Application Note

Main contact resistance measurement of a Circuit breaker with both sides grounded (BSG)

Safety in high voltage substations is the highest priority for all personnel involved. Regulations and laws require all objects to be grounded on both sides before any maintenance work is performed on the object. Testing of high voltage circuit breaker can be a hazardous task due to the risk of the high electric potential. When electrical apparatus is taken out of service, there are several ways when high electrical potential can make it dangerous to test personnel. For example if a fault occurs and unwanted electrical potential reaches this object; if lightning strikes somewhere on de-energized lines connecting with the object; due to capacitive coupling from nearby HV conductors causing a dangerous potential on the object in question; or if high voltages are induced on the apparatus under test from adjacent energized objects. A properly grounded object cannot become dangerous.

This Application Note describes two methods of the circuit breaker contact resistance measurement with both sides grounded (BSG). Technology for resistance measurement is well known; generate a current through the test object, measure the voltage drop and calculate the contact resistance. The generated current now has two paths (through the contact and the grounding cables) and is therefore not equal to the current through the circuit breaker contact.

1. Contact resistance measurement using Micro Ohmmeters with current clamp

Micro Ohmmeters from RMO-G and RMO-D series can be used to measure contact resistance applying this method, since they are designed to operate with current clamp. Current clamp is used to measure the current through grounding cables. To provide that the selected test current flows through circuit breaker contacts, Micro Ohmmeter generates an adjusted current. This adjustment is based on the total current the instrument measures, and the current through grounding cables that current clamp measures.

The advantage of this method is obtaining the result immediately after one measurement. Disadvantage is susceptibility of the current clamp to influence of electromagnetic field from adjacent energized circuits, which could affect precision of the result.

Figure 1.1 shows a connection diagram of the Micro Ohmmeter with a current clamp to the high voltage circuit breaker where both sides are grounded.

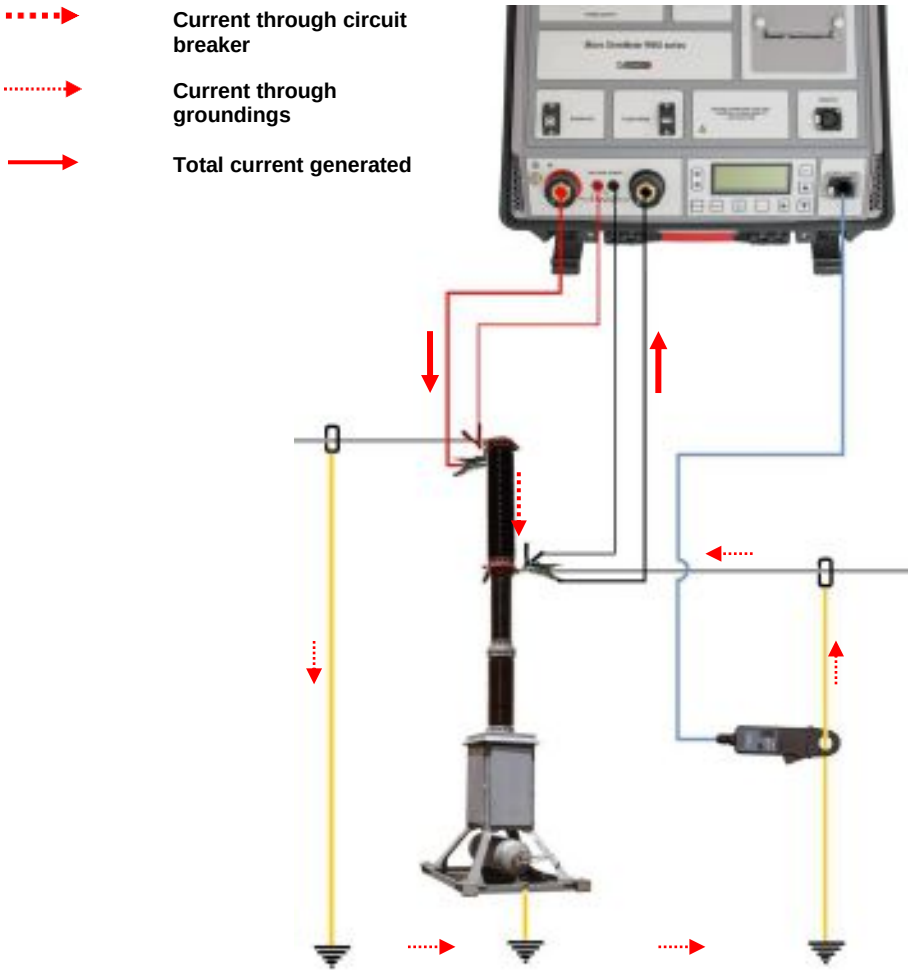

Figure 1.1 *Circuit breaker contact resistance measurement using current clamp*

Before the measurement is initiated, it is necessary to open the main contacts of the circuit breaker, and then to open the disconnectors on both sides of the circuit breaker. Visual check is required to make sure that the circuit breaker has been completely separated from the system.

Circuit breaker contact measurement procedure with both sides grounded:

1. Ground both sides of the circuit breaker;
2. Close the main contacts of the circuit breaker;
3. Ground the Micro Ohmmeter;
4. Connect the mains voltage supply cable first to the Micro Ohmmeter, then to the supply source;
5. Connect the current cables to the circuit breaker;
6. Connect the voltage sense cables to the circuit breaker inside of the already connected current cables;
7. Connect the current clamp to one of the circuit breaker grounding cables (it does not matter which one) and choose 20 A range;
8. Turn on the Micro Ohmmeter.

2. Contact resistance measurement using Micro Ohmmeter without current clamp

This way a Micro Ohmmeter from any of the three (RMO-A, RMO-G, RMO-D) series can be used. The current clamp is not used. This method consists of three steps:

1. Grounding cables resistance R_{gr} is measured with the current that is 100 times lower than the test current (e.g. if the test current is 500 A, grounding cables resistance is measured with current approximately 5 A), while the main contacts are open;

2. The main contacts are closed, and parallel resistance R_p of both main contacts and grounding cables is measured;

3. The main contacts resistance R_c is calculated (manually or using DV-Win software):

$$\boldsymbol{R_c = \frac{R_{gr} * R_p}{R_{gr} - R_p}}$$

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The disadvantage of this method is that two measurements need to be done and the contact resistance is calculated, but the advantage is that the current clamp is not used.

It is recommended to ground both grounding cables at the same point. This way only grounding cables resistance is included and it may be expected to be in range from one to a few tens of mΩ. Since contact resistance is typically in a range of tens of μΩ, it may be assumed that the current through circuit breaker contact is more than 100 times higher than the current through grounding cables (when parallel resistance are measured). This is the main reason why the current used for measuring grounding cables resistance should be approximately 100 times lower than the test current.

Before the measurement is initiated, it is necessary to open the main contacts of the circuit breaker, and then to open the disconnectors on both sides of the circuit breaker. Circuit breaker contact resistance measurement procedure with both sides grounded (Figure 2.1.):

1. Ground both sides of the circuit breaker;
2. Ground the Micro Ohmmeter;
3. Connect the mains voltage supply cable first to the Micro Ohmmeter, then to the supply source;
4. Connect the current cables to the circuit breaker;
5. Connect the voltage sense cables to the circuit breaker inside of the already connected current cables;
6. Turn on the Micro Ohmmeter;
7. Measure grounding cables resistance R_{gr} (as shown in figure 2.1a));
8. Close circuit breaker main contacts;
9. Measure parallel resistance R_p of both main contacts and grounding cables (as shown in figure 2.1b));
10. Calculate main contact resistance R_c .

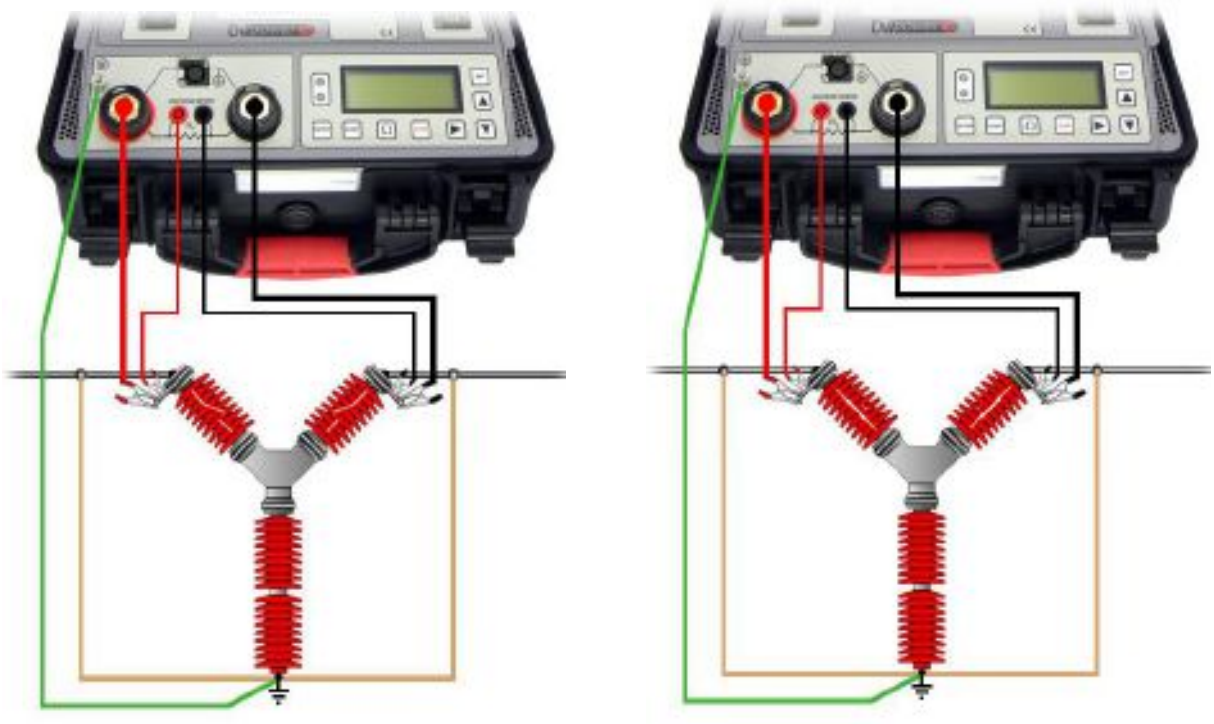

Figure 2.1. a) Grounding cables resistance measurement (main contacts are open) and b) parallel resistance measurement (main contacts are closed)

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