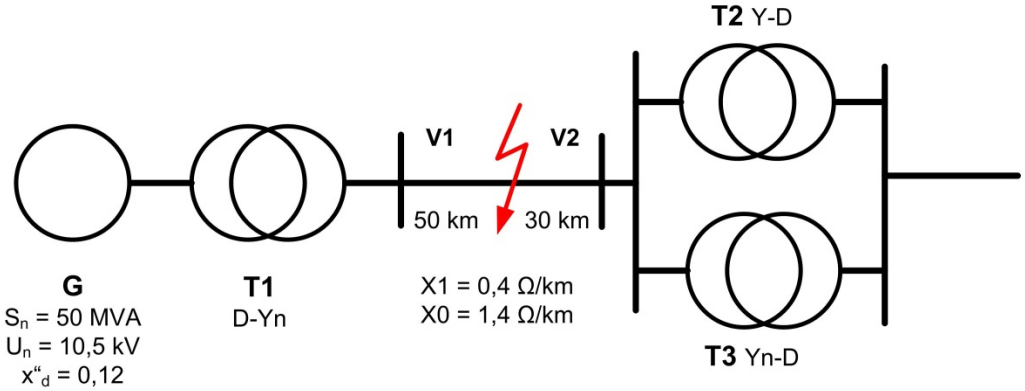
Calculate initial sub-transient short-circuit current in case of single-phase-to-ground, phase-to-phase and three-phase short-circuit.
Parameters T1, T2, T3: 31,5 MVA; 10,5/110 kV; u_k = 10,5 %;
T2 has different winding connection than T1 and T3. G voltage is 10,5 kV.



1) base power $S_v = 31{,}5\ MVA$

2) reactances recalculation to S_v a and voltage in the short-circuit place (110 kV) for sequences **positive (1), negative (2) and zero (0)**.

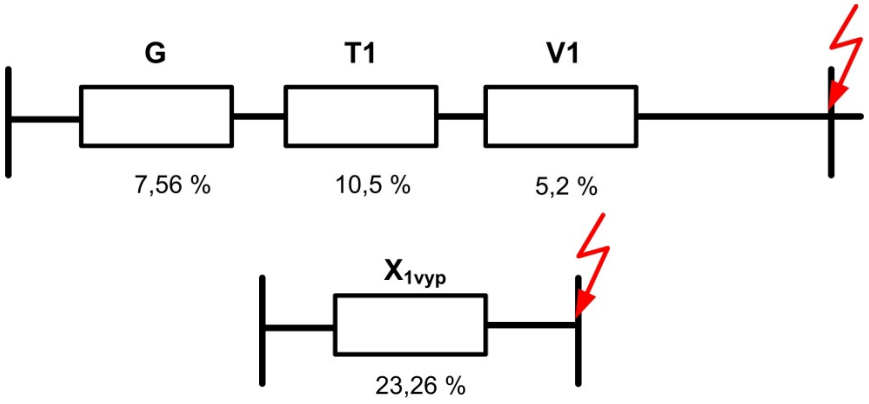
G: $$X_{1G} = X_d'' \cdot \frac{S_v}{S_{nG1}} = 12 \cdot \frac{31{,}5}{50} = 7{,}56\ \% = X_{2G}$$

T1, T2, T3: $$X_{1T} = U_k \cdot \frac{S_v}{S_{nT}} = 10{,}5 \cdot \frac{31{,}5}{31{,}5} = 10{,}5\ \% = X_{2T}$$
$$X_{0T1} = X_{0T3} = X_{1T} = 10{,}5\ \%$$
$$X_{0T2} = \text{Infinity for T2}$$

V1: $$X_{1V1} = X_1 \cdot l \cdot \frac{S_v}{U_{nV1}^2} \cdot 100 = 0{,}4 \cdot 50 \cdot \frac{31{,}5}{110^2} \cdot 100 = 5{,}2\ \% = X_{2V1}$$
$$X_{0V1} = X_0 \cdot l \cdot \frac{S_v}{U_{nV1}^2} \cdot 100 = 1{,}4 \cdot 50 \cdot \frac{31{,}5}{110^2} \cdot 100 = 18{,}22\ \%$$

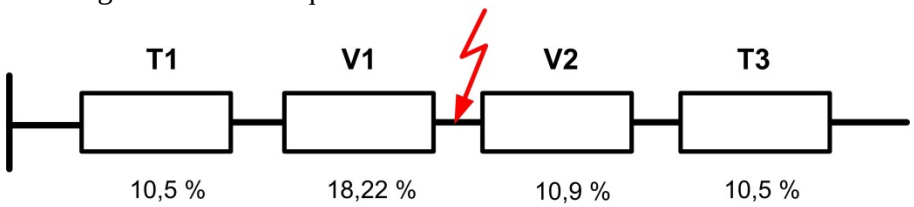
V2: $$X_{1V2} = X_1 \cdot l \cdot \frac{S_v}{U_{nV2}^2} \cdot 100 = 0{,}4 \cdot 30 \cdot \frac{31{,}5}{110^2} \cdot 100 = 3{,}13\ \% = X_{2V1}$$
$$X_{0V2} = X_0 \cdot l \cdot \frac{S_v}{U_{nV2}^2} \cdot 100 = 1{,}4 \cdot 30 \cdot \frac{31{,}5}{110^2} \cdot 100 = 10{,}9\ \%$$

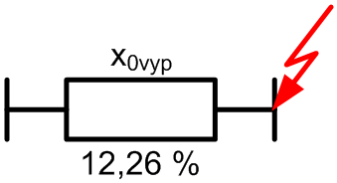
3) substitute diagram for **positive** and **negative** sequences and their calculational reactances:



$$X_{1vyp} = X_{2vyp} = 23{,}26\ \%$$

4) substitute diagram for **zero** sequence and its calculational reactance:





5) base current

$$I_v = \frac{S_v}{\sqrt{3} \cdot U_v} = \frac{31{,}5}{\sqrt{3} \cdot 110} = 0{,}165\ kA$$

6) three-phase short-circuit

$$I_{k0}^{"(3)} = k \cdot \frac{I_v}{X_{1vyp}} = 1{,}1 \cdot \frac{0{,}165}{23{,}26} \cdot 100 = 0{,}78\ kA$$

7) phase-to-phase short-circuit

$$I_{k0}^{"(2)} = k \cdot \frac{\sqrt{3} \cdot I_v}{X_{1vyp} + X_{2vyp}} = 1{,}1 \cdot \frac{\sqrt{3} \cdot 0{,}165}{23{,}26 + 23{,}26} \cdot 100 = 0{,}614\ kA$$

8) single-phase-to-ground short-circuit

$$I_{k0}^{"(1)} = k \cdot \frac{3 \cdot I_v}{X_{1vyp} + X_{2vyp} + X_{0vyp}} = 1{,}1 \cdot \frac{3 \cdot 0{,}165}{23{,}26 + 23{,}26 + 12{,}26} \cdot 100 = 0{,}926\ kA$$