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isa Application Notes

APPLICATION NOTES APPLICATION NOTES

New testing method for HV Circuit Breaker with both sides grounded

The background

The HV circuit breaker is the most important component of an HV substation, as it has the task, sometimes the terrible task, to remove the fault, no matter what is the fault current. Even the nominal current could be difficult to be opened, as 2000 A on a 380 kV line mean something close to half a GigaWatt per phase; yet, this is not the worst case, when the current to be opened can be 20, 40 or even 80 times the nominal one. So, when the matter of what should be tested in a substation is being discussed, nobody argues about the need of being pretty sure that the CB of the plant operate correctly.

On the other side, performing tests is an expensive task, demanding highly skilled engineers, strictly observed procedures, programming and a relevant test execution time. Laws and Standards dictate how the test should be performed in order to avoid any risk to people at work.
All this conflicts with the need of reducing time and the level of skill of people involved.

Circuit Breaker Testing

The most important tests performed on circuit breakers are: main contacts timing and contact resistance. These tests required two instruments, that were connected in turn to the circuit breaker main contact.
During these tests, the operator safety is ensured by connecting to earth both sides of the test object. In the normal practice, the safety grounding is removed at one side during the test, because, otherwise, the timing test cannot be performed by the traditional test sets. This is the "de facto" practice, even if laws and standards would not allow it. The point is that when the contact is closed there is no risk, but when, during the test, the contact is opened, the risk is there: high voltage induction, no protection in case of fault. As this is a risky practice, here comes the need for highly skilled people.

The ISA test solution

ISA for almost 70 years it has been working side by side with power utilities personnel helping them performing their work safely and efficiently.
ISA is making substation testing safer for the test engineers and at the same time helps make operation of utilities and service companies more efficient.
Our latest born equipments for testing Circuit Breakers, the CBA1000 and CBA2000, incorporate the main contact timing test and the contact resistance test, static or dynamic: this means reducing the test time.
As all other test sets, time measurement cannot be performed unless only one side is grounded. Now they come along with the BSG option, that stands for Both Sides Grounded, that allows to perform tests without removing the safety ground connections on both sides of the main contact. Working in this condition will bring all advantages described above, by removing the risk and the consequences of arc-flash and electrocution accidents.

The technology to measure the operating time of the circuit breaker when it is grounded on both sides is based on resistance measurement.
Circuit breakers are always placed in a very high position: long connection cables must be used to ground them. The resistance of these leads is usually in the range of 20 to 30 mΩ, whilst the contact resistance of the breaker is in the range of 20 to 30 $\mu\Omega$, and the resistance of the graphite coating is in the range of 200 to 500 $\mu\Omega$. Goal of the test is a safe detection of the contact being: closed, graphite or open, and not the measurement of the contact resistance; so, as the grounding connection resistance is much bigger than the graphite and contact resistance, its presence does not affect the test.

CBA1000 connected to BSG-1000

And here comes our solution:

- A microOhm meter tester for each individual contact of the circuit breaker injects the test current and meters the contact resistance.
- The resistance value is measured and compared with two thresholds, for instance 100 μΩ and 1 mOhm;
- R > 1000 μΩ: the contact is OPEN
- R < 1000 μΩ and > 100 μΩ: GRAPHITE
- R < 100 μΩ: the contact is CLOSED

The result is then converted into a voltage signal and provided to CBA1000 for two time measurements.

The technology used with the BSG to generate the test current is similar to that used for the DRM of the CBA's: a large capacitor is charged and then discharged through an electronic circuit, that stabilizes the current to 20 A.

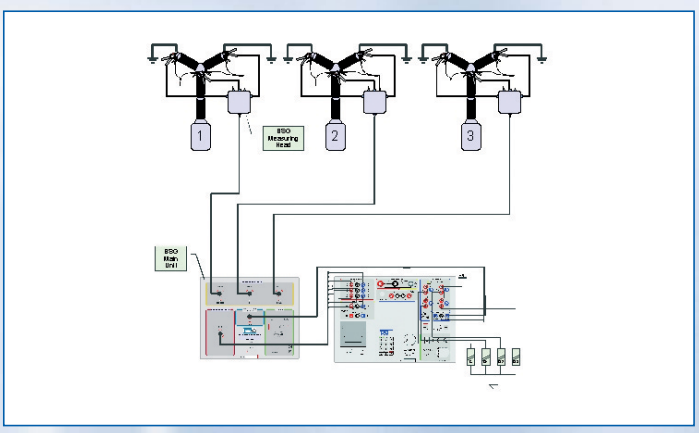
Description

Two types of BSG1000 are available:

- BSG1000-1, for testing one break per phase;
- BSG1000-2, for testing two breaks per phase (displayed in the figure).

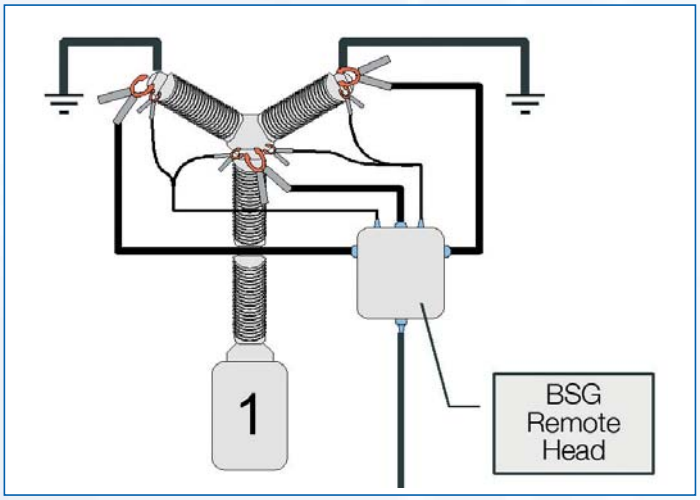
Each BSG1000 is made of the following elements:

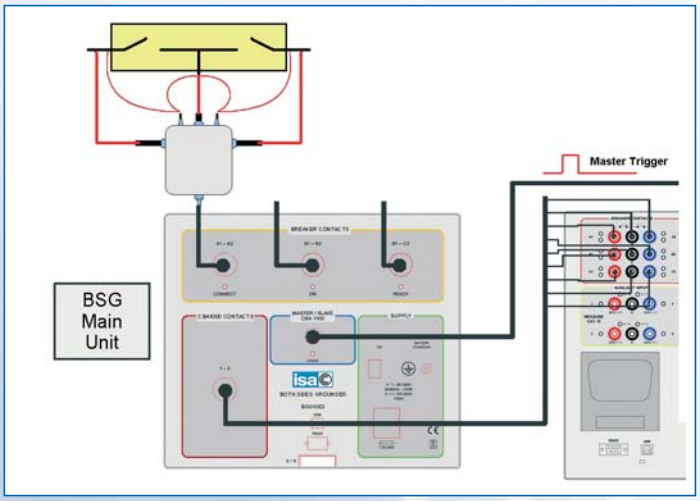
- Three BSG Remote Heads, types 1 or 2. They are connected close to the main breaker contacts, and include the current generator and the two level comparator, that communicates the result in digital form to the Main unit. Each head has two type of cables, each 3 m long: one for the connection of the test current to the CT under test, and the other one (shielded) for the open / close detection of the CB contacts. One set of cables for type 1; two sets for type 2.
- One BSG Main unit, that includes the microprocessor supervising the heads, and the DAC's for CBA inputs. It is connected to the heads and to the CBA by a cable kit, including:
  - Three 8 m long cables, terminated with multi-pole connectors, for the connection between remote heads and the Main unit.
  - One cable, 1 m long, terminated with multi-pole connectors, for the connection of the BSG Main unit to CBA1000 or CBA2000.



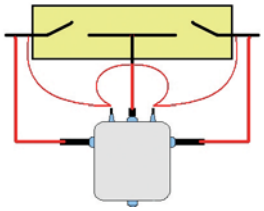
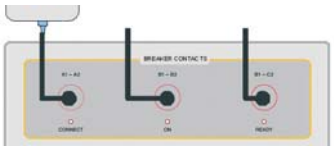
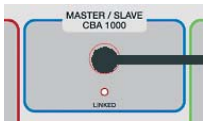
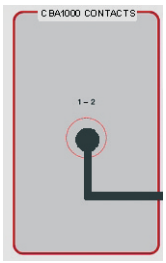
Sequence of operation

- The BSG measuring heads generate the current only when a test is to be performed.
- The current generation is initiated by CBA1000 or CBA2000, by means of the Master output. The START signal goes to the BSG Main unit, that, in turn, commands the Measuring Heads.
- When the current is OK the heads inform the CBA via the Main unit; at this moment, the CBA drives the CB coils, and the time measurement starts.
- The head measures the contact resistance, compares it to the threshold and communicates in real time the result (CLOSED, GRAPHITE or OPEN) to the Main unit;
- The Main unit converts this information into a voltage level that is sensed by CBA as CLOSED, RESISTANCE or OPEN. These operations are performed at very high speed, so that the time measurement is not influenced;
- CBA measures the times, and displays the results as a thick – intermediate – thin line;
- It is possible to change the resistance threshold operating on the CBA screen.





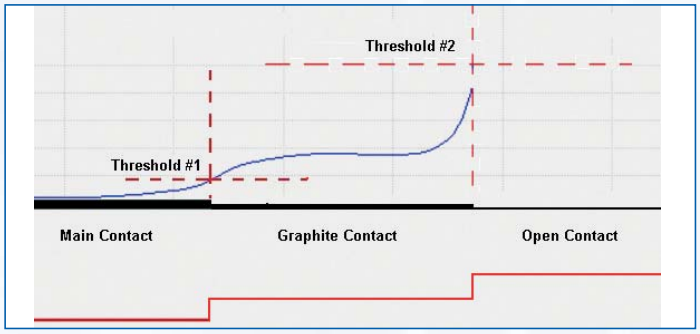
Test set-up

Lift the Measuring head up to the circuit breaker. Connect the Current terminals to the main CB contacts. Connect the voltage sensors to the main CB contacts, so that the current terminals voltage drop does not influence the resistance measurement.	Connect the Measuring Head control cable to the BSG Main unit, in the Breaker Contact section.	Connect the Main unit Master / Slave input to the CBA output	Connect the Main unit output connector to the CBA inputs, following the connector markings.
			

Siemens Graphite contacts

Besides, if the Circuit Breakers has a graphite nozzle, CBA1000 displays the timing at which the graphite is engaged, and when the main contact is reached, thus allowing to check the deterioration of the graphite.

How does the BSG detects the graphite contacts?
The BSG has two voltage thresholds to detect which section of the contact is engaged: graphite or metallic.



And the other Circuit Breakers ?

Siemens is very keen to use equipments which are able to detect when the main contact is engaged by filtering out the Graphite contact.

For other circuit breakers we have a similar picture: we can measure the time when the main contact are engaged by filtering out the Arcing contact.
In fact, the resistance profile is very similar to the Graphite contact, and therefore the same Siemens method can be applied to any sort of HV Circuit breaker making our devices: CBA1000, CBA2000 and GSG the prefect tools for a safe and more comprehensive circuit breaker testing.

BSG-1000 Remote Heads

ISA srl
Via Bergamo, 41
21020 TAINO (Va) Italy
Tel. + 39 0331 956.081
Fax + 39 0331 957.091
Web site: www.isatest.com
E-Mail: isa@isatest.com