Lecture-5

Single line to ground fault, line to line fault, double line to ground fault, open conductor fault.

Topic Covered

- Sequence Components in Fault
- Interconnection Of Sequence Network
- L–L faults

Sequence Components in Fault Analysis Program

- Step 1–

Three Phase Model .

Formulate Admittance Matrix.

$$[\mathbf{I}\mathbf{abc}]_{3\mathbf{n}\times 1} = [\mathbf{Y}\mathbf{abc}]_{3\mathbf{n}\times 3\mathbf{n}} \times [Vabc]_{3n\times 1}$$

- Step 2–

Sequence Model Formulation.

$$[\mathbf{I}012]_{\mathbf{n}\times 1} = [\mathbf{Y}012]_{\mathbf{n}\times \mathbf{n}} \times [V012]_{n\times 1}$$

- Step 3–

$$[el] = [0\ 0\ 0\ 0\ 1\ .\ .\ 0\ 0]'$$

Inject 1.0 p.u. current at bus /i.e. Let,

Compute V_l of desired sequence i.e. solve

- $Z_{th}^{0,1,2}$ at /bus= V_l^{012}

$$[\mathbf{Y}012][V012]_{n\times 1} = [\mathbf{e}l012]$$

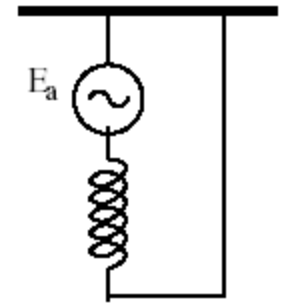
Input to Fault Analysis program

- ✓ Depends on type of fault
  - Three phase fault.
    - ⇨ Only Positive Sequence Data. Negative, Zero sequence Network not excited.
  - SLG fault
    - ⇨ Positive, Negative, Zero sequence Data.
  - Typical fault study
    - ⇨SLG (√)

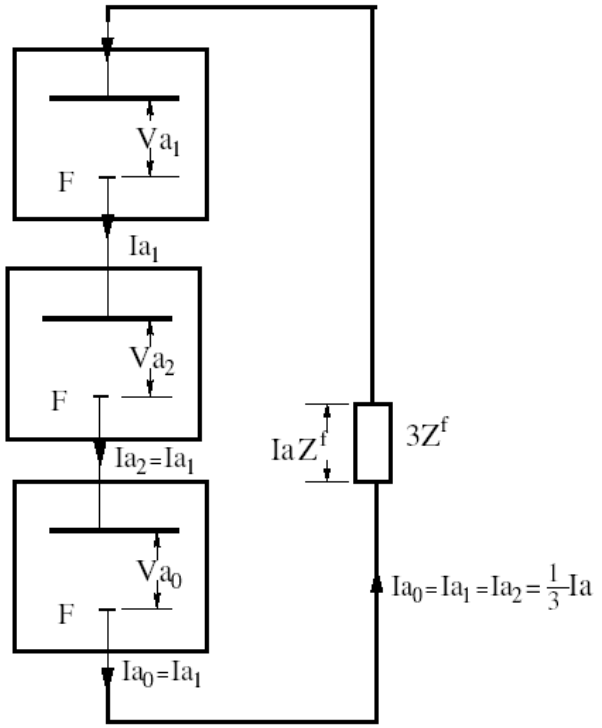
    Fault current can range in utility systems from a few percent to possibly 125% of the three phase fault value.
    - ⇨Three phase(√)

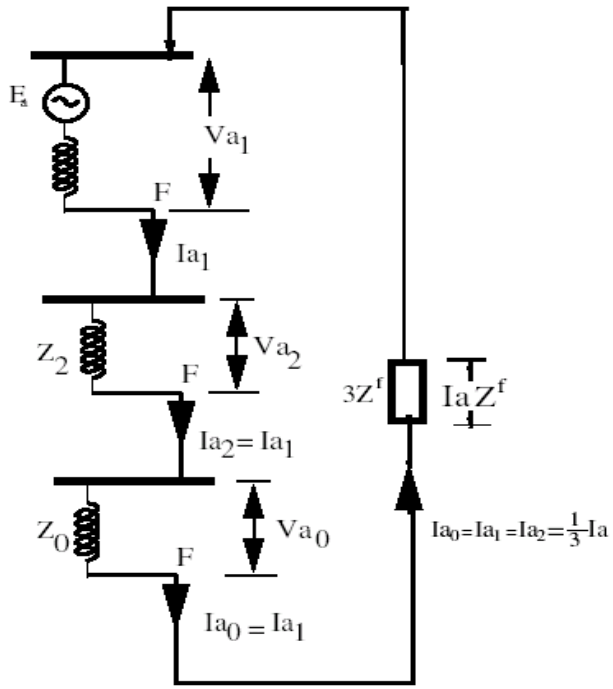
    In industrial systems line to ground fault current of more than three phase value is rare.
    - ⇨LL (X) } fault currents are approximately 87% of three-phase fault current
    - ⇨LLG (X)

Interconnection Of Sequence Network.

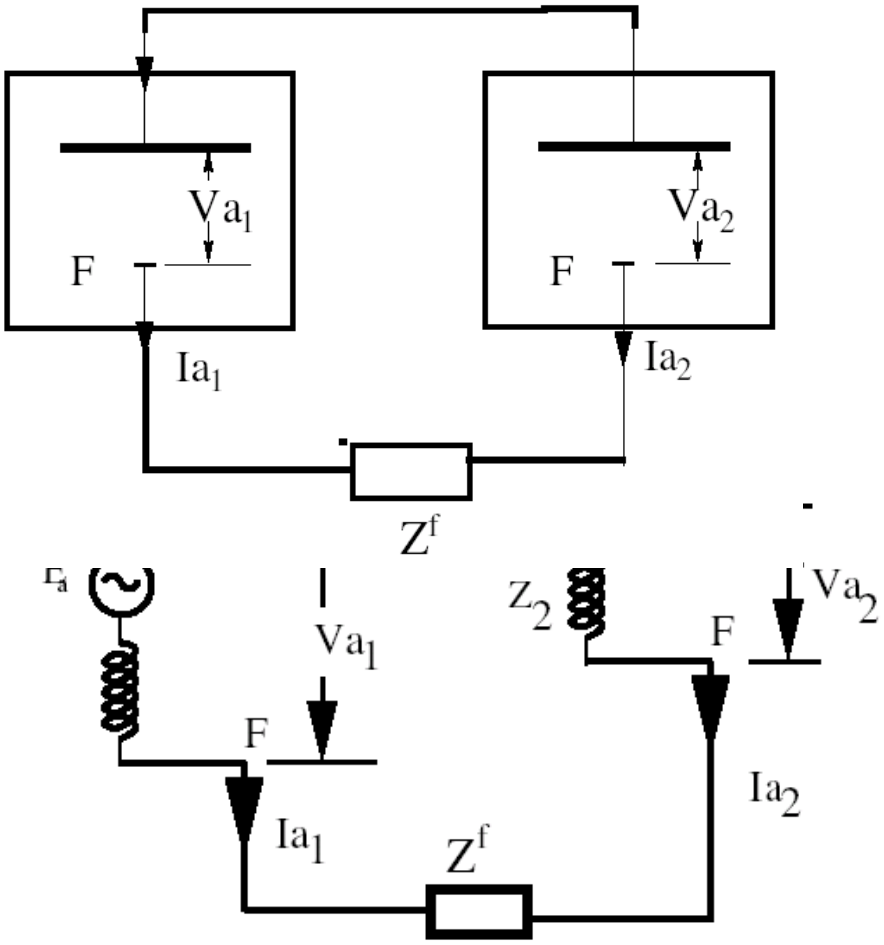


Three Phase Fault.





Single Line To Ground Fault.



Line To Line Fault.

Fault Current Formulae

Three Phase Fault :- For a Three Phase fault only Positive Sequence Network is considered. The fault currents are given by the following equations.

- $I_1 = \frac{V}{Z_1}$ $(solid\ Fault)$
- $I_1 = \frac{V}{Z_1+Z_f}$ $(Fault\ Through\ impendence Z_f)$

Single Line To Ground Fault(SLG) :- The Positive Sequence, negetive Sequence and Zero Sequence Fault currents are given by

- $I_1 = I_2 = I_0 = \frac{V}{Z_1+Z_2+Z_0}$ $(Solid\ Fault)$
- $I_1 = I_2 = I_0 = \frac{V}{Z_1+Z_2+Z_0+3Z_f}$ $(Fault\ Through\ impendence\ Z_f)$
- $I_{aF} = I_1 + I_2 + I_0 = 3I_1 = 3I_2 = 3I_0$

LL fault :- The Zero Sequence Data is not required for this fault.

- $I_1 = -I_2 = \frac{V}{Z_1+Z_2}$ $(solid\ Fault)$
- $I_1 = -I_2 = \frac{V}{Z_1+Z_2+Z_f}$ $(Fault\ Through\ impendence Z_f)$

Line to Line Ground Fault (LLG) :-

1. solid Fault :-
   - $I_1 = \frac{V}{Z_1+\frac{z_2 Z_0}{Z_2+Z_0}}$
   - $I_2 = -I_1 \frac{Z_0}{Z_2+Z_0}$
   - $I_0 = -I_1 \frac{Z_2}{Z_2+Z_0}$

Line to Line Ground Fault (LLG) :-

1. solid Fault :-
   - $I_1 = \frac{V}{Z_1 + \frac{z_2 z_0}{z_2 + z_0}}$
   - $I_2 = -I_1 \frac{Z_0}{Z_2 + Z_0}$
   - $I_0 = -I_1 \frac{Z_2}{Z_2 + Z_0}$

2. Fault Through impendence Z_F

- $I_1 = \dfrac{V}{Z_1 + \frac{Z_F}{2} + \frac{(Z_2 + \frac{Z_F}{2})(Z_2 + \frac{Z_F}{2} + 3Z_{FG})}{Z_2 + Z_0 + Z_F + 3Z_{FG}}}$
- $I_2 = -I_1 \dfrac{(Z_2 + \frac{Z_F}{2} + 3Z_{FG})}{Z_2 + Z_0 + Z_F + 3Z_{FG}}$
- $I_0 = -I_1 \dfrac{(Z_2 + \frac{Z_F}{2})}{Z_2 + Z_0 + Z_F + 3Z_{FG}}$

$Z_f$is Fault impedence between the lines,
While $Z_{FG}$is the Fault impendence to Ground.