R.N.G.P.I.T, Bardoli

Electrical Engineering Department

Subject: EMMI

Prepared By:

Dr. Shaikh Mohammed Suhel

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- Name: Dr. Shaikh Mohammed Suhel
  (Assistant Professor RNGPIT, Surat)
- Former Assistant Professor in SCET, SNPIT&RC, VIT
- Qualification: PhD (Power- Electronics & Drives, NIT, Surat), M.Tech (Industrial Electronics, NIT-Surat), GATE, B.E. (Electrical Engineering., VNSGU-Surat).
- Experience: 13 Years.

CH: Analog Instrumentation

- This Lecture contain

➢ Instrument Transformer and their applications in the extension of instrument range

Introduction

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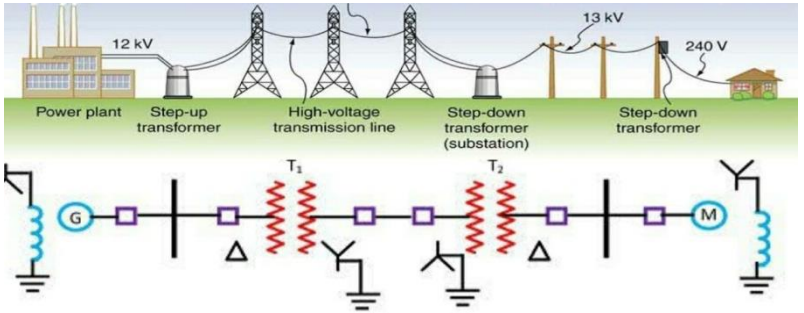
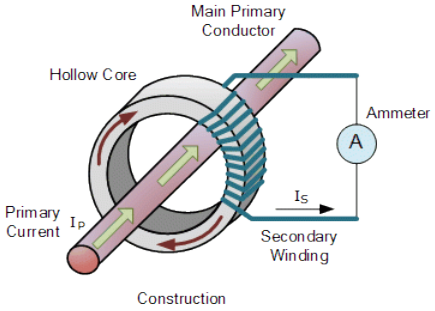
- *Instrument Transformer:*

- *In Power system current and voltage handled are very high and hence direct measurement with conventional instrument is not possible without compromising operator safety.*
- *The solution is to step down these current and voltage with the help of instrument transformer so that instrument of moderate rating can be used for measurement.*

- *The transformer used in conjunction with measuring instrument for the measurement purpose are called "instrument transformer".*



- Construction and operation:
- The transformer used for measurement of current is called “current transformer” (CT).
- Transformer used for voltage measurement is called “voltage transformer or potential transformer” (PT)
- Instrument transformer are used to (1) extend the range of measuring instrument (2) isolate the measuring instrument from a high voltage line.
- The voltage and current of PT & CT are standardized at 110V & 5A.
- It is safe for operator and equipment in the switchyard or meeting room.
- There are very less power loss in CT & PT compared to shunts & series for extending the range of instrument.
- Several instrument can be operated from single instrument transformer



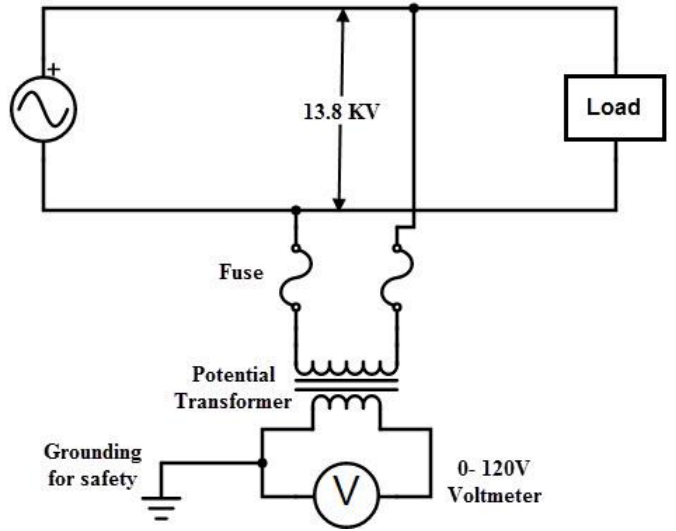
- *Operation:*

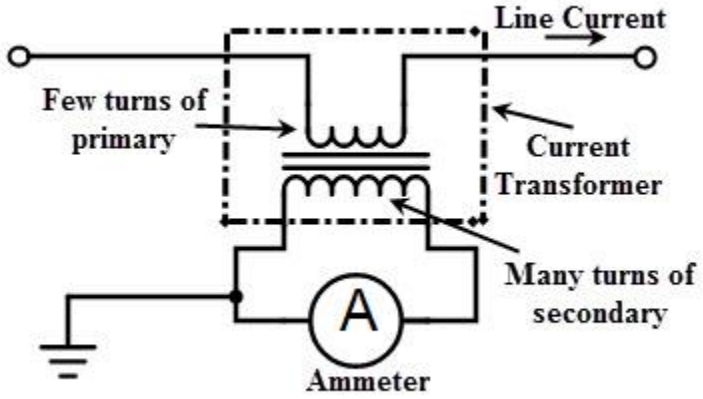
$$\frac{N_1}{N_2}=\frac{V_P}{V_S} \qquad V_S=\frac{N_2}{N_1}V_P$$

$$MMF_1=MMF_2$$

$$N_1 I_P=N_2 I_S$$

$$I_S=\frac{N_1}{N_2}I_P$$





- ## Ratios of instrument Transformer:

The ratio mentions on name plate of instrument transformer is "Nominal Ratios"

$$\text{Transformation Ration (R)} = \frac{|\text{Primary Phasor}|}{|\text{Secondary Phasor}|}$$

$$R = \frac{\text{Primary winding Current}}{\text{Secondary winding Current}} \Rightarrow C.T.$$

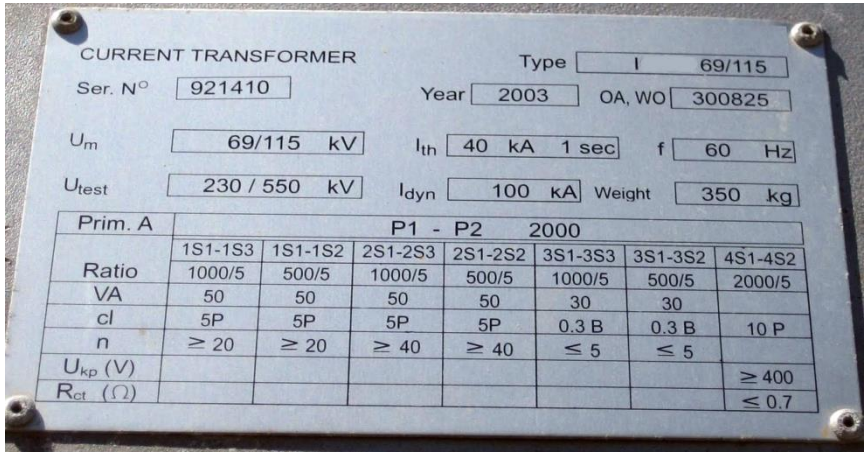
$$R = \frac{\text{Primary winding Voltage}}{\text{Secondary winding Voltage}} \Rightarrow P.T.$$

$$\text{Transformation Ratio(R)} = \text{Nominal Ratios (n)} \times \text{ratio correction factor (R.C.F)}$$

$$\%\text{Ratio error} = \frac{\text{Nominal ratio-Actual Ratio}}{\text{Actual Ratio}}$$

$$\text{Nominal Ratios (n)} = \frac{\text{No. of turns of secondary winding}}{\text{No. of turns of primary winding}} \Rightarrow C.T.$$

$$\text{Nominal Ratios (n)} = \frac{\text{No. of turns of Primary winding}}{\text{No. of turns of Secondary winding}} \Rightarrow P.T.$$



- *Burdon of an instrument transformer:*
- *The rated burden is the volt-ampere (VA) loading which is permissible without errors exceeding the limits for a particular class of accuracy.*

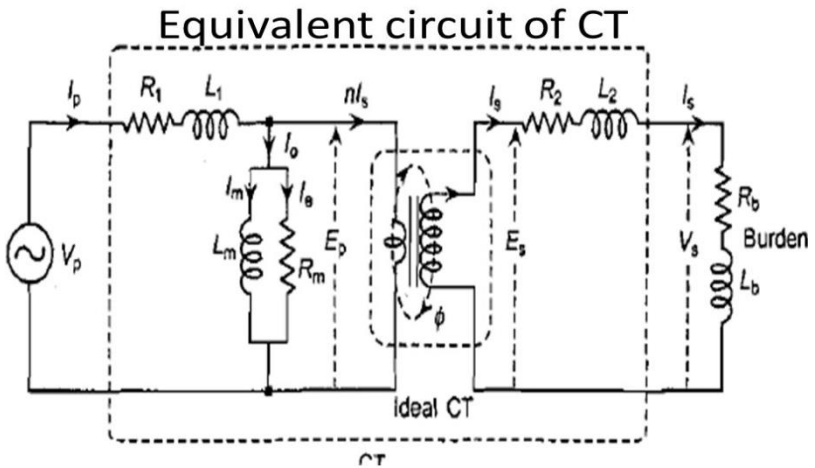
$$\text{Total secondary winding burdon} = \frac{(\text{secondary winding induced voltage})^2}{\left(\begin{array}{l}\text{Impedance of secondary winding circuit}\\ \text{including impedance of secondary winding}\end{array}\right)}$$

$$\text{Total secondary winding burdon} = (\text{secondary winding current})^2 \times (\text{Total impedance of secondary winding circuit})$$

$$\text{Secondary winding burdon due to load} = \frac{(\text{secondary winding terminal voltage})^2}{(\text{Impedance of load on secondary winding})}$$

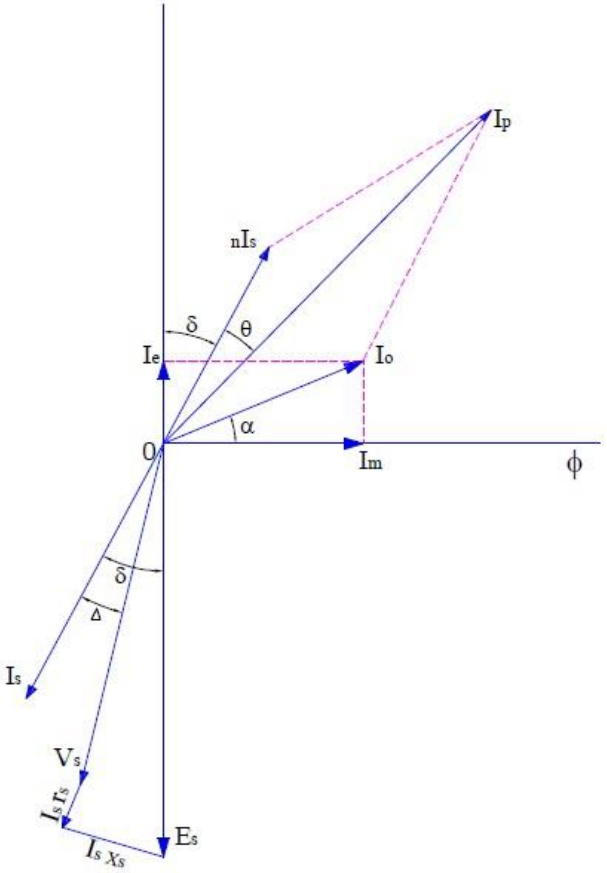
$$\text{Secondary winding burdon due to load} = (\text{secondary winding current})^2 \times (\text{Impedance of load in secondary winding circuit})$$

- *Operation:*



$$N_1 I_P = N_2 I_S$$

$$I_S = \frac{N_1}{N_2} I_P$$



- To reduce error (because of no load current):

- High permeability core.
- Decreasing Core losses.
- Decreasing the leakage reactance
- Turns compensation (to reduce ratio error)
- EX: Let us consider 1000/5A CT with loss component equal to 0.6% of primary winding current.

$$R \approx n + \frac{I_C}{I_S}$$

End

THANK YOU