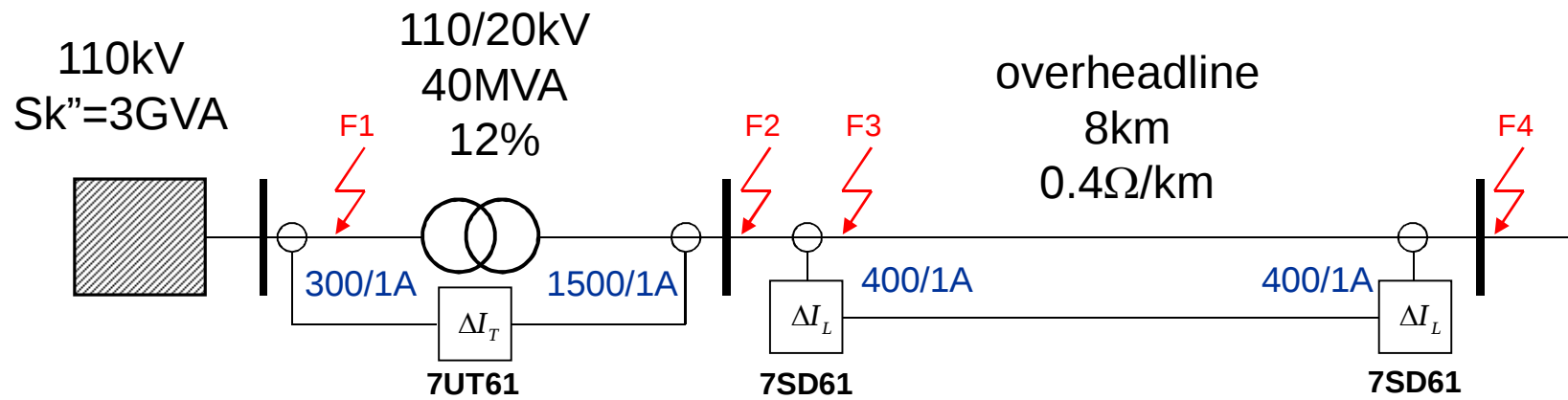


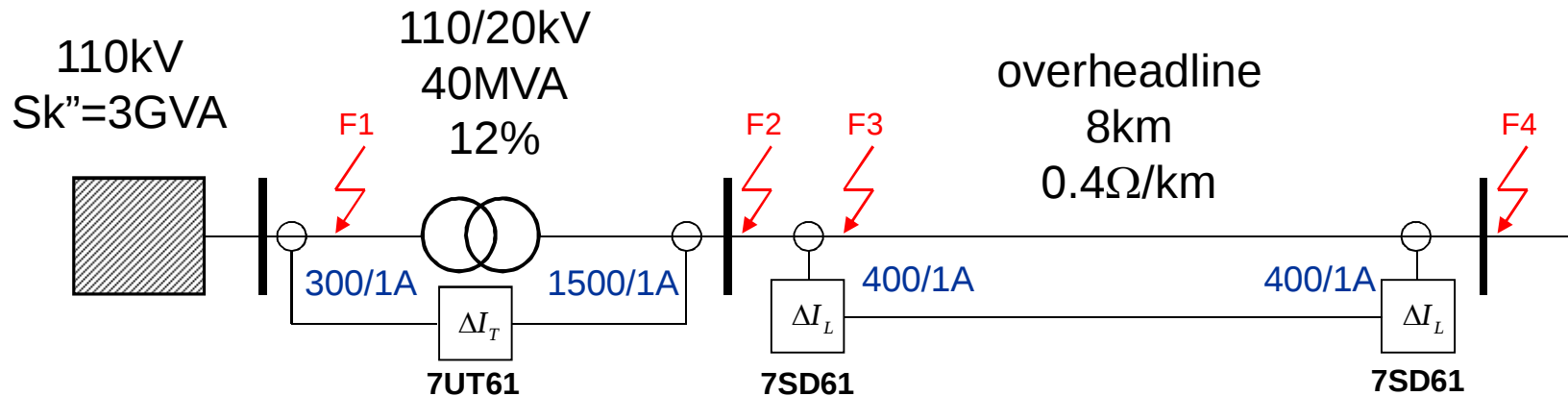
CT Dimensioning - Example



Example



Example



net impedance:

110 kV

$$\text{net} \quad Z_N = \frac{U_N^2}{S_K''} = \frac{(110\text{kV})^2}{3\text{GVA}} = 4.03\Omega$$

$$\text{transf.} \quad Z_T = \frac{U_N^2}{S_{T,N}} \cdot \frac{u_K}{100} = \frac{(110\text{kV})^2}{40\text{MVA}} \cdot \frac{12\%}{100} = 36.3\Omega$$

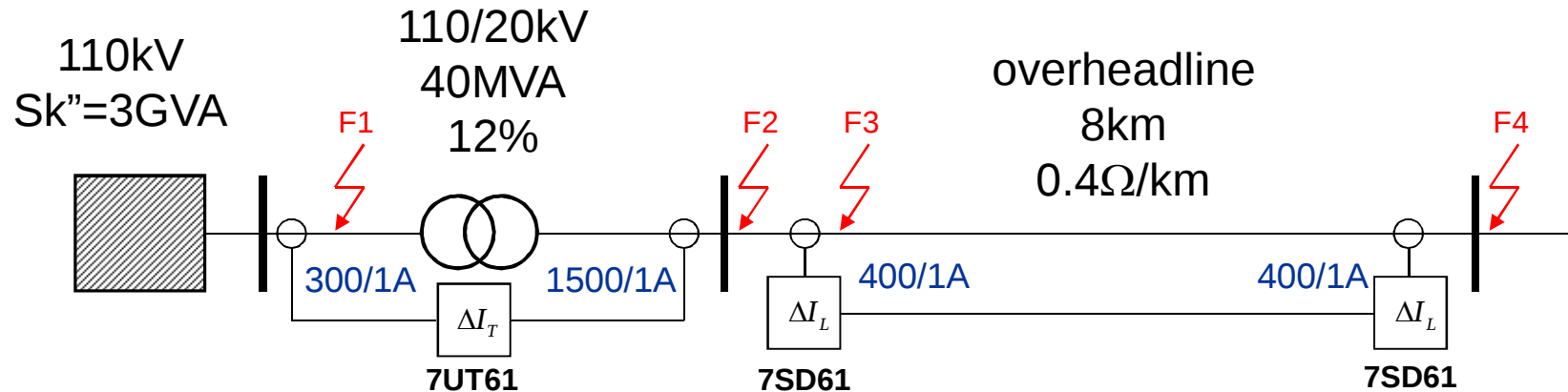
20 kV

$$\text{net} \quad Z_N = \frac{U_N^2}{S_K''} = \frac{(20\text{kV})^2}{3\text{GVA}} = 0.13\Omega$$

$$\text{transf.} \quad Z_T = \frac{U_N^2}{S_{T,N}} \cdot \frac{u_K}{100} = \frac{(20\text{kV})^2}{40\text{MVA}} \cdot \frac{12\%}{100} = 1.2\Omega$$

$$\text{line} \quad Z_L = Z_L' \cdot l = 0.4 \frac{\Omega}{\text{km}} 8\text{km} = 3.2\Omega$$

Transformer Differential Protection



short-circuit currents:

$$\text{F1} \quad I_{K,F1,110kV} = \frac{1.1 \cdot U_N / \sqrt{3}}{Z_N} = \frac{1.1 \cdot 110kV / \sqrt{3}}{4.03\Omega} = 17.3kA$$

$$\text{F2} \quad I_{K,F2,110kV} = \frac{1.1 \cdot U_N / \sqrt{3}}{Z_N + Z_T} = \frac{1.1 \cdot 110kV / \sqrt{3}}{4.03\Omega + 36.3\Omega} = 1.73kA$$

$$\text{F3} \quad I_{K,F3,20kV} = \frac{1.1 \cdot U_N / \sqrt{3}}{Z_N + Z_T} = \frac{1.1 \cdot 20kV / \sqrt{3}}{0.13\Omega + 1.2\Omega} = 9.55kA$$

$$\text{F4} \quad I_{K,F4,20kV} = \frac{1.1 \cdot U_N / \sqrt{3}}{Z_N + Z_T + Z_L} = \frac{1.1 \cdot 20kV / \sqrt{3}}{0.13\Omega + 1.2\Omega + 3.2\Omega} = 2.8kA$$

Transformer Differential Protection

protection relay **7UT612**

- requirement for external fault

$$K_{td} \geq 4 \text{ (8 ms accuracy limiting time)}$$

110 kV-Seite CT: 300/1A, 5P?, connected burden 2.5 VA

maximum external fault → **F2**

$$ALF' = K_{td} \cdot \frac{I_{K,F2,110kV}}{I_N} = 4 \cdot \frac{1730}{300} = 23$$

CT: 300/1A, 5P25, 2.5VA

$$ALF \geq ALF'$$

Not recommended:

$$ALF_n = ALF' \cdot \frac{P_{ct} + P'}{P_{ct} + P_n} = 23 \cdot \frac{2 + 2.5}{2 + 5} = 14.8 \rightarrow 20$$

CT: 300/1A, 5P20, 5VA, P_{ct}=2VA

Transformer Differential Protection

protection relay **7UT612**

- requirement for external fault

$$K_{td} \geq 4 \text{ (8ms accuracy limiting time)}$$

20 kV side

CT: 1500/1A, 5P?, connected burden 2.5 VA

maximum external fault → **F2**

$$ALF' = K_{td} \cdot \frac{I_{K,F2,20kV}}{I_N} = 4 \cdot \frac{9550}{1500} = 26$$

CT: 1500/1A, 5P30, 2.5VA

$$ALF \geq ALF'$$

Not recommended:

$$ALF_n = ALF' \cdot \frac{P_{ct} + P'}{P_{ct} + P_n} = 26 \cdot \frac{5 + 2.5}{5 + 5} = 19.5 \rightarrow 20$$

CT: 1500/1A, 5P20, 5VA, $P_{ct} = 5VA$

Line Differential Protection

protection relay **7SD61**

- requirement for external fault

$$K_{td} \geq 1.2 \text{ (5ms accuracy limiting time)}$$

20 kV line

CT: 400/1A, 5P?, connected burden 0.5 VA

maximum external fault → **F4**

$$ALF' = K_{td} \cdot \frac{I_{K,F4,20kV}}{I_N} = 1.2 \cdot \frac{2800}{400} = 8.4$$

CT: 400/1A, 5P10, 1.25VA

$$ALF \geq ALF'$$

Not recommended:

$$ALF_n = ALF' \cdot \frac{P_{ct} + P'}{P_{ct} + P_n} = 8.4 \cdot \frac{2 + 0.5}{2 + 2.5} = 4.7 \rightarrow 10$$

CT: 400/1A, 5P10, 2.5VA, P_{ct} = 2VA