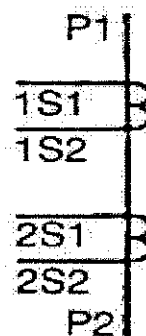


Instrument transformer

- Reduce current by current transformer (CT)
- Reduce voltage by potential transformer (PT)

Current transformer

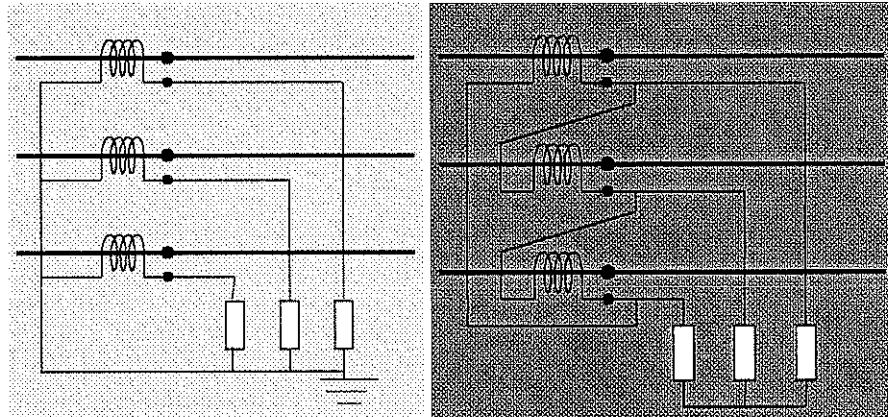
- Polarity
- Ratio



Transformer with two secondary windings

Current transformer

- Connection & star point



Current transformer

- Accuracy class & burden

Class P

Specified in terms of :

- Rated burden
- Class (5P, 10P)
- Accuracy Limit Factor (A.L.F.)

Example : 15 VA 10 P 20

Current transformer

- A.L.F. = Multiple of rated current up to which declared accuracy will be maintained with rated burden connected.

$$Z_B = \text{Rated burden in ohms}$$

$$= \text{Rated VA} / I_N^2$$

Current transformer

- Knee point voltage : V_K

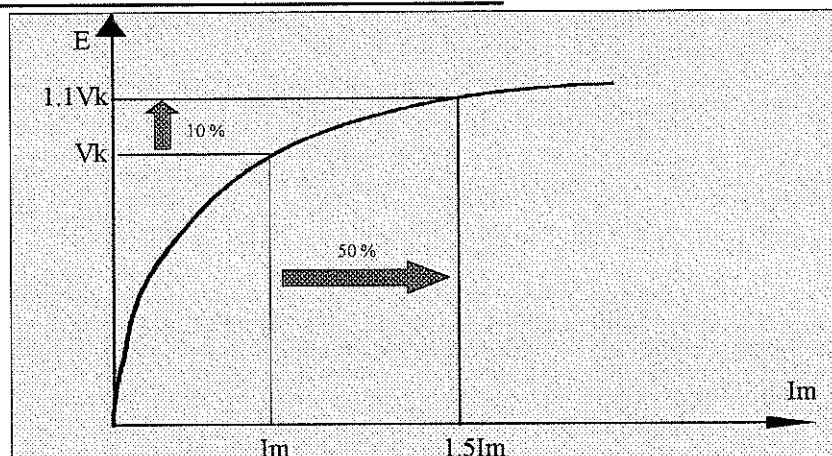
Value of the voltage V_K applied to the secondary which, increased by 10%, causes a maximum increase of 50% in the magnetizing current, I_m

Current transformer

- Knee point voltage : V_K

$$V_k = \frac{V_A * ALF}{I_N}$$

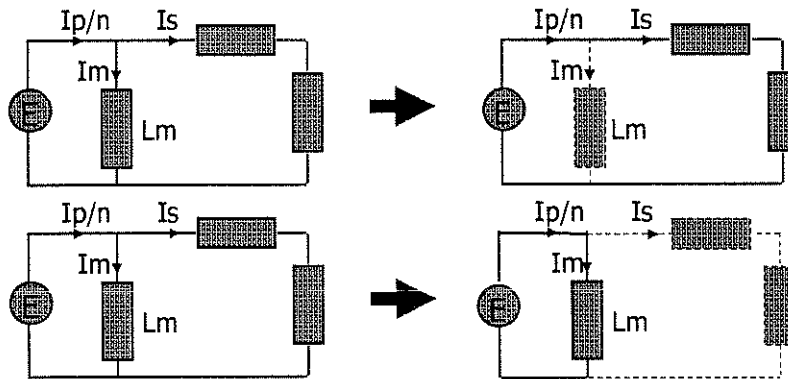
Current transformer



Magnetizing characteristics

Current transformer

- Equivalent circuit (normal / saturate)



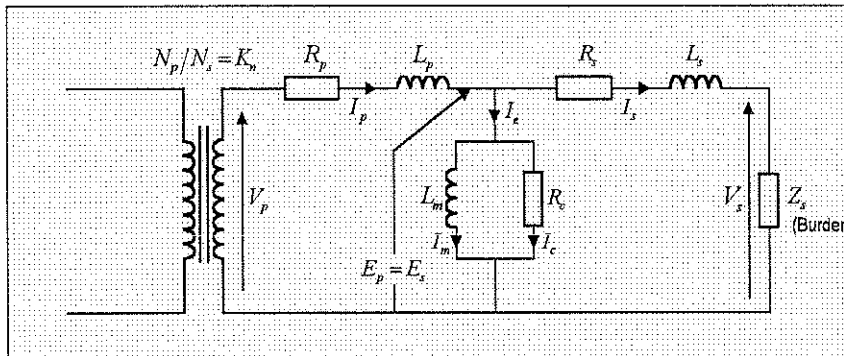
CT caution

- Don't open CT circuit during load
- Secondary CT that doesn't use, should be shorted
- CT ratio $>$ full load current

Potential transformer

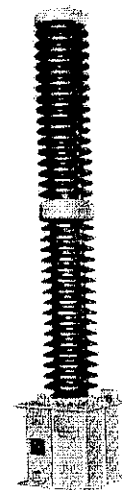
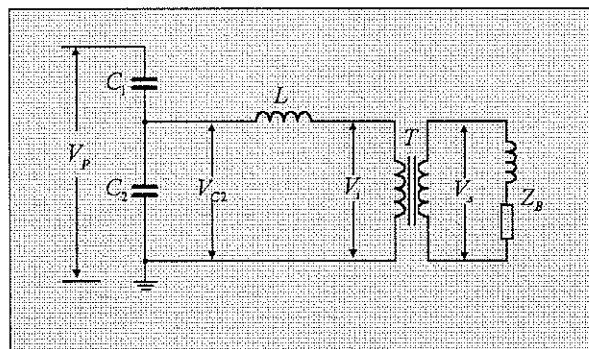
Type of PT

1. Electromagnetic PT.



Potential transformer

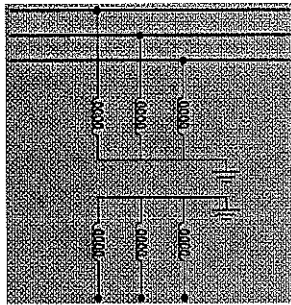
2. Coupling Capacitor VT. (CCVT)



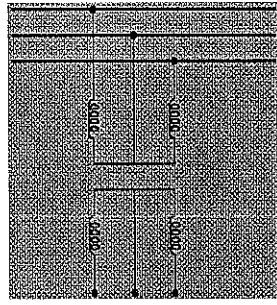
Potential transformer

- Connection

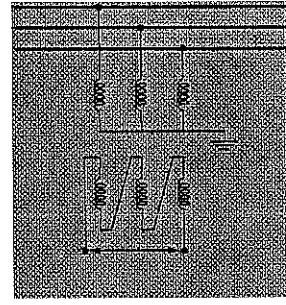
Y



V

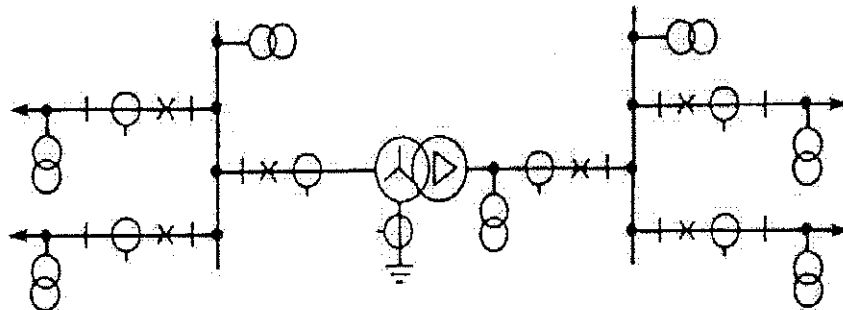


Open delta



Potential transformer

Location of CT's and VT's in Substations



Potential transformer

- Ratio

Rated primary voltage U_p
phase-to-earth voltage

$$U_p = \frac{U}{\sqrt{3}}$$

Rated secondary voltage U_s
typical values :

$$\frac{100}{\sqrt{3}} \text{ V}, \frac{110}{\sqrt{3}} \text{ V}$$

Potential transformer

Requirements for protection VT, according to IEC 186 standard

Rated voltage factor kT

defines the maximum primary voltage that the VT can withstand
depends on the earthing system and VT primary connection

Typical values :

$kT = 1.9$ 8 hours
for phase-to-earth VT

$kT = 1.2$ unlimited
for phase-to-phase VT

Potential transformer

- Accuracy class

3P or 6P

3P : 3% error for U between 5% U_p and $kT U_p$

6P : 6% error for U between 5% U_p and $kT U_p$

Example

phase-to-phase VT used for protection:
230000V/100V 100VA cl 3P

VT caution

- Don't short VT circuit during load
- Secondary VT that doesn't use, should be opened
- Choose VT burden properly to load

Potential transformer

- Ferromagnetic resonance

Phenomenon due to saturation of the VT magnetic core during voltage fluctuations

- following switching operations
- following a phase-to-earth fault (isolated neutral system)

Potential transformer

- Ferromagnetic resonance

CONSEQUENCES

- Voltage oscillations that may reach $2U_n$
- Increase in the current in the primary of the VT