Circuit Breaker Testing

Application Note

Timing measurements on GIS

DualGround technology

The innovative method, called DualGround, allows for accurate, safe and efficient testing of the circuit breaker compared to conventional timing. Conventional timing methods require one ground to be lifted on one side of the breaker in order to sense the change in contact status. This procedure makes the test cables and the instrument a part of the induced current path while the test is performed. The DualGround method allows for safe and reliable measurements with both sides of the circuit breaker grounded thus making the test faster and easier. This technique also makes it possible to test circuit breakers in configurations such as GIS applications, generator breakers and transformer applications where conventional timing methods requires removal of jumpers and bus-bar connections which is difficult and cumbersome.

Application

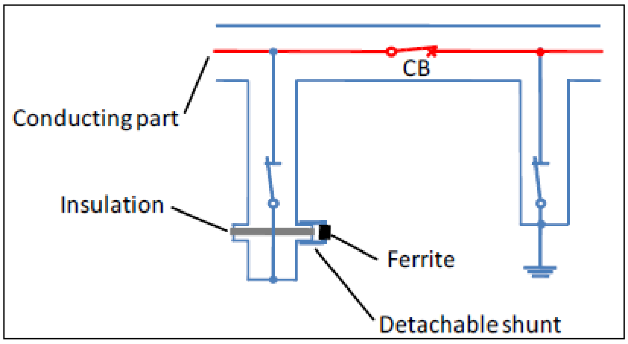
Time measurement, using TM1700/1800 with Dynamic Capacitive Measurement (DCM) on Gas Insulated Switchgear (GIS) Circuit Breakers (CB) grounded on both sides using ground/earth switches. In order to perform successful timing measurement it is required that ground links or jumpers at the ground/earth switch are surrounded by ferrites. Such ferrites are included in the Megger Ferrite kit (XB-40090).

One property of a ferrite is that it increases the impedance of the conductor it surrounds. Since the DCM technology uses high frequency AC current as test current we can take advantage of this property to increase ground loop impedance.

Ferrites are needed when the ground loop has low impedance compared to the circuit breaker loop. On Air Insulated Switchgear (AIS) ferrites are normally not required due to that the ground loop is considerably longer than the circuit breaker loop. On GIS breakers, though, the ground loop is usually about the same length as the circuit breaker loop and therefore ferrites are required to increase the impedance in the ground loop.

Prerequisites for breaker

At least one of the ground switches need to be of insulated type, i.e. there must be a part, connected to the inner conducting part (through the closed ground switch), that is possible to disconnect electrically from ground by detachable jumpers or shunts.



The jumper must be shaped in a way that makes it possible to attach a ferrite around it. Likewise, there must be enough space between the shunt and the casing of the ground switch to fit a ferrite (see example with Siemens 8DN8 breaker below). If the dimensions of the jumper and/or the spacing does not allow for attaching a ferrite, the jumper can be replaced by a flexible cable on which a round shaped ferrite can be attached.

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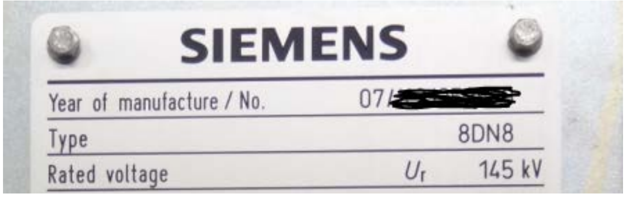
Siemens 8DN8



This GIS breaker may be one of the easier for mounting ferrites. The grounding bar is clearly visible and accessible for the operator. Four "I" and "C" shaped ferrites from the kit need to be used since grounding bar is connected to outer tubing of GIS in two places between the phases. There is enough space to put ferrites around the copper bus, but it require some careful handling.

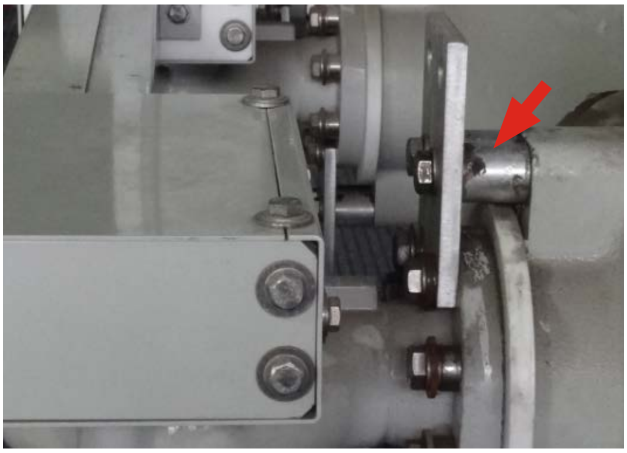
DCM connections are made on the ground bar bolts for each phase and on the GIS outer enclosure. The bolts on outer enclosure may be painted and therefore it is important to find a place with good contact.

The "I" and "C" ferrites mounted on the copper bus.

One of the ferrites (C plus I) on the copper bus.

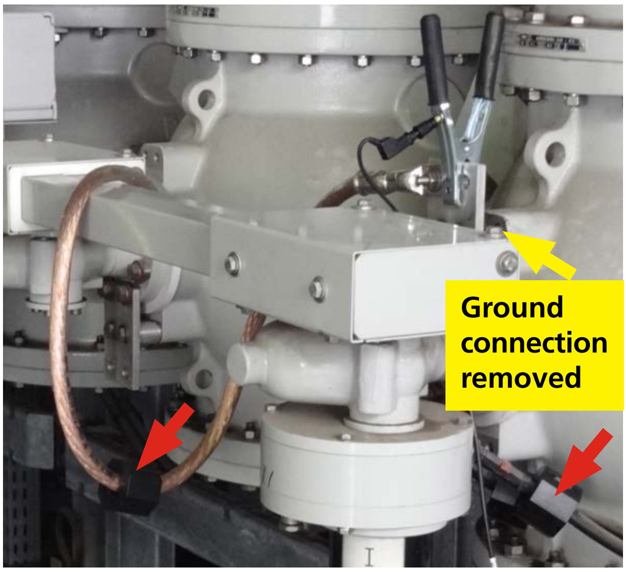
Alstom FB14

This breaker has a ground switch with removable grounding bar or connection which can be used for ferrite mounting. Unfortunately the space is too small to fit a ferrite around the connection. In this case a flexible grounding is used in parallel to the original connection which is subsequently removed.



The existing ground connection must be removed, as can be seen in the picture below.

The flexible grounding is fitted with a round ferrite and connections are made between outer enclosure and bolts on ground switch. It is important to avoid connecting on bolts or other parts which are painted. Another important point is to put one round ferrite around the cable coming from the ground switch.



Round ferrites mounted on the ground cables.

Problems to be avoided

To achieve desired functionality ferrites must be applied on all shunts and/or devices that interconnect the insulated part of the ground switch to ground, for example:

Maneuver shafts

The ground switch might be operated by a maneuver shaft that transfers the power from the operating mechanism to the switch, in case the operating mechanism is externally located. If this maneuver shaft is made of a conducting material you need to apply a ferrite around it. If the same maneuver shaft operates all three phases, ferrites need to be applied between the phases to separate them from each other.

Shielded cables

If there is a signal cable going to the ground switch it is most likely of shielded type and then it is necessary to apply a ferrite around the cable.

All other ground connections

In some installations the isolated part of the ground switch is not only grounded through the shunts but also has a separate grounding bar. In such case ferrites need to be applied to the grounding bar.

Too many parallel ground connections

A parallel shunt/ground connection decreases the impedance by half although ferrites are applied on both paths. If there are too many parallel connections to ground the resulting impedance might be too low for DCM to sense a difference between a closed or open circuit breaker. The highest number of parallel paths cannot be set explicitly; it must be experimentally found from one installation to another.

On the contrary, putting ferrites in series on the same shunt/ground connection increase the impedance. So this may be a solution when there are too many parallel paths to ground.

Too long measurement loop

The DCM measurement circuit is optimized for best amplitude response when connected to GIS circuit breakers having reasonable distance between ground switches; say 10 m (33’), however, distances up to 20 m (66’) might be managed.

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