Measuring resistance with 10 A

Entering the discussion

Some groups and companies require the use of a 100-amper or higher d. c. “test current” for proper measurement of low resistance values like those found in high-voltage circuit breakers.

In the other hand, a few test & measurement equipment manufacturers use the latest microcomputer and electronics technology to produce equipment that is more convenient to use, while maintaining or improving the accuracy of traditional products.

Before going any further, it is important to note that, whichever the DC current level is used by a microohmmeter, the purpose of the injection is to perform a *measurement,* rather than *testing* anything. The reason why the accuracy of this measurement should be independent of the amount of current used is evident from the Ohm’s Law, and the practical implementation of this principle is overviewed in the following paragraphs.

The PME-500-TR Circuit Breaker Analyzer

This product is oriented to satisfy the general demand of a measurement tool that turns simple analysis of high- and medium-voltage circuit breakers into an easy, fast and accurate procedure. Its most outstanding *tangible* characteristics are small size, lightweight and reduced price.

One of the key features of the PME-500-TR is the built-in battery. This component provides two valuable benefits –

1. Mobility: the unit will work for an average 10-hour with no need of external AC supply. The battery will be automatically recharged when the instrument is plugged into an AC supply.
2. DC supply: pure d. c. injection for accurate measurement of the breaker’s contact resistance using “Kelvin” (4-wire) connection to the measured point.

How is the measurement done?

The operator connects two pairs of leads to both sides of each breaker’s chamber: the *timing leads,* that are used for detecting and recording changes in the contact’s positions (open / closed), are also used for injecting the “test current” when determining the resistance in the closed contact; and the *voltage leads,* that measure the voltage drop at the point of contact when the “test current” is injected. According to the *Ohm’s Law,* the voltage drop will be proportional to the injected current for any given resistance value:

(1)

$$V = I \times R$$

For example, injecting 10, 100 or 200 A through a contact resistance of 20 μOhm, the voltage will drop the following amounts:

$$10 \times 0.00002 = 0.0002 \text{ volts}$$
$$100 \times 0.00002 = 0.002 \text{ volts}$$
$$200 \times 0.00002 = 0.004 \text{ volts}$$

So, by applying formula (1) above:

(2)

$$R = \frac{V}{I}$$

any instrument would always calculate the same resistance value (0.00002 Ohm) whichever the used current is:

$$\frac{0.0002}{10} = \frac{0.002}{100} = \frac{0.004}{200} = 0.00002$$

Then, why *Bigger* should be *Better*?

There are two practical reasons why to use 200 rather than 100 or 10 A:

1) Accuracy. The smaller the voltage, the more sensitive and accurate must the voltmeter be. The voltmeter needed to reliably measure 0.0002 V is twenty times more sensitive and accurate than that needed for 0.004 volts.

2) Influence of the *thermoelectric voltage*. A measurable voltage builds up at any two pieces of metal that come into contact. This voltage is present before and during the current injection, so it will add up to the total voltage drop measured as described above. This voltage component, however, is NOT proportional to the injected current because it is not due to the contact's resistance.

   As a consequence of this, the resistance calculation will always contain an error:

   $$\frac{0.0002 + V_j}{10} = 0.00002 + \frac{V_j}{10},$$

   $$\frac{0.002 + V_j}{100} = 0.00002 + \frac{V_j}{100}, \text{ and}$$

   $$\frac{0.004 + V_j}{200} = 0.00002 + \frac{V_j}{200}$$

   Where V_j is the *thermoelectric voltage*. It is obvious that the error introduced is *inversely proportional* to the amount of current used: *bigger current = smaller error.*

   However, V_j can be measured *before* injecting the "test current" and then removed from the results. In modern instruments, this task is performed by a microprocessor automatically at a very high speed.

Conclusion

If your instrument's voltmeter is not accurate enough or it does not implement a method of removing the *thermoelectric voltage,* then you should be better using as big a *"test current"* as possible to calculate the contact resistance.

Fortunately, the PME-500-TR includes both quality features in order to perform easy, fast and reliable contact resistance measurement at 10 A only without adding useless size and weight.

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