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Abstract: This article discusses the difference between Micro-ohms and Meg ohms. It is important to understand the difference. Some meters are capable of making measurements across such a wide range, and care should be exercised to select the proper range when evaluating an electric machine. This article helps shed a little light on the basic subject.

1. Introduction:

A Digital Low Resistance Ohm-meter is used for measurement of very minimal circuit resistance. The circuit resistance it could be used to measure might be a coil of enameled wire, etched traces on a circuit board, or a length of power feeder cable, etcetera, there are myriad possibilities.

The resistances of such items are in general, very small. In other words, they are low resistance measurements. *In the most general terms, a constant DC current is injected into the circuit by test leads (from the meter) and the voltage drop across the unknown resistance helps solve for the unknown resistance. Sometimes several amperes of current are injected, to develop a measureable voltage drop.*

The opposite is true of a Meg Ohm meter. The Meg Ohm meter is designed to perform tests of very large resistances. The resistance it could be measuring could be so very large it would no longer be considered resistance, but instead be considered electrical insulation. It might be the electric insulation inside an electric motor, a bushing, or the electric mains input to a piece of equipment, etcetera, there are many possibilities

Meg Ohm meters are also known as an Insulation Tester's. *In the most general terms, a constant DC voltage is impressed across the test*

circuit by test leads (from the meter) and the current that passes through the test circuit is used to help solve for the unknown resistance. Sometimes, several thousand volts are impressed to force measurable current to flow.

Notice the not so subtle difference between the two methods?

2. Example; Low resistance ohm meter:

For examples sake, consider a 125HP 400V 3 phase electric motor. This particular example might have 6 leads. Its 6 terminal lugs could be wired for wye or delta. If it is wired wye, the terminal to terminal DC resistance across motor leads 1 to 2 could be about 150 milli-ohms. (150 thousandth of an ohm, a pretty low value) A standard 2 wire ohm-meter would probably indicate either 0.1 or 0.2 ohms. I have seen some 2 wire meters read 0.0 to 0.5 ohms when the meter leads are simply touched together. Squeeze them together and you might see the reading drop down. In a case like this, we could say not enough repeatable information to make any fair judgment.

Now what would you expect if the same example motor was wired delta? Keeping in mind that the DC resistance of each phase would be about 0.075 ohms, we would expect a reading across the motor leads to be something in the area of about 0.074 ohms. Our conventional 2 meter would again probably indicate 0.1 or 0.2 ohms.

This is why other methods are used; there is simply too much contact resistance at the alligator or crocodile clip contact surfaces! In this author's experience, +/- 50 milli-ohms can be encountered each time the 2 wire meter lead tips are pressed home.

It is possible to avoid the variable effects of this type of contact resistance variable. A technique called "4 wire" or sometimes "Kelvin" resistance is used. 2 wires form the current carrying path,

and two parallel wires are used for measurement of the voltage drop across the unknown resistance. Nearly all milli-ohm and micro-ohm meters on the market these days use this method to extend their measurement capabilities.

For rotating machines, the L/R time constant of the motor circuit could affect your results as well. Look for a meter designed for this type of circuit. It takes a period of time for current to stabilize when the circuit is measured.

For the last word on accuracy, you should really consider temperature correcting your results. IEEE standard 118 can be consulted about how to do this.

3. Example; Meg Ohm meter or Insulation Tester:

Meg Ohm meters (in the context of electric machine testing) are governed by IEEE standard 43. This recommended practice suggests Meg Ohm meters capable of providing 500 volts DC to as much as 10,000 volts DC. There is certainly Meg Ohm meters available on the market that supply 100 volts or less. These are not really acceptable for insulation *testing* of electric rotating machines. In a nutshell, you need high enough voltage to roughly approximate operating voltage of the motor. The elevated electric “pressure” is necessary to meet the IEEE recommendation and other standards as well.

Unlike a resistance *measurement*, there is some element of risk of improper readings associated with performing an insulation *test*. Let’s say you are asked to perform an insulation test on an electric motor that has been shut down for periodic maintenance. It is important that several steps are followed.

- A) Select an appropriate test voltage with your Meg Ohm meter. The test voltage is closely associated with the operating voltage of the apparatus being tested.

- B) Make sure the electric machine is in a safe condition to test. In an industrial setting, lock out/tag out procedures are likely in place, and should be followed.
- C) Make sure the electric machine is clean and dry. If the motor is a bit wet, you receive very low Meg Ohm readings. If the machine/motor has heater elements, take steps to ensure they are still functional. It may be necessary to operate the heaters for some time to drive out any residual moisture.
- D) Temperature correct your results. It is a fact of life that the effects of temperature on insulation resistance need to be compensated for. If you do not temperature correct your results, you may get a trend graph that looks like a saw tooth. Not really what you want. Temperature correction will cancel most of the variability.

4. Summary.

This brief article was intended to summarize some of the salient differences between Micro-Ohm meters, or Digital Low Resistance Ohmmeters, and Insulation Testers.

The article should point out a few minor pitfalls to avoid.

For your micro ohm meter, be sure it is optimized for inductive circuits. This usually entails provision for stabilization time, being necessary for repeatability purposes.

For your Insulation tester, be sure it is rated to apply proper test voltages.!

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