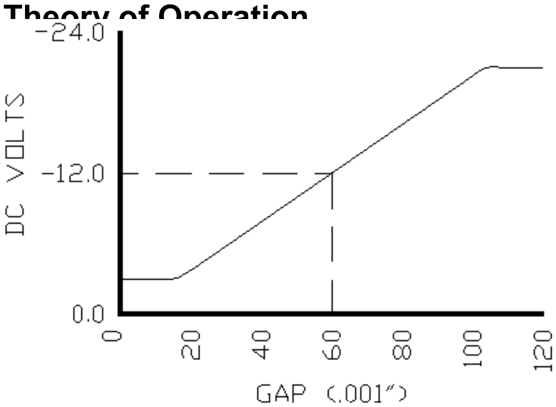
Field Application Note

Eddy Current Transducer Installation — Part 2-Thrust Position

Thrust Position Monitoring was one of the earliest applications for Eddy Current Transducers. When utilized for this application, it is one of the most important components of a complete machinery protection system.

Thrust bearing failure produces one of the most catastrophic failures of a rotating machine. This could result in very expensive repairs and the possibility of machine replacement.

Theory of Operation



Eddy Probe Transducers work on the proximity theory of operation. A System consists of a matched component system: a Probe, an Extension Cable and an Oscillator / Demodulator. A high frequency RF signal @2 MHz is generated by the Oscillator/Demodulator, sent through the extension cable and radiated from the Probe tip. Eddy currents are generated in the surface of the shaft. The Oscillator /Demodulator demodulates the signal and provides a modulated DC Voltage where the DC portion is directly proportional to gap (distance) and the AC portion is directly proportional to vibration. In this way an Eddy Current Transducer can be used for both Radial Vibration and distance measurements such as Thrust Position and Shaft Position.

Special Considerations

Single or Dual Voting

When determining the number of transducers for monitoring thrust position on a machine, several factors should be considered. First, will the system be required to trip the machine if thrust failure is detected, or secondly what other means are available to verify thrust failure.

One of the rotating machinery instrumentation standards, API-670 (American Petroleum Institute), specify Dual Voting Thrust Position at each thrust bearing. This approach to thrust position measurement requires that two transducers be mounted at each thrust bearing. Their respective output signals are then compared to alarm and shutdown limits. Both output signals must exceed the shutdown limit before the machine is tripped. This method of thrust measurement increases the system's reliability, and is recommended for shutdown operation.
A single Eddy Current transducer for thrust position measurement should only be used when the monitoring system is not required to shutdown the machine, and other means are available to verify thrust failure.

Circuit OK and Fault Detection Circuits are not used when monitoring thrust position, as they could effect the proper monitoring of this parameter. The reason for this is that a rapid thrust failure could cause Fault Detection Circuits to operate inhibiting a valid shutdown alarm.

Linear Range

Several versions of Eddy Current Transducers are available with a variety of Linear Ranges and body styles. In most cases, SKF-CM's Model CMSS65 and 68 with a linear range of 90 mils (0.090") is more than adequate for thrust position measurements. Other Eddy Current transducer systems are available with ranges of 250, 500 and 1000 mils.

The range required for each thrust application can be calculated per the following example:

Active Direction Allowable Wear	30 mils
Float Zone	10 mils
Inactive Direction Allowable Wear	30 mils
Total Range Required	70 mils

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Transducer Location

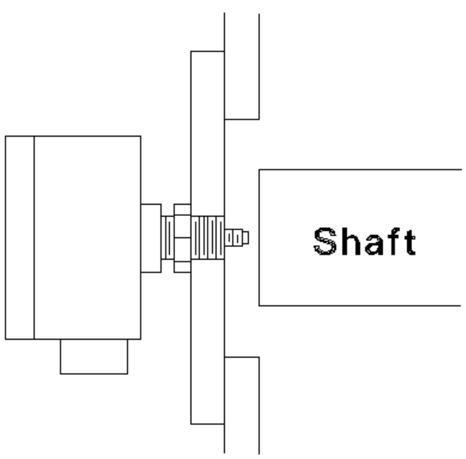
Transducer location is very important for a proper Thrust Position monitoring system. The objective of the system is to measure actual thrust position. Thusly, care needs to be taken that the system is not observing items such as thermal growth of the shaft.

STI recommends that the Eddy Current Transducers used to monitor thrust position be located within two (2) shaft diameters of the thrust bearing. This assures that the eddy Current system is not adversely affected by shaft thermal growth. In some cases this is not possible, and the engineer needs to be aware of the thermal growth expected and plan accordingly.

STI also recommends that the Eddy Current Transducer (s) observe an integral part of the shaft, as it possible for a nonintegral part to loosen creating a false reading. As an example, sweated on Thrust Collars have been known to come loose, causing normal thrust readings while the machine is experiencing a catastrophic failure.

External Mounting

External mounting is the preferable method of mounting, and can be completed when the end of the shaft is accessible through a cover plate or end plate. Care must be taken to insure that the thrust bearing is on the same end of the machine so that the measurement will not be affected by thermal growth of the shaft. The SKF-CM Model CMSS912 Dual Axial Probe Mounting Adapter with NPT is available for this application.



Advantages of External Mounting

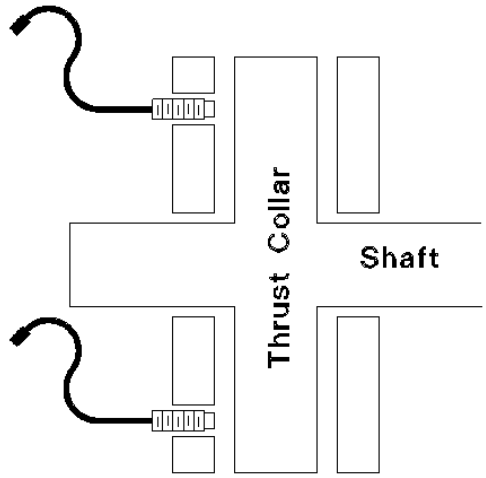
1. Eddy Current Probe replacement while machine is running.
2. Usually good viewing surface
3. Gap may be changed while machine is running.

Disadvantages of External Mounting:

1. May not be close to thrust bearing.

Internal Mounting

Internal mounting is accomplished by installing the Eddy Current Transducer either directly through the thrust bearing or with a custom designed bracket viewing the thrust collar directly or a nearby shoulder on the shaft. Care must be taken in locating and tying down the transducer cable(s) to prevent damage. If an existing exit hole from the case does not exist, one will need to be drilled and tapped above the oil line.



Advantages of Internal Mounting:

1. Usually good viewing surface
2. Close to thrust bearing.

Disadvantages of Internal Mounting:

1. No access to transducer while machine is running.
2. Cables must be tied down due to "windage".
3. Transducer cable exits must be provided.
4. Care must be taken to avoid oil leakage.

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Measurement Conventions

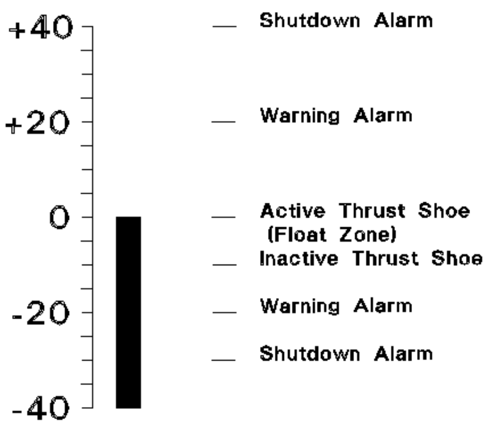
There are several important measurement conventions that must be decided upon prior to installation and calibration of the system. It is suggested that the conventions used be common throughout a plant to avoid confusion.

Thrust Position Signal Conditioning Cards and Display Scales are available in many different ranges to satisfy most applications, specials are available on request. The most common thrust position full scale range is +40-0-(-) 40 mils, which is smaller than the maximum range of 90 mils for the SKF-CM's Model CMSS65 and 68.

SKF-CM Thrust Position Signal Sensor Cards have a jumper so that upscale and downscale may be changed to reflect actual movement of the shaft. Care needs to be taken to document active (normal) thrust direction of the shaft, and the actual measurement direction of the Eddy Probe Installation.

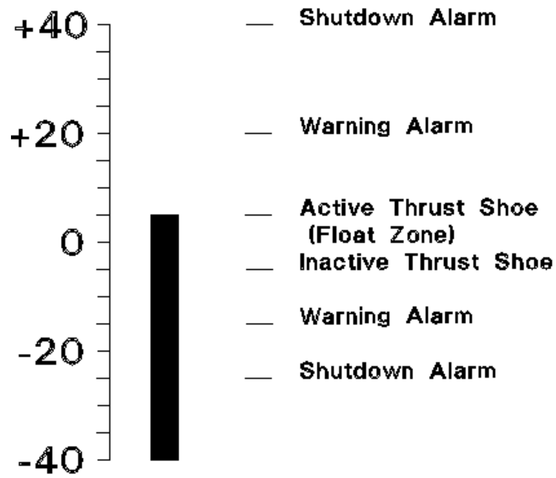
Zero (0) Active Shoe

When using the "Zero Active Shoe" method of gapping the Eddy Current Transducer, the shaft is mechanically barred in the active or normal direction through the float zone until it is against the active thrust shoe. The Eddy Probe and Monitoring System are then calibrated to Zero (0). This method of calibration provides more system range in the active direction, and when the machine is operating normally with no wear of the thrust bearing the monitoring system will read "0".



Zero (0) Center of Float Zone

When using the "Center of Float Zone" method, the shaft is mechanically barred to accurately measure the total float zone with the Eddy Probe or a dial indicator. The Eddy Current Transducer and monitoring system are then gapped and calibrated to read zero (0) when the thrust collar is in the center of the float zone. This method provides equal range in both active and inactive directions, and when the machine is running normally with no wear the monitoring system will display one half the float value (i.e.: +5 mils).



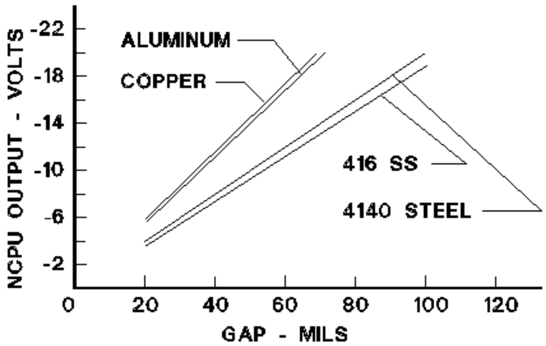
Plus (+) Active (Normal) Direction

All thrust position monitoring systems are installed and calibrated so that wear on the active thrust bearing or normal direction produces a plus (+) or up scale reading. Minus (-) or down scale readings indicate motion towards the inactive thrust bearing.

Target Material/Target Area

Target Material

Eddy Current Transducers are calibrated at the factory for 4140 Steel unless specified otherwise. As Eddy Probe's are sensitive to the permeability and resistivity of the shaft material, any shaft material other than 4000 series steels must be specified at the time of order. In cases of exotic shaft material, a sample may need to be supplied to the factory.



Mechanical Runout

Eddy Probe Transducers are sensitive to the shaft or target smoothness. For thrust position, a perfectly smooth finish is not required, as the system will average the DC signal. An area approximately 3 times the diameter of the Eddy Probe must be provided for a viewing area.

Transducer (Probe) side clearances

The RF Field emitted from the Probe tip of an Eddy Probe is approximately a 45^0 coned shape. Clearance must be provided on all sides of the Probe tip to prevent interference with the RF Field. As an example, if a bearing is drilled to permit installation, the hole must be counter bored to prevent side clearance interference. Care must also be taken to avoid collars or shoulders on the shaft that may thermally "grow" under the Probe tip as the shaft grows from heat.

Eddy Probe tip-to-tip clearances

Although Eddy Probe tip to tip clearances are not normally an issue on most machines, it should be noted that Eddy Probe's radiate an RF Field larger than the Probe tip itself. As an example, Model CMSS65 and 68 should never be installed with less than one (1) inch of Probe tip-to-tip clearance. Larger Probe's require more clearance. Failure to follow this rule will allow the Oscillator/Demodulator to create a "beat" frequency, which will be the sum and difference of the two Oscillator/Demodulator RF frequencies.

System Cable Length and Junction Boxes

Eddy Probe Transducer Systems are a "tuned" length, and several system lengths are available. Length is measured from the Eddy Probe tip to the Oscillator/Demodulator, and is measured electrically which can slightly vary the physical length. For example, the CMSS65 and 68 are available in 5, and 10-meter system lengths. Care must be taken to insure that the proper system length is ordered to reach the required Junction Box.

Grounding and Noise

Electrical noise is a very serious consideration when installing any vibration transducer, and special care needs to be taken to prevent unnecessary amounts of noise. As most plant electrical noise is 60 HZ, and many machines running speed is also 60 HZ, it is difficult to separate noise from actual vibration signal. Therefore, noise must be kept to an absolute minimum.

Instrument Wire

A 3-wire twisted shielded instrument wire (i.e.; Belden #8770) is used to connect each Oscillator/Demodulator to the Signal Conditioner in the Monitor. Where possible, a single run of wire from the Oscillator/Demodulator (Junction Box) to the Monitor location should be used. Splices should be avoided.

The gauge of the selected wire depends on the length of the instrument wire run, and should be as follows to prevent loss of high frequency signal:

Up to 200 feet 22 AWG
Up to 1000 feet 20 AWG
Up to 4000 feet 18 AWG

The following wiring connection convention should be followed:

1. Red -24 VDC
2. Black Common
3. White Signal

Common Point Grounding

To prevent Ground Loops from creating system noise, system common, ground and instrument wire shield must be connected to ground at one location only. In most cases, the recommendation is to connect commons, grounds and shields at the Monitor location. This means that all commons, grounds and shields must be floated or not connected at the machine.

Occasionally due to installation methods instrument wire shields are connected to ground at the machine case and not at the monitor. In this case, all of the instrument wire shields must be floated or not connected at the monitor.

Dedicated conduit should be provided in all installations for both mechanical and noise protection. Flexible metal conduit should be used from the Eddy Probe to the Oscillator /Demodulator junction box, and rigid bonded metal conduit from the junction box to the monitor.

Calibration

All Eddy Current Systems (Probe, Cable and Oscillator Demodulator) should be calibrated prior to being installed. This can be done by using a SKF-CM CMSS601 Static Calibrator, -24 VDC Power Supply and a Digital Volt Meter.

The Eddy Probe is installed in the tester with the target set against the Probe tip. The micrometer with target attached is then rotated away from the probe in 0.005" or 5 mil increments. The voltage reading is recorded and graphed at each increment. The SKF-CM Model CMSS65 and 68 systems will produce a voltage change of 1.0 VDC +-.05 VDC for each 5 mils of gap change while the target is within the Probe's linear range.

Gap

Extreme care must be taken to insure that the thrust position Eddy Probes are gapped properly. Failure to gap the transducer properly will result in the allowed mechanical thrust range being outside the transducer's linear range.

Prior to gapping the Eddy Probe, the allowable wear; float zone and associated alarm levels should be over-laid onto the Probes calibration work sheet. This will insure that all alarms are within the linear range of the Eddy transducer and provide the optimum installed gap.

It will be necessary to mechanically bar the shaft to a known position, usually against the active thrust shoe (see Measurement Conventions). The Eddy Probe can then be gapped and the DC voltage documented.

Installation Checklist

1. Mounting Type, Internal or External
2. Number of Transducers, Single or Dual
3. Linear Range
4. Close to Thrust Bearing (Thermal growth)
5. Target Integral to Shaft
6. Target Material, 4140 or Other
7. Smooth Target Area
8. Size of Target Area
9. Active Thrust Direction
10. Eddy Probe Installation Documented
11. Junction Box Location(s)
12. Metal Conduit (Junction Box to Monitor)
13. Flexible Conduit (Junction Box to Eddy Probe)
14. Correct Instrument Wire
15. Shielding Convention, Monitor or Machine
16. Calibration
17. Gap Set and Documented

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