

# Circuit Breaker Contact Resistance Testing: Understanding the standards and test results

## Introduction

In the electrical industry, contact resistance testing is often a component of an acceptance test procedure, and is intended to be a predictor of circuit breaker thermal performance when placed into service. It would be more properly called "pole-resistance" testing because in a sealed molded case circuit breaker it is not possible to isolate the contacts, and so the test reading reflects the resistance of the entire current path and may include lugs or other terminating hardware, all of which will affect the measured resistance value. Understanding the variable factors affecting pole-resistance and correctly interpreting the test results will help avoid time-consuming and costly circuit breaker returns and/or replacement.

## Industry Standards and Practice



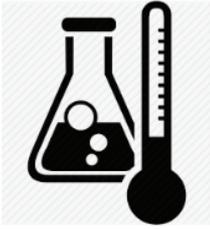
Per industry standard NEMA AB-4: "The millivolt drop of a circuit breaker pole can vary significantly due to inherent variability in the extremely low resistance of the electrical contacts and connectors. Such variations do not necessarily predict unacceptable performance and should not be used as the sole criteria for determination of acceptability."

The International Electrical Testing Association, Inc.® (NETA®) has published a specification (not an industry standard) named "NETA Acceptance Testing Specifications" which is widely used by independent test companies. It suggests that pole resistance that deviates by more than 50% from the lowest pole should be investigated. It does not indicate that such a result constitutes a "failure", though it is commonly misinterpreted as such. Their suggested test procedure simply states that results outside of this arbitrary target should be investigated.

It should be noted that the 50% specification is neither scientific nor a reliable predictor of circuit breaker performance in service. This becomes clear when one considers that a circuit breaker with high but consistent pole resistance values will meet this specification, but a similar circuit breaker with much lower resistance values will not meet the specification if the deviation from the lowest resistance is more than 50%. For example, a circuit breaker with pole resistance readings of 50, 60, 76 milli-ohms would "fail" the test but a circuit breaker with 130, 180, and 150 milli-ohms resistance would pass. A second evidence is the observable weak correlation between new-circuit breaker pole resistance testing and temperature in service.

NETA does not identify their specification as pass/fail criteria, and neither does NEMA or Schneider Electric. While not a perfect test, circuit breakers meeting the NETA specification are not likely to have thermal issues in service; however, circuit breakers not meeting the NETA specification may also be good and variant test results merely indicate that further investigation is in order.

## Evaluating Test Results



Variable factors affecting circuit breaker pole resistance include: contact contamination in the form of resistive oxides which develop over time, possible accumulation of particulate contaminants during shipping and storage, and loose terminals or a manufacturing issue with the current path assembly. Each of these contributes to the pole resistance value. Consistent pole resistance values, such as NETA suggests, indicate that the circuit breaker is usable. But also, per NEMA AB-4, "...due to inherent variability in the extremely low resistance of the electrical contacts and connectors..." wide variation in test values do not mean something is wrong. Per both NEMA and NETA it merely means that further investigation is warranted. Review of test method, contact conditioning, load bank testing, and consultation with the manufacturer are good next steps.

## Alternative or Additional Test Methods



Load bank testing will typically normalize pole resistance as it gives the circuit breaker rated current and voltage which allows the contacts to reach their normal operating temperature and potentially burn away resistive oxides and it simulates service conditions. Acceptable thermal performance during load bank testing demonstrates that the circuit breaker is usable regardless of initial pole resistance test results. If load bank testing is not feasible, placing the circuit breaker in service and monitoring for thermal issues will accomplish the same results. Refer to Schneider Electric document *0600DB1603* titled "Circuit Breaker Operating Temperatures" for UL recognized thermal limits.

Contact conditioning is a reasonable alternative to load bank testing as it will burn through resistive oxides. To condition the contacts, primary inject the circuit breaker with 300% of the circuit breaker's rated current for 75% of the circuit breaker's minimum tripping time (per the trip curve), allow the circuit breaker to cool, and then measure contact resistance again without toggling the circuit breaker. If one or the other of these methods do not give acceptable results, circuit breaker replacement may be in order.

## Conclusion



Pole resistance is a quick and easy test to perform, but interpreting the results requires more than a quick calculation or reading numbers off a chart. Neither NEMA nor NETA recommends pass/fail criteria for pole resistance testing, and while pole resistance information may be useful, interpretation of test results requires a consideration of all the factors indicated above.

## Additional Information



<https://www.schneider-electric.us/en/download>

Square D™ field testing and maintenance guides, available in the download center, contain typical watts loss data to be used for heat generation estimates. Resistance can be calculated from the watts loss data if desired, but for reasons noted above, Schneider Electric does not recommend using these values to determine the usability of a circuit breaker.

"Circuit Breaker Operating Temperatures", document number *0600DB1603*, describes the acceptable operating temperature of a circuit breaker as defined by the UL489 standard.

For more information concerning Square D brand low voltage circuit breakers, refer to the appropriate product catalog. These catalogs contain general and detailed information on circuit breaker characteristics, accessories, wiring diagrams, and trip curves.