Application Note

Straight Differential Expansion Measurements with the VM600

Turbine supervisory instrumentation

The ***VM600 machinery protection system*** is specifically designed to perform critical measurements that 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 SKF application note CM3073, *Differential Expansion of Steam Turbine Generators*.

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 MPC-4 machinery protection card configuration example.

Fig. 1. Turbine.

The straight differential expansion configuration is the most basic of all configurations. As shown in **fig. 2**, 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 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 **fig. 2** 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 1 000 mils, the sensor being mounted internal to the low pressure shell of the machine. 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 **TQ403**, which has an 18 mm tip diameter and a measurement range of 12 mm. The probe is used in combination with an **EA403** extension cable and **IQS453** signal conditioner.

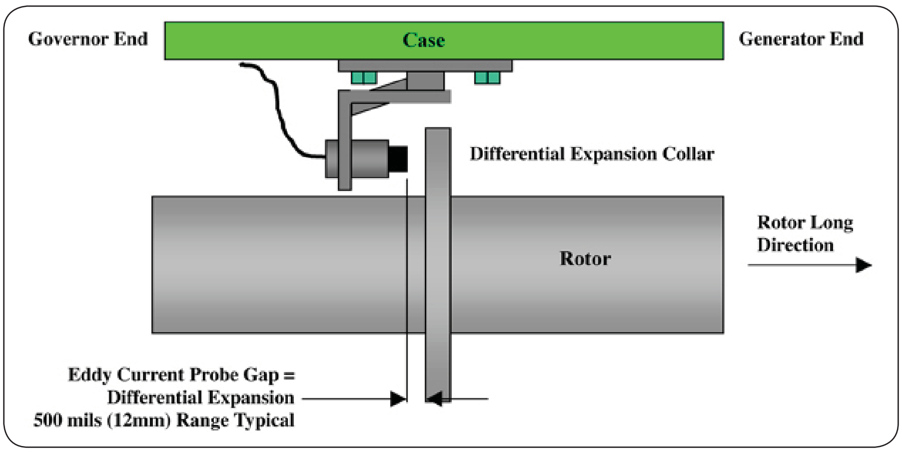

Fig. 2. Straight differential expansion configuration.

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 curve, which should be prepared against target material like any other eddy current probe installation.

Fig. 3. Differential expansion probe.

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 that 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 to 20 mA signal. The concept is illustrated in **fig. 4** and shown in **fig. 5**. A typical pendulum probe is the model DP241, which measures ±15 mm *(± 600 mils)*.

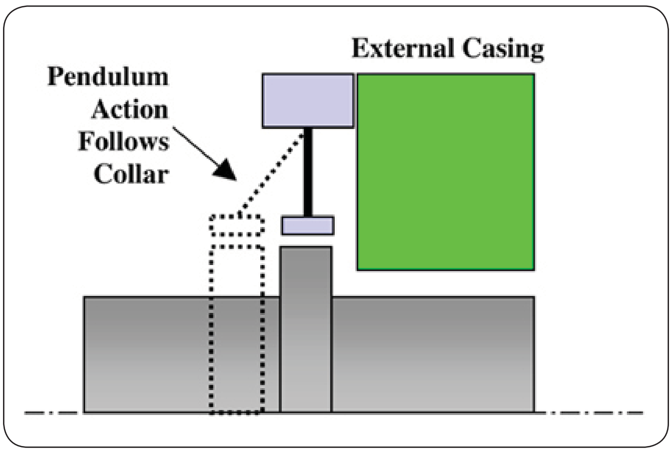

Fig. 4. Pendulum probes.

Fig. 5. Pendulum probe installation.

Configuring the MPC-4 protection card

For straight differential expansion, the MPC-4 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 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 MPC-4 channel is required. **Fig. 6** shows the input set up typical for a 12 mm range probe. Note transducer sensitivity is 1 330 mV/mm *(34 mV/mil)*. **Fig. 7** shows the processing that the MPC-4 performs on the input. It is a simple position function. Note for the set up shown in **fig. 2**, we need an increasing voltage for increasing gap, so the “direct sensor” option is selected. Selection of the “sensor inverted” option would display a decreasing gap for increasing voltage.

Finally, **fig. 8** shows the processed output with units of millimeters, and an appropriate full scale of 12 mm *(500 mils)*, which defines the bar graph range shown on the micro display of the CPU-M module (if fitted). The “output mapping” section defines 4 to 20 mA (or 0 to 10 V) ranges.

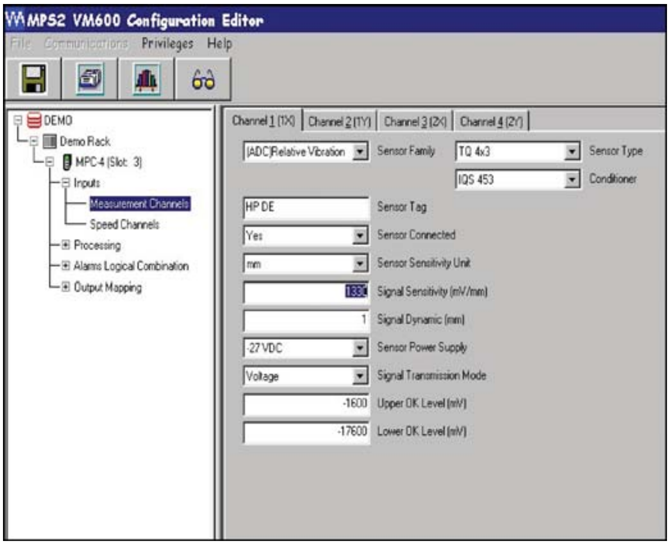

Fig. 6. MPC-4 input set up.

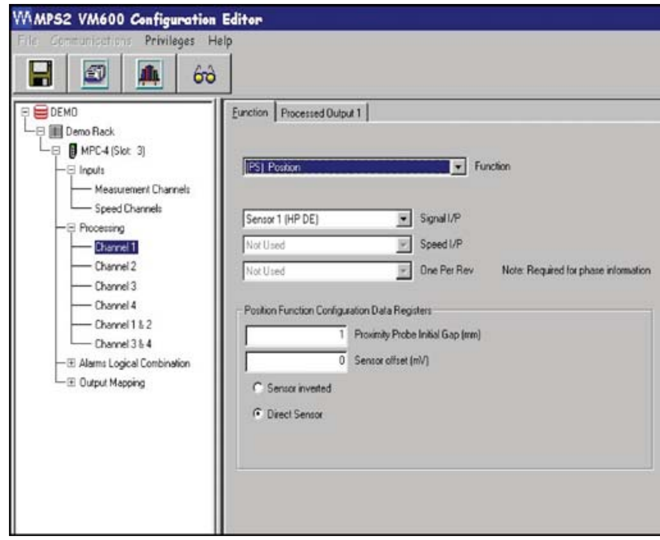

Fig. 7. MPC-4 processing set up.

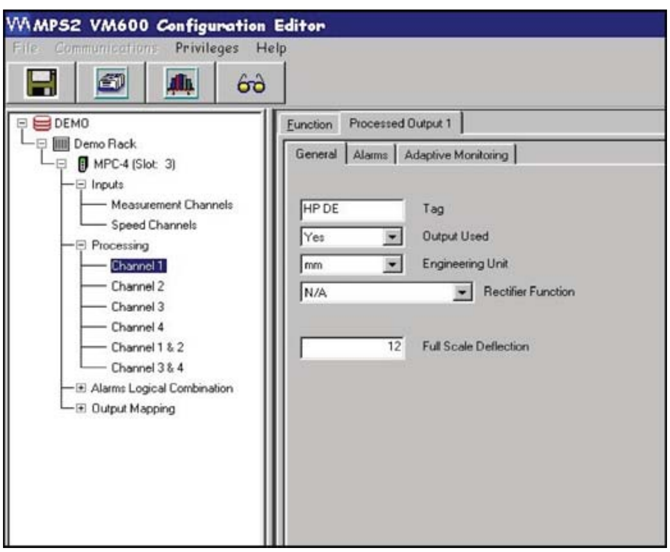

Fig. 8. MPC-4 processed output set up.

Please contact:

SKF USA Inc.
Condition Monitoring Center – San Diego
5271 Viewridge Court · San Diego, California 92123 USA
Tel: +1 858-496-3400 · Fax: +1 858 496-3531

Web: www.skf.com/cm

PUB CM3074 EN · January 2012