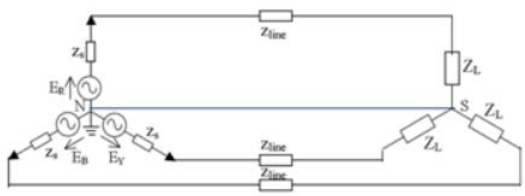
Reactor %Z impedance derivation

By Wayne Walcott

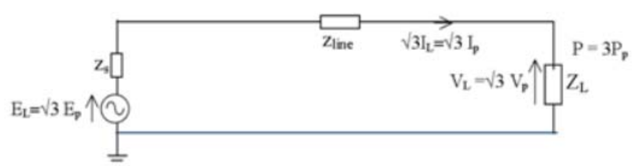
$\%Z = \frac{I_l \, 2\pi f L \sqrt{3}}{V_{L-L}}$ X 100 where does it come from?

The reactor is an inductive component that is identified and sized by a ratio of its reactive impedance to the applied circuit impedance: (see equations 1 & 2). Reactors by themselves don't have a % impedance value only by applying the reactor inductance and a current rating to an application with line voltage and frequency can %Z be realized. Reactor percent Z impedance is also an indication of the voltage drop across the reactor during application of the load current. To better understand the math behind the numbers we need to go through the % Z derivation.

Consider the circuit's below to help understand the how a reactor's impedance is calculated.



Three Phase circuit



Equivalent of 3 Phase system

1. $\%Z = \frac{Z_{reactor}}{Z_{(line-neutral)}}$ X 100

2. $Z_{reactor} = \sqrt{R_{DC}^2 + (2\pi f L)^2}$ DC resistance is low so let's use $Z_{reactor} = 2\pi f L$

3. $Z_{(line-neutral)} = \frac{V_{L-L}}{I_l \sqrt{3}}$ This is the Ohms law part for 3 phase E=IR or R=E/I

Then combining #2 and #3 into #1:

4. $\%Z = \frac{2\pi f L}{\frac{V_{L-L}}{I_l \sqrt{3}}}$ X 100 normalizing the equation to $\%Z = \frac{2\pi f L \, I_l \sqrt{3}}{V_{L-L}}$ X 100

5. Final result for reactor impedance $\%Z = \frac{I_l \, 2\pi f L \sqrt{3}}{V_{L-L}}$ X 100

MTE Corporation, N83 W13330 Leon Road, Menomonee Falls WI 53051
Phone: 262-253-8200 ♦ Fax: 858-300-5070 ♦ Toll-Free Fax: 866-842-3305 ♦ Email: sales@mtecorp.com ♦ www.mtecorp.com