Example: Calculate all types of short-circuit currents in given network location below. Network parameters are as follows.

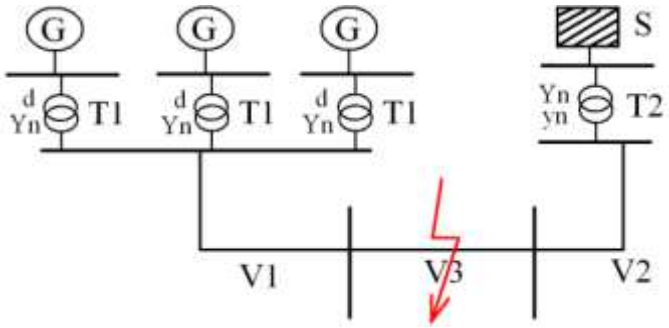
G: $x_d''^{(1)}$ = 20 %, $x_d''^{(2)}$ = 10 %, $x_d''^{(0)}$ = 5 %, U_n = 15 kV, S_n = 40 MVA;

T1: u_k = 10 %, U_n = 15 kV, S_n = 63 MVA, p = 15/110 kV; V1: X = 0.4 Ω/km, ℓ = 100 km;

V2: X = 0.35 Ω/km, ℓ = 50 km; T2: u_k = 12%, U_n = 220 kV, S_n = 200 MVA, p = 220/110 kV;

V3: X = 0.3 Ω/km, ℓ = 80 km; S: c_{max} = 1.1, U_n = 220 kV, I_{k3f}'' = 30 kA, $X_{s0} = 3X_{s1}$.

For all power lines applies: $X_0 = 3X_1$. The short-circuit is located in the middle of power line V3. Note: Neglect all resistances (real parts of impedances) in the network. Power sources are symmetrical.



Calculation:

$$X_{G1}^{(1,2,0)} = \frac{x_d''^{(1)}}{100}\frac{U_n^2}{S_n}\frac{1}{(15/110)^2} = 60.5\,\Omega\,(30.25\,\Omega, \times)$$

$$X_{T1}^{(1,2,0)} = \frac{u_k}{100}\frac{U_n^2}{S_n}\frac{1}{(15/110)^2} = 19.20635\,\Omega$$

$$X_{V1}^{(1,2,0)} = X_{V1}l_{V1} = 40\,\Omega\,(40\,\Omega, 120\,\Omega)$$

$$X_{V2}^{(1,2,0)} = X_{V2}l_{V2} = 17.5\,\Omega\,(17.5\,\Omega, 52.5\,\Omega)$$

$$\frac{1}{2}X_{V3}^{(1,2,0)} = \frac{1}{2}X_{V3}l_{V3} = 12\,\Omega\,(12\,\Omega, 36\,\Omega)$$

$$X_S^{(1,2,0)} = \frac{cU_n}{\sqrt{3}I_k''}\frac{1}{(220/110)^2} = 1.164323\,\Omega\,(1.164323\,\Omega, 3.492969\,\Omega)$$

$$X_{T2}^{(1,2,0)} = \frac{u_k}{100}\frac{U_n^2}{S_n}\frac{1}{(220/110)^2} = 7.26\,\Omega$$

Final short-circuit impedances (positive-/negative-/zero- sequence):

$X_k^{(1)} = 25.57806\ \Omega$, $X_k^{(2)} = 24.40814\ \Omega$, $X_k^{(0)} = 61.60359\ \Omega$

Value of single-phase short-circuit current:

$$I_{1fk}^{"} = \frac{\sqrt{3}cU_n}{X_k^{(1)} + X_k^{(2)} + X_k^{(0)}} = 1878.112\ A$$

Value of 2-phase short-circuit current:

$$I_{2fk}^{"} = \frac{cU_n}{X_k^{(1)} + X_k^{(2)}} = 2420.668\ A$$

Value of 2-phase-to-earth short-circuit current:

$$I_{2fzk}^{"} = \frac{\sqrt{3}cU_n X_k^{(2)}}{X_k^{(1)} X_k^{(2)} + X_k^{(2)} X_k^{(0)} + X_k^{(1)} X_k^{(0)}} = 1381.184\ A$$

Value of 3-phase short-circuit current:

$$I_{3fk}^{"} = \frac{cU_n}{\sqrt{3}X_k^{(1)}} = 2731.223\ A$$