Application Note

Selecting Test Current

Winding resistance measurements is a routine test for all transformers. This test is of fundamental importance for calculation of the I^2R component of conductor losses and checking conductor connections are correct. The test results accuracy is very important in order to get a correct state assessment of transformers. Direct (DC) current is used for the measurement. Selecting the optimal value of test current is crucial.

Three parameters are important for the optimal test current selecting:

1- Transformer saturation;
2- Minimum measurement voltage value;
3- The impact of the winding heating on a resistance value.

Transformer saturation

It is important to understand the correct value of a winding resistance cannot be measured until the current and the inductance reach stable states. The inductance value of a transformer depends on the current injected in the windings. A transformer is normally designed to reach saturation when the current is 1,2 times the peak value of the no-load current. The no-load current is normally in the range of 0,2 to 5 percent of the nominal winding current. The larger the transformer, the lower the percentage of the current that saturates the transformer (comparing to the nominal value). When measuring the winding resistance the test current should be at least 1,2 times the no-load current of the transformer.

For winding resistance measurement the DV Power devices use charging voltage of 55 V and specific charging algorithm for reaching the preselected current faster.

Minimum measurement voltage value

As previously said, the accuracy of the measured winding resistances is very important. The value of the measured voltage signal is one of the parameters influencing the accuracy of the measurement. The minimum value of this signal should be 10 mV to obtain reliable measurement results.

Higher measured voltage can be obtained using higher test currents. Typical accuracy of DV Power devices of ± (0,1 % rdg + 0,1 % F.S.) (*rdg*-reading, *F.S.*-full scale) is valid if the maximum possible current is being used. A current as high as possible should always be selected, but respecting the limitations to avoid the risk of heating the winding (electrical resistance of conductive material is dependent on material temperature).

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The impact of the winding heating on the resistance value

Whenever a current flows through a conductive material that has some resistance, it generates heat. Heat is directly proportional to the square of the current (I^2) passing through the conductor, the conductor resistance (R), and time (t) for which current flows through the conductor ($R \cdot I^2 \cdot t$).

According to international standards, the maximum test current should not be higher than 10% (IEC) or 15% (ANSI) of the nominal winding current to avoid significant heating of the winding.

The Figure 1 shows the influence of the winding heating on the winding resistance. The nominal current of the tested transformer is 250 A. The test was performed using the test current 50 A. The test current was 20% of the transformer nominal current and influence of the winding heating is significant.

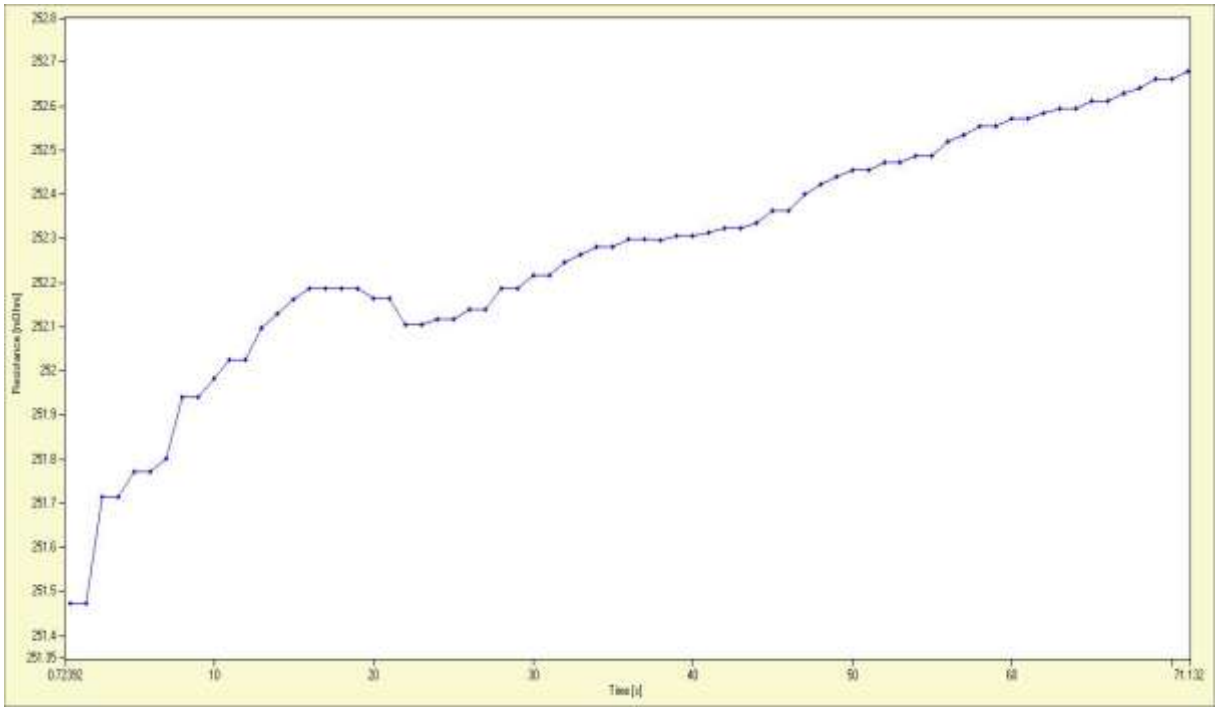

Figure 1 Winding resistance increasing due to heating

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Example

The test current should be selected according the transformer nominal (rated) current.

The transformer nominal (rated) current value is provided on the transformer nameplate. The nominal current is marked in the Figure 2.

The optimal test current value should be high enough to saturate the transformer core (0,25 - 6 % of a transformer nominal current). If the tested transformer is a big unit (several hundred MVA) the saturation DC current is even less than 1 % of a transformer nominal current.

To avoid significant heating of the winding, it is important the test current is less than 10 % of the nominal current.

The voltage drop value ($R \cdot I$) should be high enough (≥ 10 mV) to get accurate results.

It is recommended to use the test current which is 10 % of a transformer nominal current, if the device is able to output the current.

The transformer rated current from the Figure 2 is 198,4 A. The suggested test current for the winding resistance measurement of the transformer is 20 A (~10 % of the rated current).

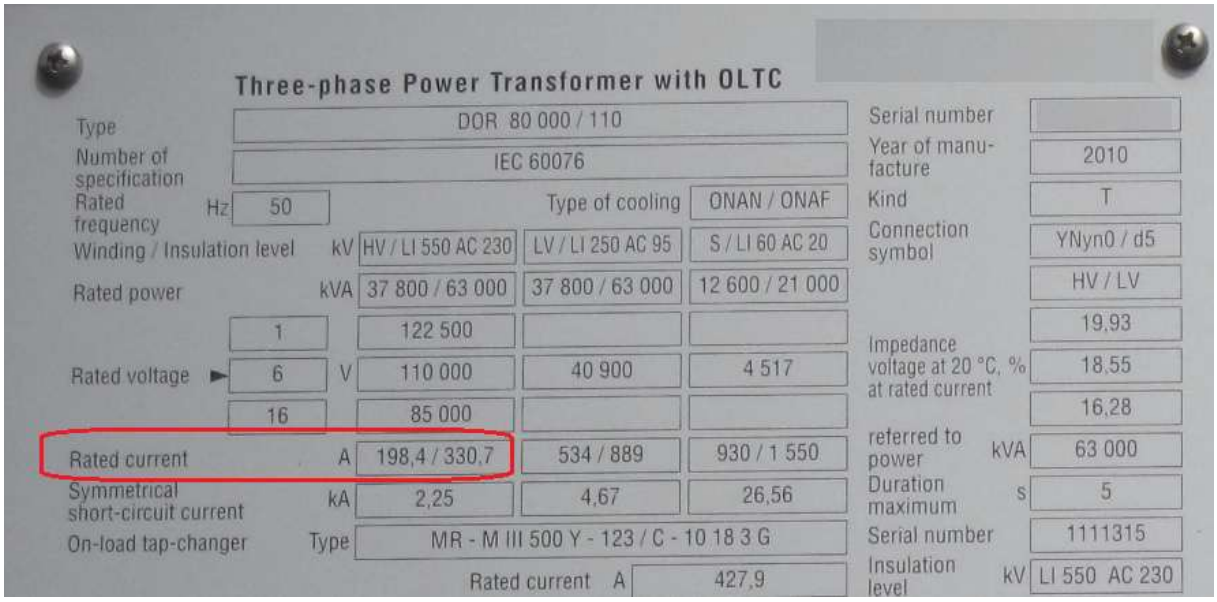

Figure 2 Transformer nameplate

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