
Faculty of Engineering
FE
EEE4227: POWER SYSTEM PROTECTION
TERM: FINAL-TERM


Lecture 11
Generator protection

Necessity of generator protection

- Generating units, especially the larger one, are fewer in number.
- Individual unit is higher is cost.

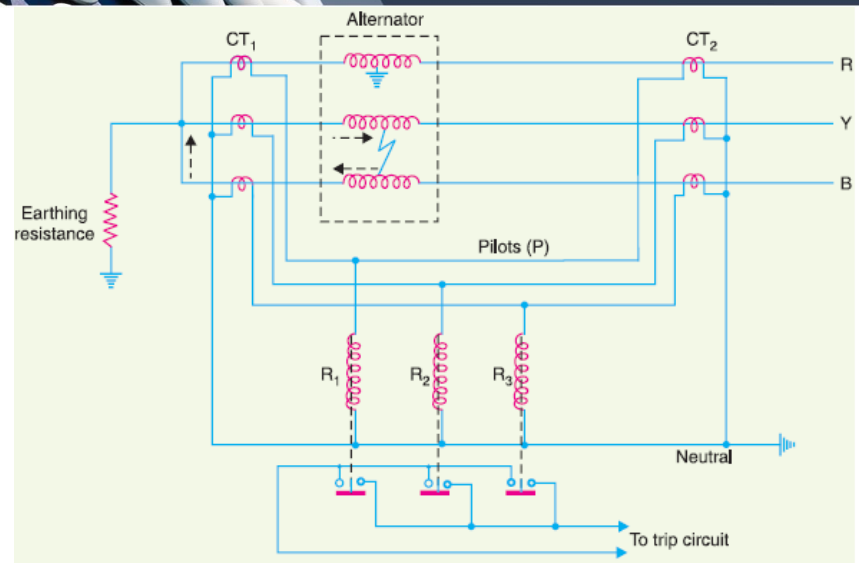
Types of fault in a generator

- Stator fault-
  - Phase to ground fault- very common
  - Phase to phase fault- less common
  - Inter turn fault- involving turns of the same phase winding
- Failure of prime mover
- Failure of field
- Over current
- Over voltage
- Failure of field
- Unbalance loading

Stator protection

- Primary protection-
  - Scheme is Mertz-price protection or simple circulating current differential protection scheme.
- Backup protection-
  - O/C relay

Primary protection of stator winding

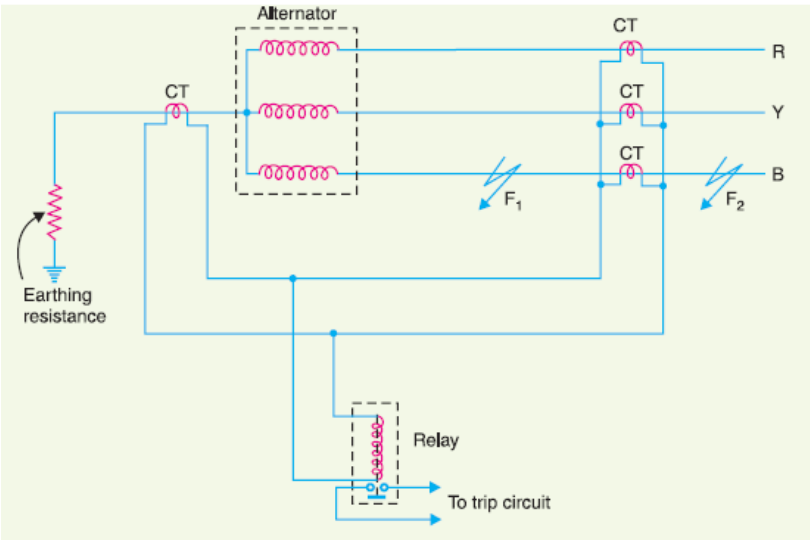


Earth fault protection

- Primary protection-
  - Restricted earth fault protection scheme
- Backup protection-
  - Core balance leakage protection scheme or earth fault relay

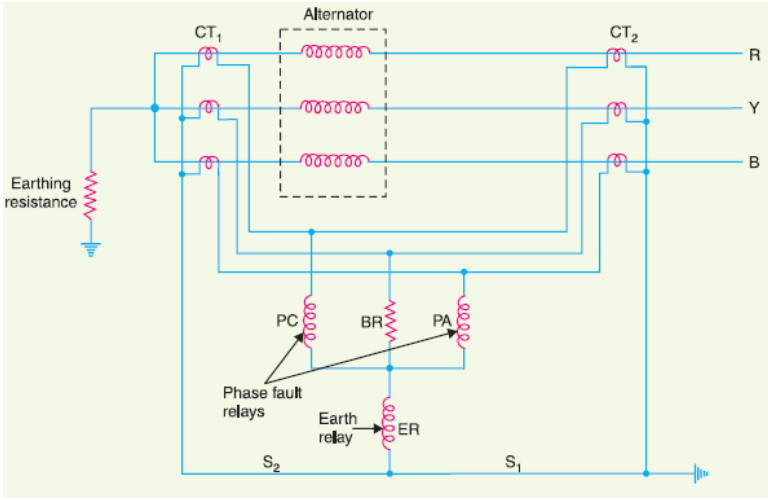
- For back up most common scheme is to use combined O/C and earth fault protection scheme.

Primary protection of generator winding against earth fault

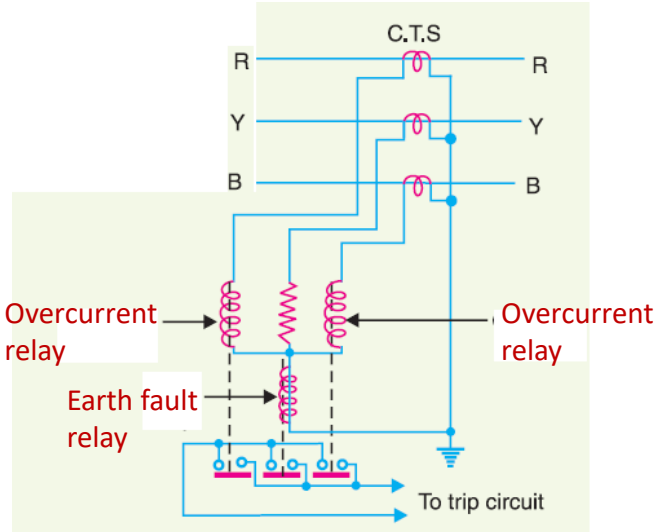


Combined primary protection against stator winding and earth fault

- Modified differential protection scheme is provided-

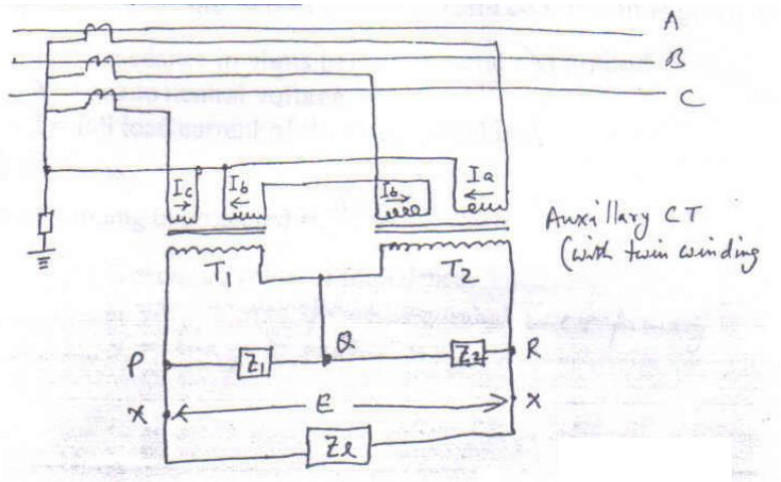


Combined backup protection against stator winding and earth fault



Protection against unbalance loading

- Negative phase sequence scheme is used-

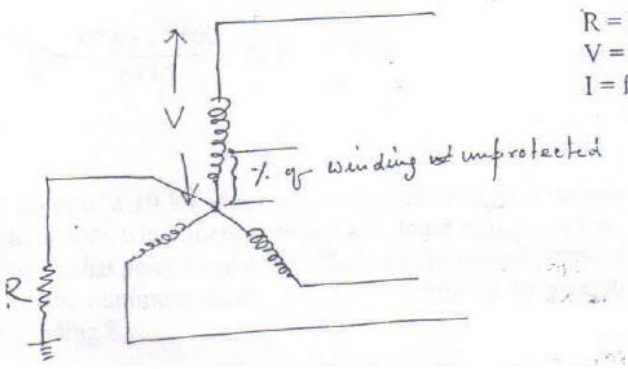


Negative phase sequence scheme

- During flow of primary load current, current through T1=(Ib - Ic) and T2=(Ia - Ib). Z1 and Z2 are chosen in such a way that points P & R remain at the same potential, as a result voltage across QR and QP are equal and opposite. In this situation relay would not operate.
- During unbalance condition these voltages (voltage across QR and QP) differ and an output voltage proportional to negative phase sequence is produced across XX (voltage E) which activates the relay.

Effect of neutral grounding resistance

- Neutral grounding resistance plays an important role in the detection of earth fault on stator winding of a generator.



R = impedance in ohms between neutral and ground
V = line to neutral voltage
I = full load current of the largest machine

Effect of neutral grounding resistance

Assume R is the resistance in neutral connection to the earth and the fault current for line to ground fault is equal to full load current of the generator or transformer, the value of impedance to be inserted in neutral to earth connection is given by : $R = \frac{V}{I}$,

Percentage of winding unprotected $= \frac{R.I_0.100}{V}$ where

R = ohmic value of impedance
I_0 = minimum operating current in CT primary
V = line to neutral voltage

Mathematical problem

Problem 01-

- A generator is provided with restricted earth fault protection. The ratings of the generator are 11kV, 5000kVA. The percentage of winding protected against line to ground fault is 80%. The relay setting is such that it trips for 25% out of balance. Calculate the resistance to be added in neutral to ground connection.

Solution:

$$V = 11000/\sqrt{3} = 6340 \text{ V}$$

$$I = 5000/(\sqrt{3}\times 11) = 262 \text{ A}$$

$$\text{So, } I_0 = 262 \times 25/100 = 65.5 \text{ A}$$

Mathematical problem

$$\text{The percentage of winding unprotected} = \frac{R.I_0.100}{V}$$

$$20 = \frac{R * 65.5 * 100}{6340}, \text{ or } R = 1.94\ \Omega$$

Mathematical problem

Problem 02-

- The neutral point of a 10kV alternator is earthed through a resistance of 10Ω. The relay is set to operate when there is an out of balance current of 1Amp.The CTs have a ratio of 1000/5.
  - (a) What percentage of winding is protected against fault to earth?
  - (b) What must be the minimum value of earthing resistance to give 90% protection to each phase winding?

Solution:

Part (a)

Out of balance current in pilot wire is 1 A.

Corresponding current in CT primary = 1×1000/5 = 200 A.

Mathematical problem

Hence, current I_0 for which the relay operates is 200 A.

$$\text{Therefore, \% of winding unprotected} = \frac{R.I_0.100}{V} = \frac{10*200*100}{\frac{10}{\sqrt{3}}*10^3} = 34.64\ \%$$

Part (b)

90 % of the winding is protected i.e. 10 % remains unprotected ; R = ?

$$10 = \frac{R*200*100}{\frac{10}{\sqrt{3}}*10^3} = \frac{R*200*100*\sqrt{3}}{10^4} \quad \text{or,} \quad R = \frac{10*10^4}{200*100*\sqrt{3}} = 2.89\Omega$$

- Reference-
- Topic 22.1,22.2,22.3/ Chapter 22/ Principles of power systems/V.K.Mehta & Rohit Mehta

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