

First Course on Power Systems

Module 12: Transmission Line Faults

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Reference Textbook:
First Course on Power Systems by Ned Mohan,
www.mnpere.com

Module 12: Transmission Line faults

Chapter 13	TRANSMISSION LINE FAULTS, RELAYING AND CIRCUIT BREAKERS	13-1
13-1	CAUSES OF TRANSMISSION LINE FAULTS	13-1
13-2	SYMMETRICAL COMPONENTS FOR FAULT ANALYSIS	13-2
13-3	TYPES OF FAULTS	13-4
13-4	SYSTEM IMPEDANCES FOR FAULT CALCULATIONS	13-8
13-5	CALCULATION OF FAULT CURRENTS IN LARGE NETWORKS	13-11
13-6	PROTECTION AGAINST SHORT-CIRCUIT FAULTS	13-12

Causes of Transmission Line Faults

- Tree branches near the right-of-way falling on transmission lines and shorting them to ground
- Sagging transmission lines touching the trees
- Backflash when the transmission-line tower or one of the ground wires is struck by lightning can raise the tower potential

Reason to analyze short circuit faults

- Set the relays so they can detect it
- Make sure that the circuit breakers ratings are such that they are capable of interrupting the fault currents

Fault (Symmetric or Unsymmetric) on a Balanced Network

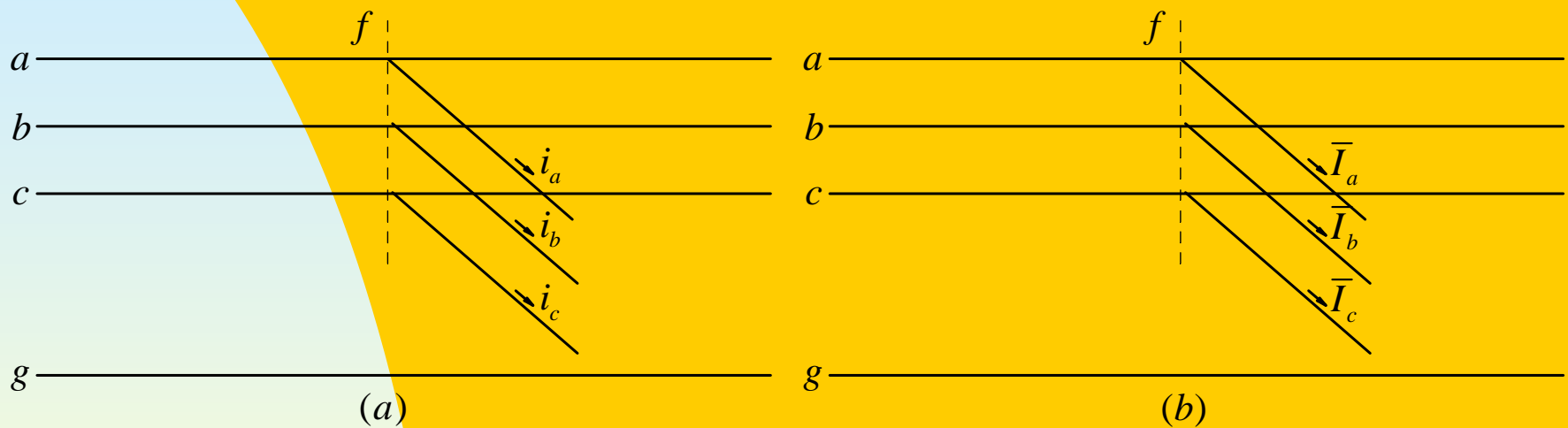


Fig. 13-1 Fault in power system.

Symmetrical Components

- by Fortesque

$$\bar{I}_a = \bar{I}_{a1} + \bar{I}_{a2} + \bar{I}_{a0}$$

$$\bar{I}_b = \bar{I}_{b1} + \bar{I}_{b2} + \bar{I}_{b0}$$

$$\bar{I}_c = \bar{I}_{c1} + \bar{I}_{c2} + \bar{I}_{c0}$$

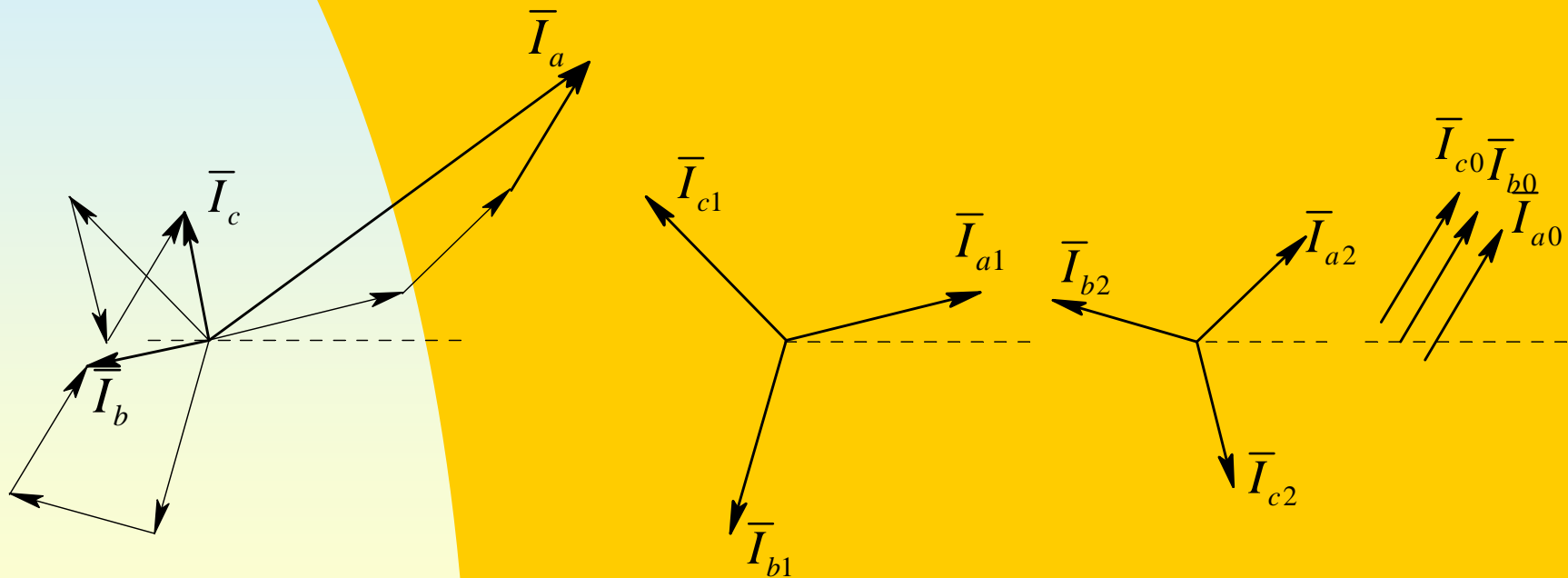


Fig. 13-2 Sequence components.

Calculating Symmetrical Components

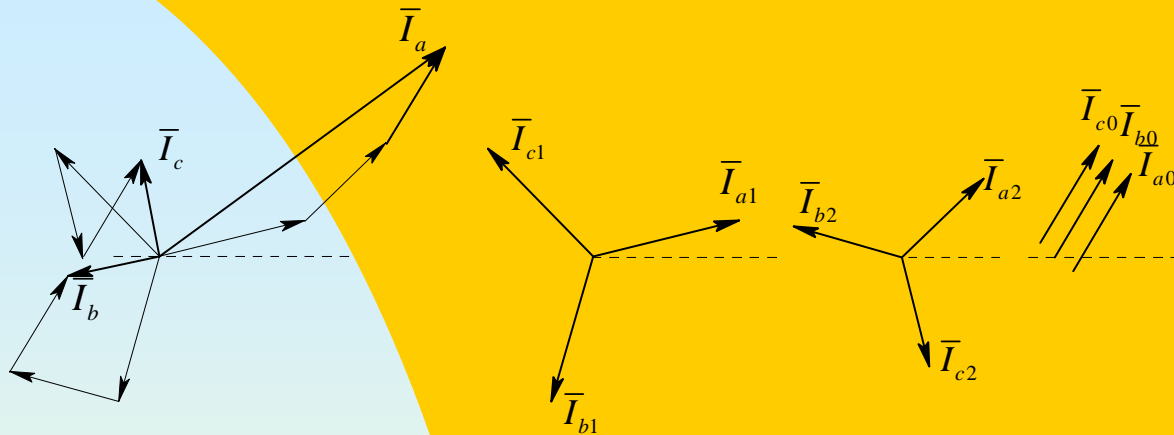


Fig. 13-2 Sequence components.

$$a = 1 \angle 120^\circ = -0.5 + j0.866$$

$$a^2 = 1 \angle 240^\circ = -0.5 - j0.866$$

$$\bar{I}_{b1} = a^2 \bar{I}_{a1}; \quad \bar{I}_{c1} = a \bar{I}_{a1}$$

$$\bar{I}_{b2} = a \bar{I}_{a2}; \quad \bar{I}_{c2} = a^2 \bar{I}_{a2}$$

$$\bar{I}_a = \bar{I}_{a1} + \bar{I}_{a2} + \bar{I}_{a0}$$

$$\bar{I}_b = a^2 \bar{I}_{a1} + a \bar{I}_{a2} + \bar{I}_{a0}$$

$$\bar{I}_c = a \bar{I}_{a1} + a^2 \bar{I}_{a2} + \bar{I}_{a0}$$

$$\begin{bmatrix} \bar{I}_a \\ \bar{I}_b \\ \bar{I}_c \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ a^2 & a & 1 \\ a & a^2 & 1 \end{bmatrix} \begin{bmatrix} \bar{I}_{a1} \\ \bar{I}_{a2} \\ \bar{I}_{a0} \end{bmatrix}$$

$$\begin{bmatrix} \bar{I}_{a1} \\ \bar{I}_{a2} \\ \bar{I}_{a0} \end{bmatrix} = \frac{1}{3} \begin{bmatrix} 1 & a & a^2 \\ 1 & a^2 & a \\ 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} \bar{I}_a \\ \bar{I}_b \\ \bar{I}_c \end{bmatrix}$$