Application Note

Contact Resistance Measurement on Dead Tank Circuit Breakers and CT Demagnetization

In contrast to live tank circuit breakers, dead tanks have a metal-enclosed interrupter unit, and the housing is always grounded.
For certain substation designs, the dead tank circuit breakers might be required instead of the standard live tank breakers. The dead tank breaker offers particular advantages if the protection design requires the use of several current transformers per a pole assembly. The dead tank circuit breaker also has an advantage in case of earth-quakes.

The most important characteristics of a dead tank breaker:

- Toroidal-core current transformers on bushings (compact construction)
- High short-circuit breaking currents possible (up to 63 kA with one interrupter unit)
- No creepage path across interrupter unit
- Low impulse load of the base
- Low center of gravity of the base (higher seismic withstand capability)
- Heating system available for low temperature applications
- Gas-insulated components ensure highest availability at minimum maintenance effort
- Metal-enclosed interrupter unit (grounded housing)

The SF6 gas filling the tank provides insulation of the high voltage live parts of the contact assembly from the housing. Outdoor bushings connect the interrupter chamber with the high-voltage terminals. This construction means an increased risk of internal earth fault or short circuit within the tank and the risk cannot be neglected. To handle those situations, the bushings on both sides of the tank are normally equipped with a current transformer further connected to protective relays (for measurement or protection purposes, fulfilling the requirements according to international standards such as IEC, ANSI, etc.).
The current transformers are mounted in a weatherproof housings on both sides of each breaker pole and they are located at the base of the bushings. A typical housing provides space for up to three current transformers per bushing.

The typical design of the dead tank circuit breaker equipped with the bushing current transformers is presented in the *Figure 1* below:

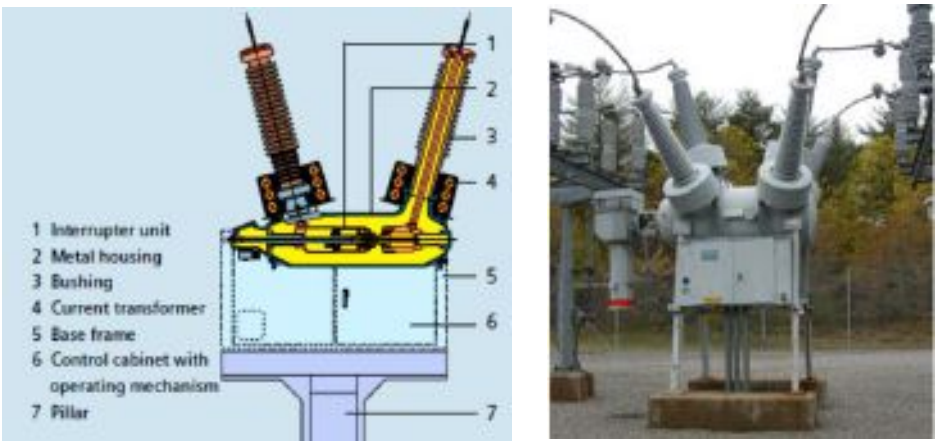

Figure 1 – *Dead tank circuit breaker*

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The contact resistance measurement of dead tank circuit breakers requires a different approach than, for example, the live tank CBs, and it is specific because of their design explained above. A DC current used for this measurement flows directly through the current transformers mounted on the bushings. Presence of current transformers (CT) in this type of circuit breakers may introduce errors during a test due to CT magnetizing process.

Hence, the following two points should be considered when performing the contact resistance measurement on Dead Tank Circuit Breakers:

1. **It is necessary to saturate a CT prior to starting measurements. This can be achieved in *DTRtest* menu, specially designed for dead tank circuit breakers.** All calculations for detecting the saturated condition of CTs are done by internal algorithm. Accordingly, the process of measurement parameters setting and testing in this mode is very simple and does not differ much from live tank circuit breaker testing (in SINGLE / CONTIN test modes).

2. **After completing the test, it is necessary to demagnetize the CT cores.** This is because after disconnecting a dead tank circuit breaker from the service, some amount of magnetic flux is probably trapped in the current transformer core. This remnant magnetism can cause various problems such as erroneous diagnostic electrical measurements on a CT or an incorrect operation of protective relays. The RMO-D device is capable of performing demagnetization automatically. Following a test in SINGLE, CONTIN, BSG or DTRtest mode, the Result Menu will be displayed (Fig. 3). Please press the START button to commence the demagnetization process.

Figure 3 – *Result menu in RMO-D devices*

Even if no remanent magnetism is present, demagnetization cannot do any harm, and the process itself is very quick. Demagnetizing magnetic core of a transformer requires alternating current applied with decreasing magnitude down to zero. By reducing the magnitude of the applied current to the zero value, the total magnetic flux, or remanent magnetism, is also annulled as presented in the *Figure 2* below.

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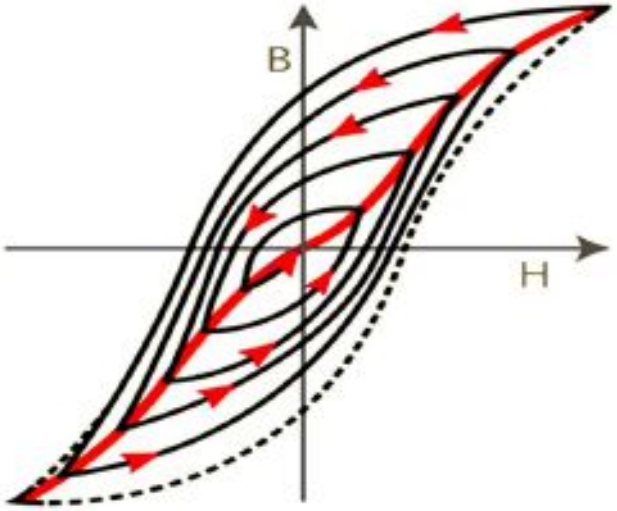

Figure 2 - *The demagnetization process*

The RMO-D provides this alternating current by internally changing the polarity of a controlled DC current source. During the demagnetization process the instrument supplies current at decreasing magnitude at each step, following a proprietary developed solution algorithm. The process is presented in the *Figure 4* in a form of I_T (t) diagram.

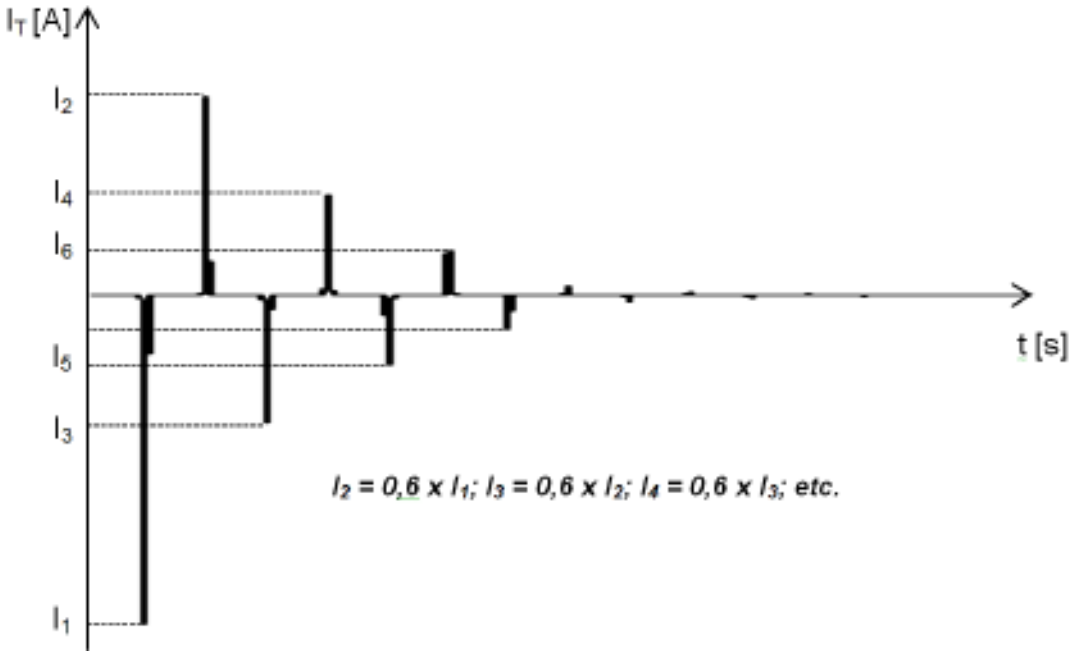

Figure 4 – *Result menu in RMO-D devices*

After Demagnetization is finished, *"Demagnetization done"* message appears on the display for 3 seconds and the last test results will be shown again. The demagnetization process does not require modification or any additional connections; it is automatic and very quick.

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