EZCT Turns Ratio Measurement

Application Notes

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October 2016
Revision 1

The Vanguard EZCT line of products use the voltage method to measure the turns-ratio on current transformers. A typical connection for a stand-alone CT is shown in figure 1.

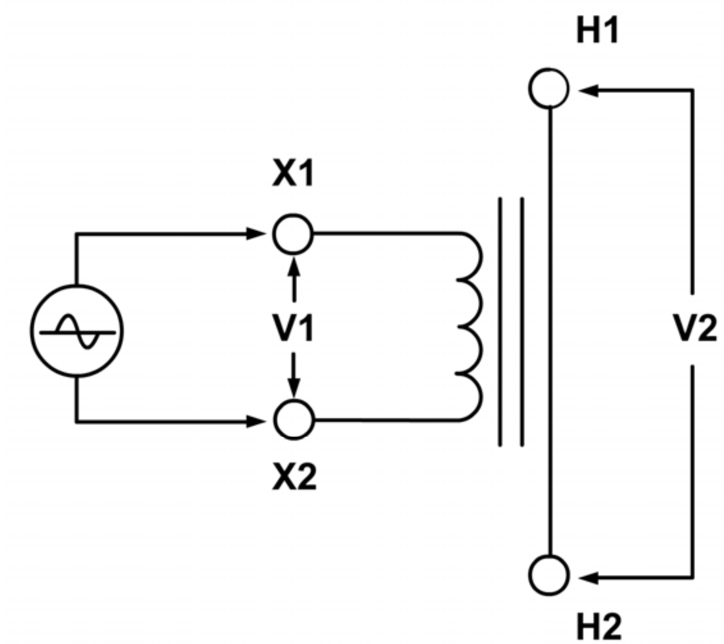

Figure 1

The EZCT applies a test voltage (V1) to the CT secondary winding. The induced voltage (V2) is sensed through the CT primary winding. In this case a single conductor is used. By definition, the turns-ratio is the voltage ratio:

$$\textbf{Ratio}=\frac{V1}{V2}$$

Figure 2A shows a typical connection of a CT mounted on the primary bushing of a single phase transformer. When the voltage V1 is introduced to the CT's secondary winding, there is an induced voltage (V3) on the primary winding of this single phase transformer. Since the only access to the transformer is between terminals H1-H2, The V3 voltage will be included and the turns-ratio will be:

$$\text{Ratio}=\frac{V1}{(V2+V3)}$$

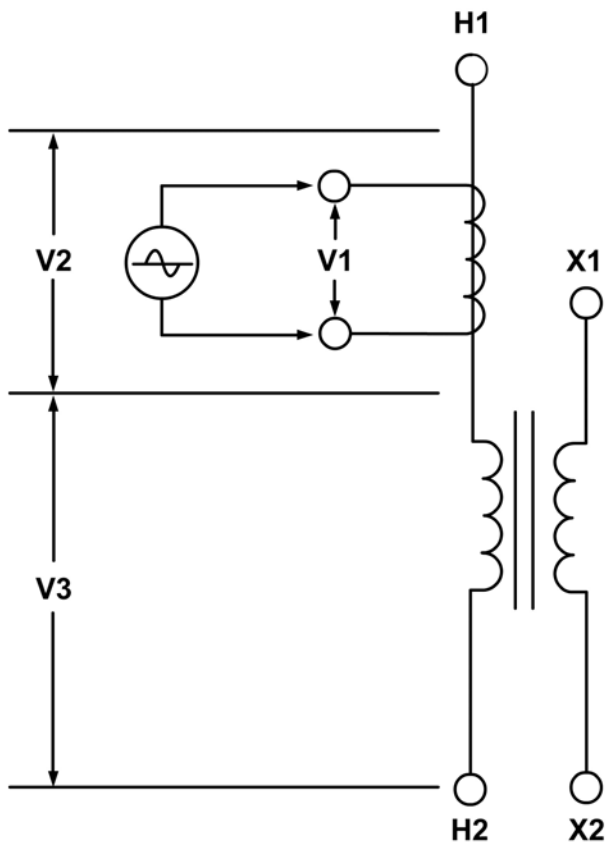

Figure 2A

Ideally, we would like to eliminate the V3 voltage and only see the V2 voltage. If the induced V3 voltage on the transformer winding cannot be eliminated, the turns-ratio measured will be wrong!

Since this is a single phase transformer, and the transformer secondary winding is accessible, the user can apply a jumper to short out the transformer secondary winding as shown in Figure 2B. By shorting out the transformer secondary winding, the user can eliminate most of the V3 voltage (V3=0V).

Now the turns-ratio will be:

$$\text{Ratio}=\frac{V1}{V2}$$

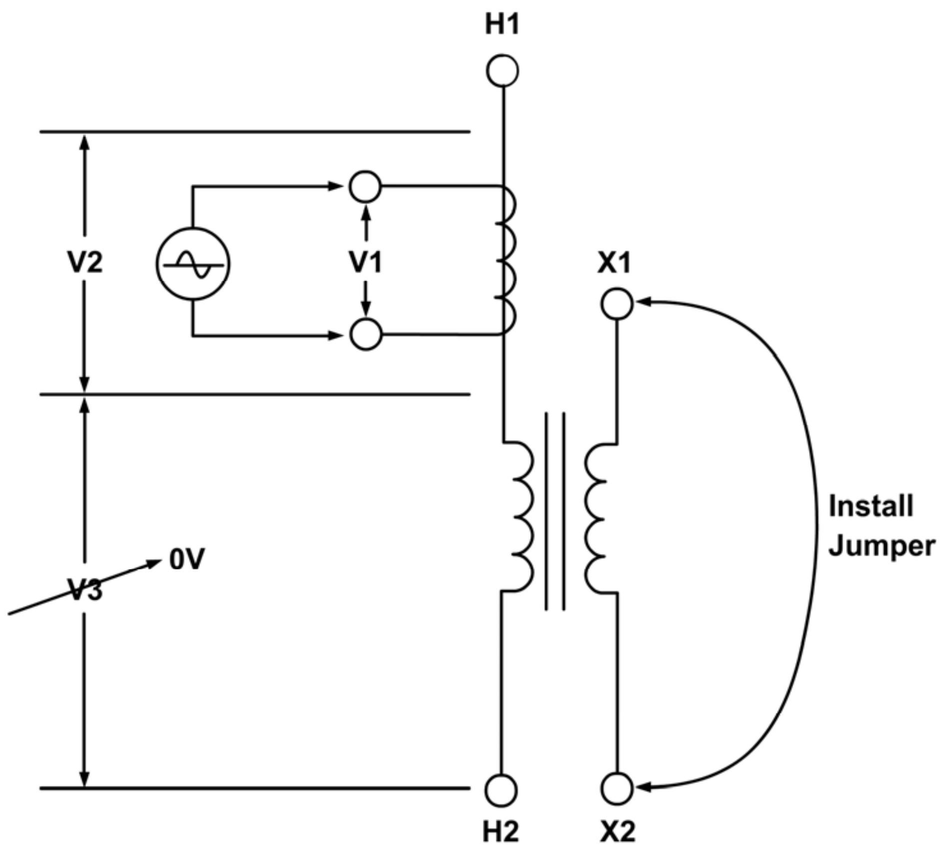

Figure 2B

Figure 3 shows a CT mounted on an auto-transformer. This configuration is very similar to the CT mounted on a single phase transformer, the main difference being the secondary winding is part of the primary winding.

The turns-ratio in this case will be:

$$\text{Ratio}=\frac{V1}{(V4)}=\frac{V1}{(V2+V3)}$$

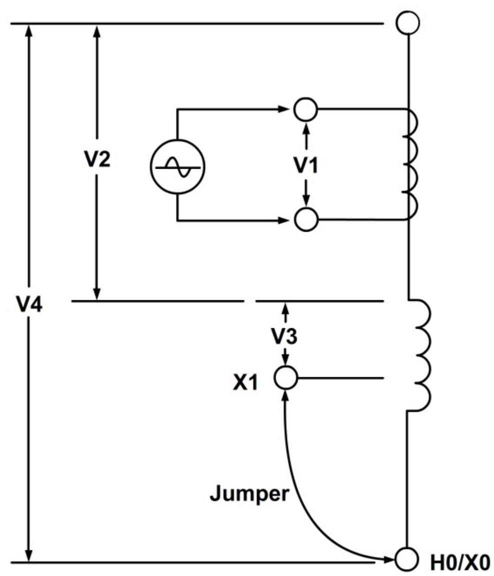

Figure 3

By shorting out the transformer secondary winding (X1 to H0/X0); we can eliminate the voltage induced from X1 to H0/X0. The voltage V3 cannot be eliminated and will create an error in the CT turns ratio measurement. The amount of error depends on the amount of turns of the secondary windings.

The alternative method to verify the CT turns ratio is shown in figure 5 & 6.

Figure 4 shows a CT mounted on a typical shunt reactor. This configuration is very similar to the CT mounted on a single phase transformer, the main difference being the lack of the secondary winding! The turns-ratio in this case will be:

$$\text{Ratio}=\frac{V1}{(V2+V3)}$$

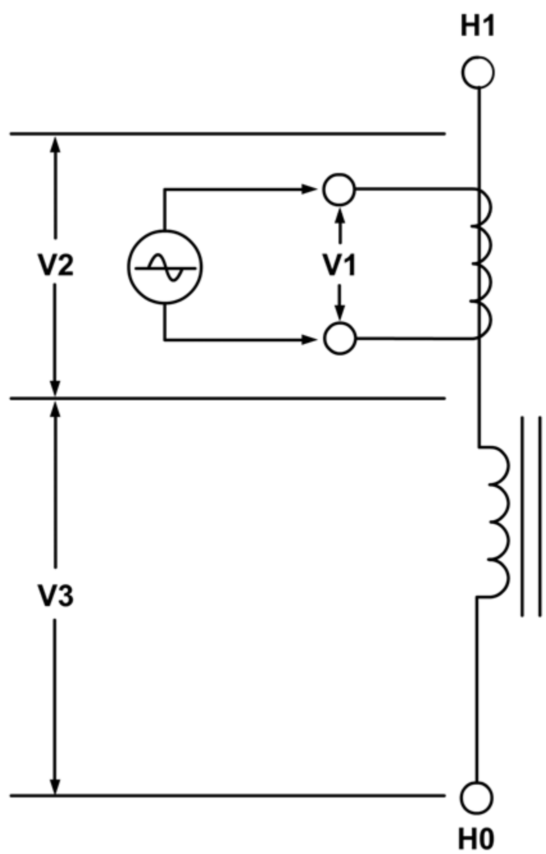

Figure 4

Since there is no secondary winding on the shunt reactor, the V3 voltage cannot be eliminated from the connection. The turns-ratio measurement from using this method will always have some built-in error. The amount of error depends on the size of the reactor winding and the number of turns on the CT's secondary winding. The alternative method to verify the CT turns ratio is shown in figures 5 and 6.

Figure 5 shows a CT with 5 taps. The turns-ratio of the CT can be measured by treating the CT secondary winding as an auto-transformer. When using this method, the effect of the shunt reactor winding is totally eliminated.

The turns-ratio [(X1-X5)/(X2-X5)] measured by the EZCT or any electronic TTR will be as follows:

$$\text{Ratio} = \frac{V1}{V2}$$

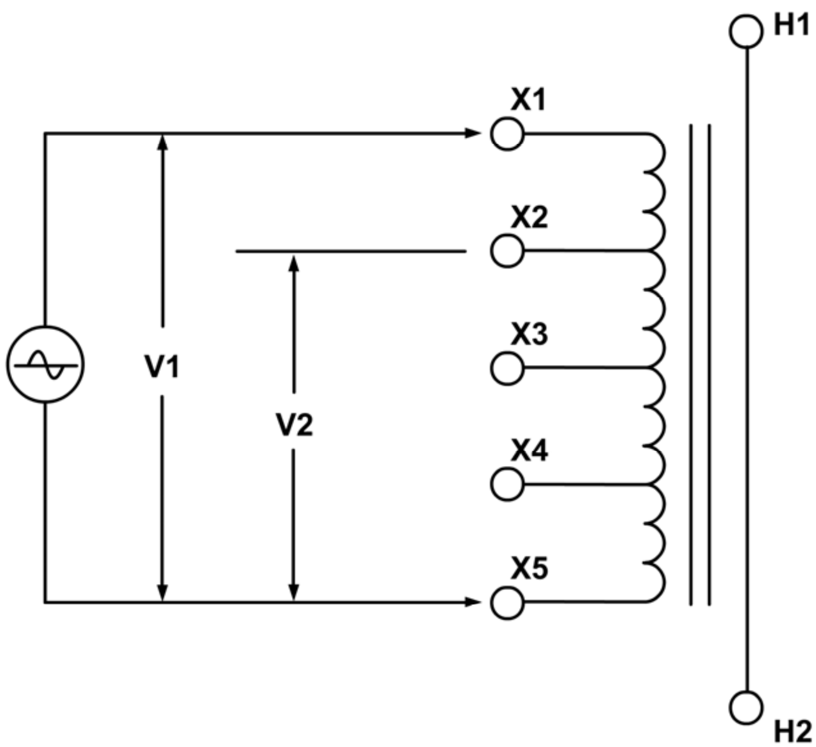

Figure 5

From the name plate of the CT shown in table below, the turns-ratio can be calculated as follows:

Ratio	Terminal
1200-5A	X1-X5
1000-5A	X2-X5

$$\text{Calculated Ratio} = \frac{Ratio\ (X1-X5)}{Ratio\ (X2-X5)} = \frac{(\frac{1200}{5})}{(\frac{1000}{5})} = \frac{240}{200} = 1.20$$

A common practice for verifying the CT turns-ratio in the field is to apply an AC voltage to the CT secondary full winding (X1-X5). A volt meter can be used to verify the voltage drop across the CT terminals.

For example, if a 120Vac voltage is applied to the X1-X5 of this CT, the voltage reading across X2-X5 is expected as follows:

$$\frac{V(X1-X5)}{V(X2-X5)} = \frac{1200}{1000} = 1.2$$

$$\frac{120v}{V(X2-X5)} = 1.2$$

V (x2-x5) = 100V

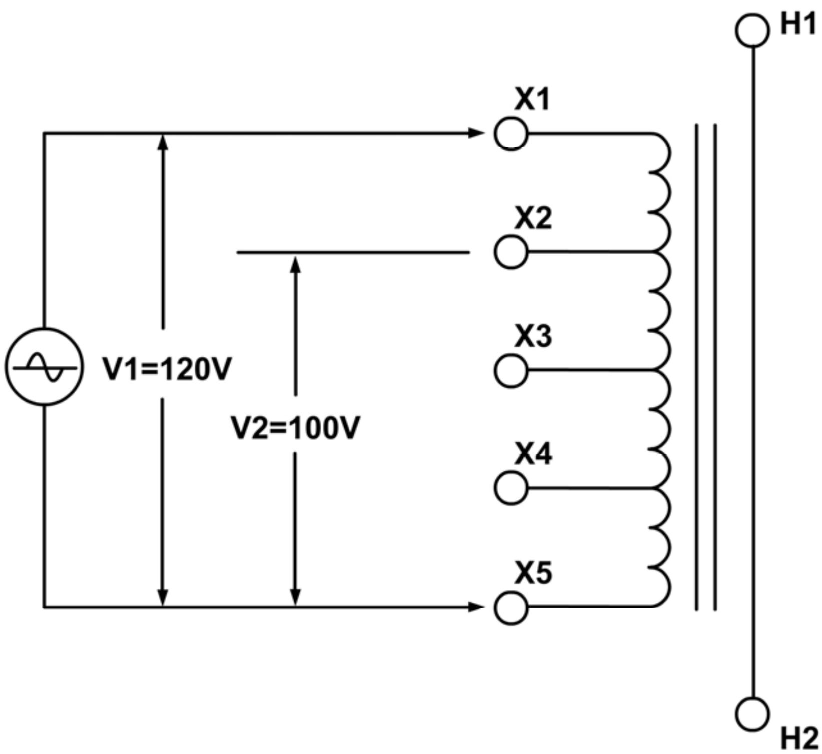

Figure 6

This method also eliminates the effect of the auto-transformer or reactor windings.

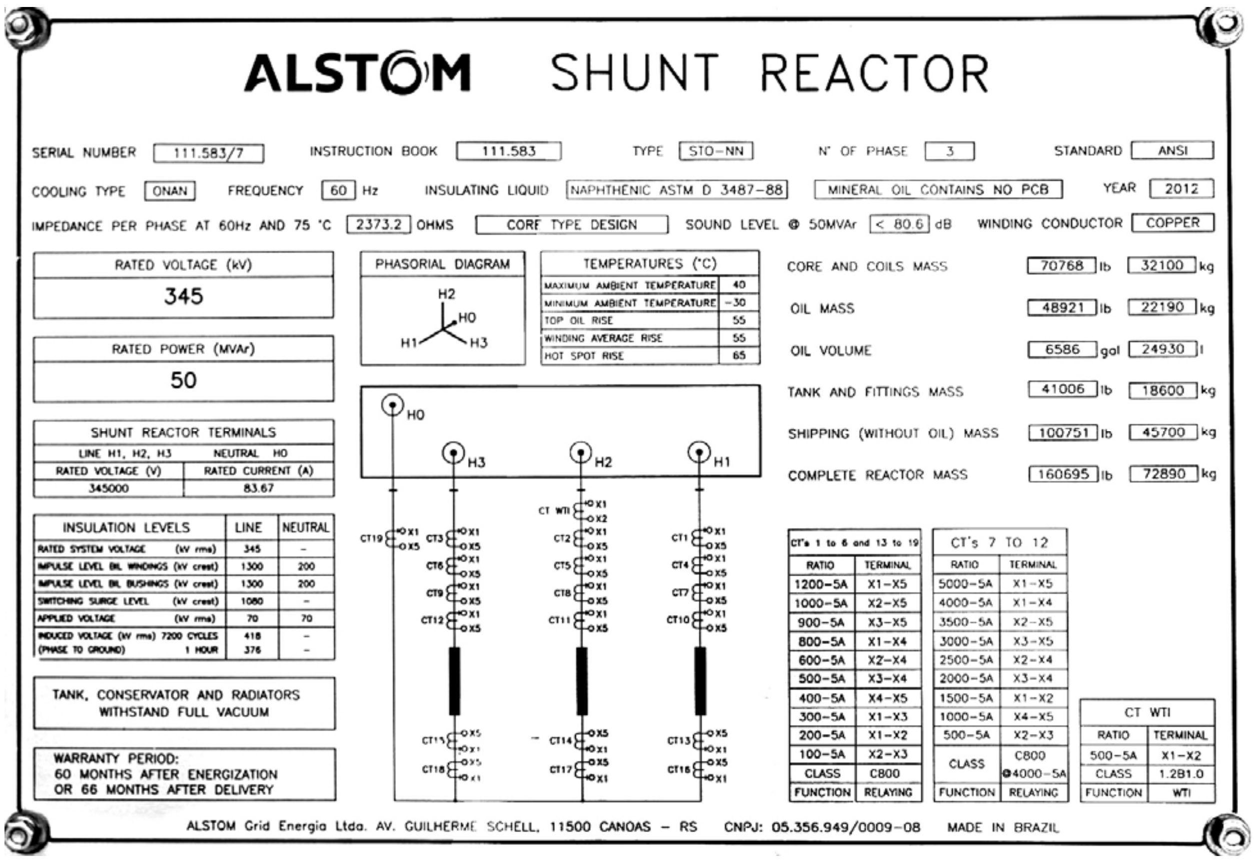
ALSTOM SHUNT REACTOR
SERIAL NUMBER 111.583/7
INSTRUCTION BOOK 111.583
TYPE STO-NN
N° OF PHASE 3
STANDARD ANSI
COOLING TYPE ONAN
FREQUENCY 60 Hz
INSULATING LIQUID NAPHTHENIC ASTM D 3487-88
MINERAL OIL CONTAINS NO PCB
YEAR 2012
IMPEDANCE PER PHASE AT 60Hz AND 75 °C 2373.2 OHMS
CORE TYPE DESIGN
SOUND LEVEL @ 50MVAr < 80.6 dB
WINDING CONDUCTOR COPPER
RATED VOLTAGE (kV) 345
RATED POWER (MVAr) 50
PHASORIAL DIAGRAM
TEMPERATURES (°C)
CORE AND COILS MASS 70768 lb 32100 kg
OIL MASS 48921 lb 22190 kg
OIL VOLUME 6586 gal 24930 l
TANK AND FITTINGS MASS 41006 lb 18600 kg
SHIPPING (WITHOUT OIL) MASS 100751 lb 45700 kg
COMPLETE REACTOR MASS 160695 lb 72890 kg
SHUNT REACTOR TERMINALS
INSULATION LEVELS
TANK, CONSERVATOR AND RADIATORS WITHSTAND FULL VACUUM
WARRANTY PERIOD:
60 MONTHS AFTER ENERGIZATION
OR 66 MONTHS AFTER DELIVERY
CT's 1 to 6 and 13 to 19
CT's 7 TO 12
CT WTI
ALSTOM Grid Energia Ltda. AV. GUILHERME SCHELL, 11500 CANOAS – RS CNPJ: 05.356.949/0009-08 MADE IN BRAZIL

Figure 7

Figure 8

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