Practical Calibration Verification Techniques

Keywords: Calibration, Certificate, Cost Reduction, Quality Control, Certification Process.

Abstract:

Periodic calibration verification is accepted as a standard practice by many business operations, quality control departments, production lines, and manufacturers. Indeed, the need for calibration verification is *required* as part of many standardization organizations. The means to this end usually requires certain important considerations. If equipment is used for electrical test, certification of voltages and currents must be proven by the concept of standard traceability. This can mean periodic offsite shipment of test equipment, and the risk of loss or shipment damage. Or, conversely it can mean on-site visits by calibration service technicians. Either approach has benefits and drawbacks. An alternative approach is discussed in the article: self certification.

1. Introduction:

It's that time again. You are busily doing your job, performing some Insulation Resistance tests with the company Meg-Ohm Meter, when out of nowhere, the quality assurance auditor shows up, clipboard in hand. Smiling broadly, the auditor sweetly asks to see if the calibration sticker on the Meg-Ohm meter. Right then, you have a sinking feeling that little to no work is going to be completed today…

You were right, the auditor found that the calibration had lapsed on your meter, and promptly red-tagged it. This stopped the work you were doing, and touched off a bit of a scramble to locate a Meg-Ohm Meter with a valid calibration sticker.

Have you experienced this type of situation in your job? Have you experienced work stoppage, while calibration verification proceedings occur? These can sometimes take days or longer to conclude, and the work is still required. What options are there?

The fact is, calibration verification is a truly necessary process. One of the best ways to provide periodic maintenance of test equipment is to perform a rigorous, periodic calibration.

2. Practical Calibration Verification Systems:

One such approach is the development and maintenance of test standards. This is an important item to consider. How does a production engineer determine the results he has been recording of his production process? Modern test equipment, from many leading vendors – provides data, in the form of a computer/micro processor controlled tester. An example might be a high quality Multi-Meter, or something more exotic like a Surge tester that includes a DC high potential test function. Insulation testers are available from multiple vendors, and may be designed to apply test voltages of 500V, 1000V, 2500V and 5000V. The data is provided, but verification of test results may take most of a calendar year. (As annual calibration would dictate 12 month periodicity)

If a production process has 2 or more electric motor test systems, how can an internal test standard be implemented? What if different results are being obtained with two different testers, on the same motor, coil or insulation? Which one is working correctly? One such approach might be to implement periodic verification to the production process.

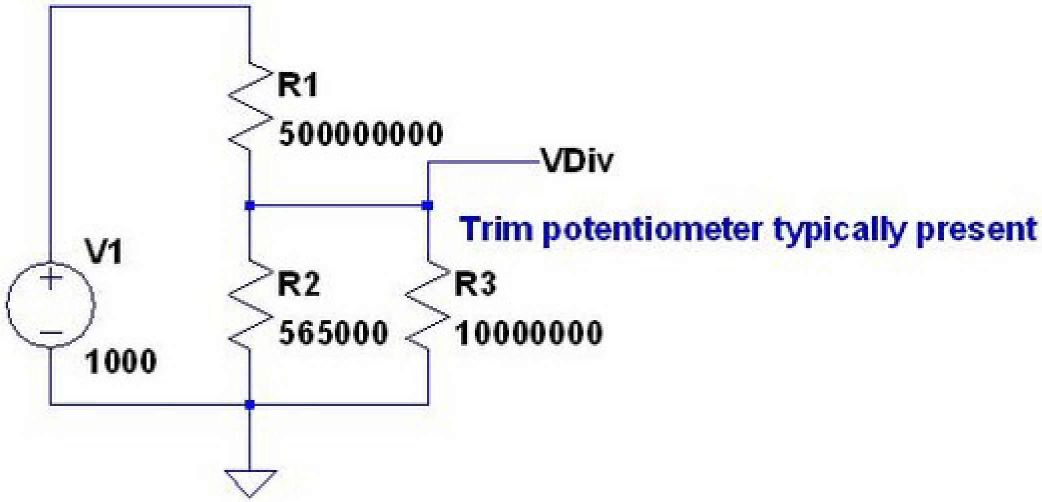
For example, a production process might verify the DC resistance of a particular type or design of electric coil. The electric coil could be AC or DC, single or 3 phase, permanent magnet, switched reluctance or a solenoid. The DC resistance, using the Kelvin or 4 wire technique is a direct measurement of the coil resistance.

3. An example of a calibration verification system:

To further our discussion of the Meg-Ohm meter, we will show how we can make some very accurate readings of the performance of our Meg-Ohm meters (i.e. Insulation Tester)

One of the first items that must be verified is the output voltage of your Insulation tester. Many vendors Insulation testers can apply high DC voltages, in some cases, too high of a voltage to safely measure with conventional multi-meters. What can be done?

Leading vendors of high voltage measurement equipment employ a widely known technique called Voltage Division. This technique is where purposefully selected, specially designed resistors are implemented in series. This results in a very nearly linear and proportional output voltage, which can be expressed as a ratio. For example, a voltage divider might be implemented with a high voltage rated resistor 500 Meg-Ohms in series with 565 Kilo-Ohms (R2). The high voltage would be impressed on the circuit node that is comprised of the 500 Meg-Ohm resistor (R1). See the below schematic for the relationship between R2 and R1.



The reason that a special high voltage resistor is required is manifold. Reasons include voltage rating, wattage and other reasons. High voltage resistors may be physically very long. Length helps to minimize the effects of surface leakage currents, or provide a less severe voltage gradient across the element. Also, they may comply with design criteria called voltage coefficient. In other words, they should respond in a very linear fashion when high voltage is impressed across them. Or, they may be specifically designed to have very low values of inductance, or extreme stability versus temperature. Regardless, they are not run of the mill components.

What is the reason for resistor R3 in the above equivalent circuit? This is here because it represents the measurement burned of many types of meter circuits (such as digital multi-meters) This parallel path affects the voltage divider ratio. Those who were reading closely might have noticed that 500 Meg Ohm in series with 565 Kilo-Ohm does not work out to exactly 1000:1 (It's actually closer to 884:1) With the parallel resistance of R3, this ratio changes to about 935:1 much closer to a 1000:1 ratio. If a lower input impedance measurement circuit is present (such as 3 Meg Ohm, this ratio becomes roughly 1051:1)

With fine tuning this ratio can be adjusted to very nearly 1000:1. In certain applications a variable trimming potentiometer will be present, where this last, critical calibration adjustment can be made. This last adjustment, if performed properly, will result in a well calibrated 1000:1 voltage divider.

Once the performance of R1, R2 and R3 have been verified, they can be used in concert to provide information about the high voltage present at V1. In the example above, V1 is 1000 Volts. Therefore, a voltage of 1.0695V will be present at node 'VDiv"

(This is the result of the 935:1 ratio discussed; with fine tuning the potentiometer this would become very nearly 1000:1)

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