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.

\[ Z_B = \text{Rated burden in ohms} \]

\[ = \frac{\text{Rated VA}}{I_N^2} \]

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, Im
Current transformer
- Knee point voltage : $V_k$

$$V_k = \frac{VA \times ALF}{I_N}$$

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:

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

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% Up and kTUp
6P : 6% error for U between 5% Up and kTUp

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 2Un
- Increase in the current in the primary of the VT