Understanding Transformer Impedance

This paper is intended as a tutorial to help explain transformer impedance and how its value is determined. Transformer impedance is a ratio of the transformer's normal full load current to the current available under short circuit conditions.

Transformer formulae:

Single phase full load current:

$$I_{FL} = \frac{KVA \times 1000}{Voltage}$$

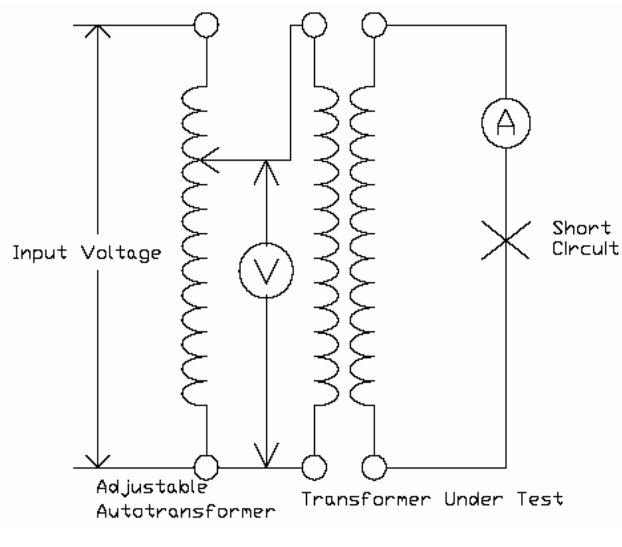
Three phase full load current:

$$I_{FL} = \frac{KVA \times 1000}{\frac{Voltage}{\sqrt{3}}}$$

Short Circuit Current:

$I_{SC} = I_{FL}/Z$, where, Z = transformer impedance

Method for determining impedance. Refer to the figure below.



An adjustable autotransformer is connected to the transformer under test. A Voltmeter is connected to the transformer's primary winding. An ammeter is connected in series with the transformer's short-circuited secondary winding.

Starting at zero volts, the primary voltage is increased until the ammeter displays the normal, full load current (I_{FL}). The impedance can now be calculated by dividing this voltage by the rated primary voltage.

An example will serve to illustrate:

Transformer data:

Capacity: 10 KVA, single phase

Primary voltage: 480V

Secondary voltage: 240V

$$I_{FL} = \frac{10\ KVA \times 1000}{240V} = 41.7A$$

Assume a primary voltage of 24V caused 41.7A (I_{FL}) to flow in the secondary. Impedance is calculated by dividing 24V by 480V.

Therefore, $Z = \frac{24V}{480V} = 0.05 \times 100 = 5\%$

Note that impedance is expressed in percent.

Now that impedance is known, short circuit current, I_{SC}, can be calculated.

$I_{SC} = I_{FL}/Z = 41.7/0.05 = 834A.$

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