



TESTING 3 PHASE AC MOTOR WINDINGS WITH THE RIGHT TOOLS

We're frequently asked by field service technicians to help them determine whether a motor winding is good or bad.

When testing and evaluating motor windings in our shop environment, we use several different diagnostic tools and techniques. Some, such as our winding analyzers, cost tens of thousands of dollars. One of our most critical tests is a visual inspection, and experience and judgment are some of our most valuable tools.

However, field testing can be done with a very high degree of confidence with two modestly priced diagnostic tools: a megohmmeter (megger) or an insulation multimeter and a milli-ohmmeter. These can be bought online (links to sellers below) OR rented from Endeavor.



Measurements to ground **MUST** be made with a megger; phase-to-phase measurements **MUST** be made with a milli-ohmmeter, **NOT** an ordinary multimeter.

A multimeter is not a substitute for a megohmmeter (megger) or a milli-ohmmeter in diagnosing a 3 phase motor winding. Unless it has an "insulation testing" feature such as the [Fluke 1587 FC](#), a multimeter doesn't generate a high enough test voltage to give any good test data about the condition of the ground wall insulation. And no multimeter utilizes the 4 lead Kelvin configuration of a milli-ohmmeter which is necessary to accurately measure the very low resistances of a motor winding.



After disconnecting all power, the first step to testing a winding is to make sure it isn't shorted to ground. The ground wall insulation is tested with a megger that applies at least 500VDC across each circuit of the winding and ground. The minimum safe value for human contact is $1M\Omega$ plus the motor voltage, so a 400V motor has a minimum safe requirement of $1.4M\Omega$ resistance to ground. However, most motor and control manufacturers recommend a much higher minimum value, usually $100M\Omega$ or more, for the protection of the sensitive electronics controlling the motor.

There is often an element of judgment involved when deciding if a resistance reading to ground is "good enough." Although the manufacturer's recommendation may be $100M\Omega$ or greater, a reading that low might also indicate that there is significant contamination inside the motor that could lead to a serious problem. Any indication of contamination should be taken very seriously because a complete failure of the winding (and damage to connected components) could occur if not addressed.

If the winding isn't shorted to ground, the next step is to make sure that there aren't any internal short circuits in the winding. This is done by comparing the resistance values of all three phases to each other. The resistance values of each phase need to be within 2% (and are usually well within 1%) of all the others. Since the resistances are usually very low and must be measured very accurately, a milli-ohmmeter such as the [Rhopoint M210](#) is required.

Understanding motor winding schematics will help you have the confidence that your tests are being done correctly. Our handy [AC Winding Field Test](#) will help you understand the lead numbering and circuit diagrams of the most common windings utilized in spindle motors and servomotors, and guide you about where to connect your meters and which readings to record.

We understand this can be confusing for those who don't spend a lot of their time diagnosing motor and winding problems, so we encourage you to contact us at 630.562.0300 for further support at any time.