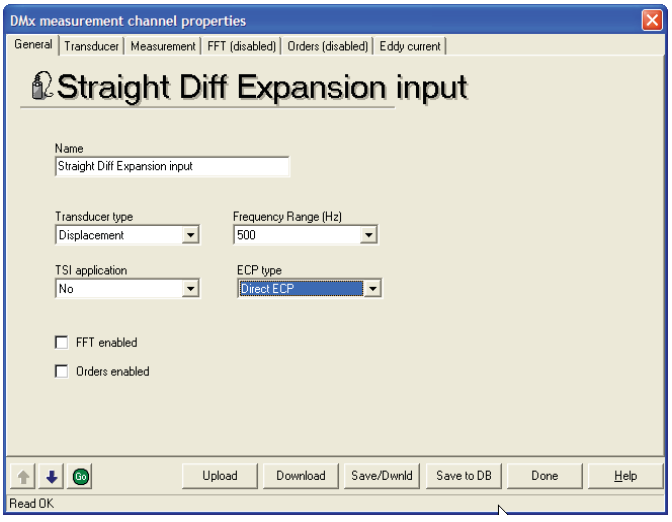


Figure 5.

When the CMSS 62 series sensor is used with straight differential expansion, the following parameters are used to "reconstruct" voltage readings and OK limits from the digital driver:

- Sensitivity: 50 mV/mill (1.9685 volt /mm)
- Usable range: 60 to 530 mil (2.36–16.14 mm) (13.78 mm)

These parameters should always be checked with the correct target material. A probe calibration curve should be made for every installation.

In SKF Multilog DMx Manager software, the information on the "General" tab is first entered as shown in **Figure 5**. The ECP type is set to "Direct ECP". If a probe system with an external driver is used, then the ECP type must be set to "ECP system". Since this is a pure axial measurement, the calculations and tabs for FFT and Orders are disabled.

The parameters for the sensor itself are then set on the "Transducer" tab, see **Figure 6**.

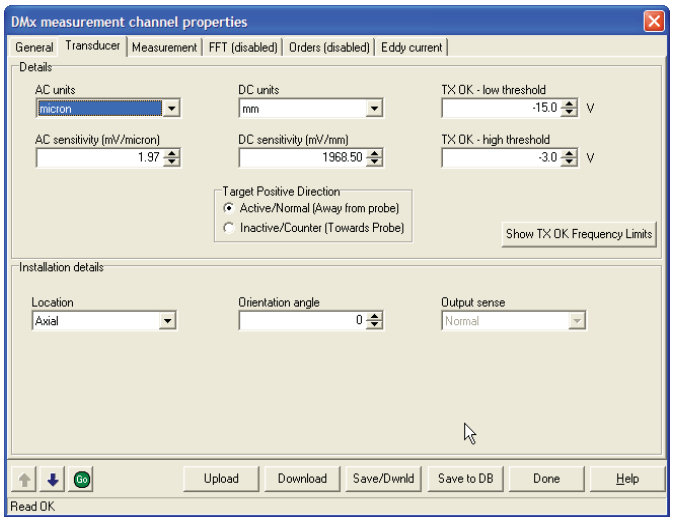


Figure 6.

The sensitivity is taken from the probe system. The OK limits must be set so that the system will alarm when the sensor is outside the limits. For the CMSS 62, series in combination with the series CMSS 620 driver, this is between -3 and -15 volts, using 4140 steel as the target.

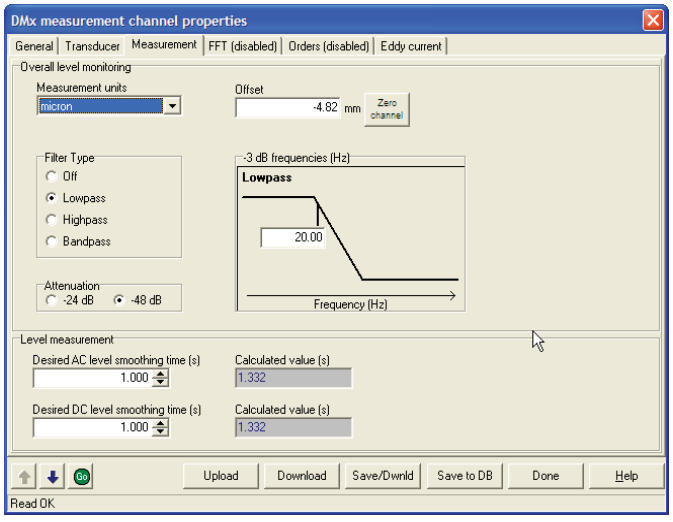


Figure 7.

On the Measurement tab, the offset may be adjusted. This offset is calculated based upon the calibration curve and the location of the K position. The offset adjusts the displayed reading to zero. A "live" reading of the offset may be taken by pressing the "Zero Channel" button when the shaft is locked in the K position and the probe is fixed. The SKF Multilog DMx Manager reads the current value and shows this value in a window as shown in **Figure 8**.

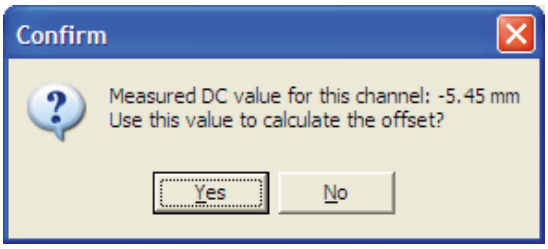


Figure 8.

When the YES button is selected, the reading is adjusted to get a readout of 0.00.

If the rotor is not in the K position, then this feature should not be used and the offset must be calculated and entered manually.

Readout selection

The SKF Multilog DMx allows for multiple processed outputs per input channels. For the straight differential expansion a "DC" measurement source is selected, and the desired full scale is input. With the "Get data from DMx" button, the current value is retrieved to view the result of the setup in the requested units.

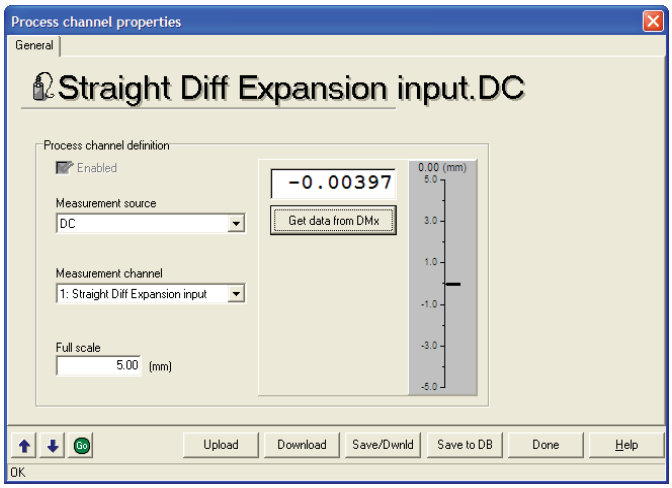
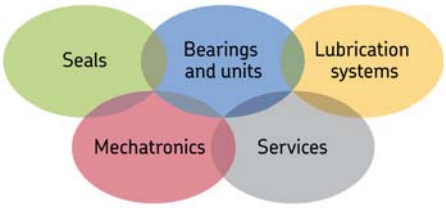


Figure 9.

Once the configuration is sent to the SKF Multilog DMx, it can be activated and the differential expansion can be measured. Alarms are configured using the standard SKF Multilog DMx alarm settings dialog.



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