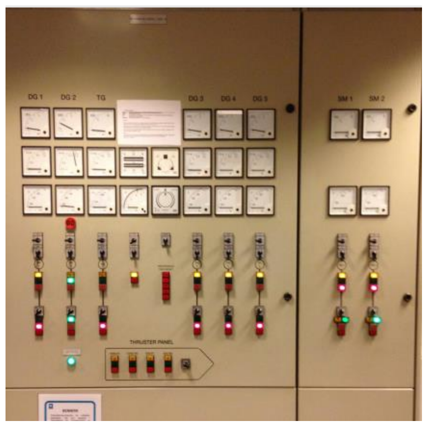
KORTSLUTNINGS BEREGNING

- 3 typer kortslutninger
- Beregningseksempel
- Spændingsfaktor c



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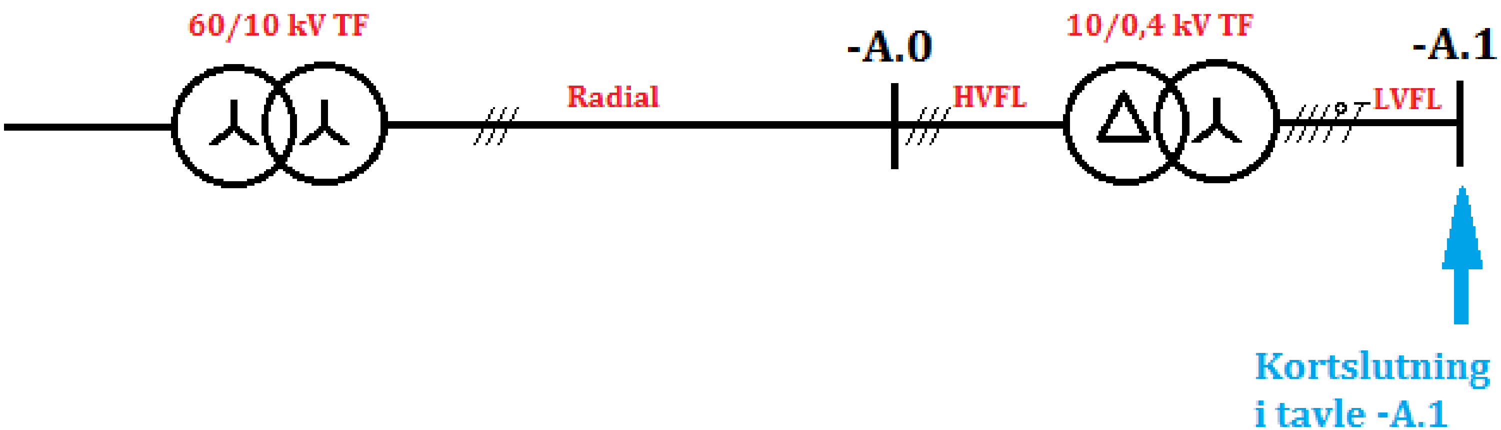
3 typer kortslutninger

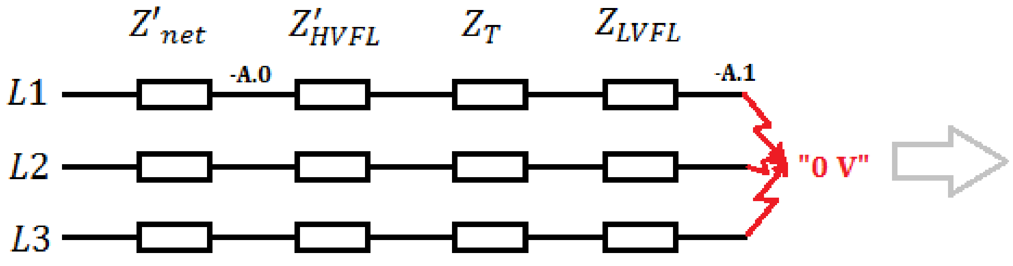
En stregs kredsskema:



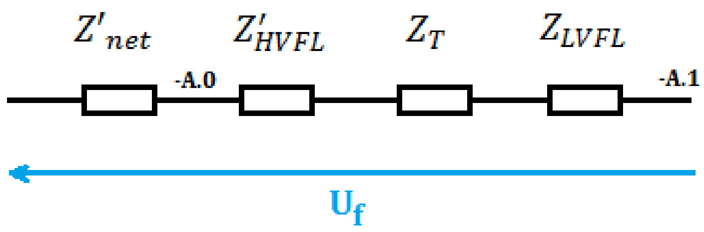
- 3 faset
- 2 faset
- 1 faset

3 faset kortslutning

Ækvivalent skema:



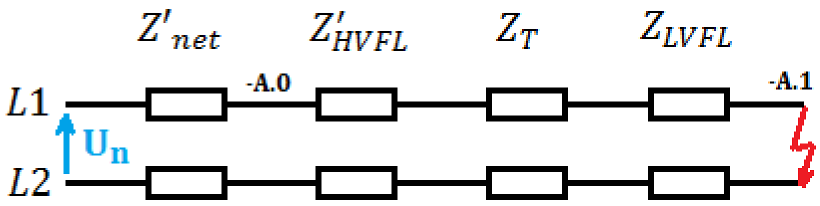
Det vil gælde for L1, L2 & L3 at:



Beregning af den 3 fasede kortslutningsstrøm:

2 faset kortslutning

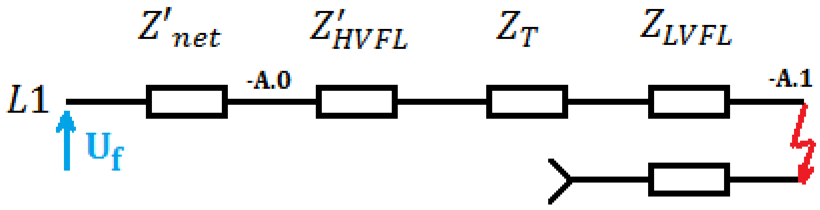
Ækvivalent skema:



Beregning af den 2 fasede kortslutningsstrøm:

1 faset kortslutning

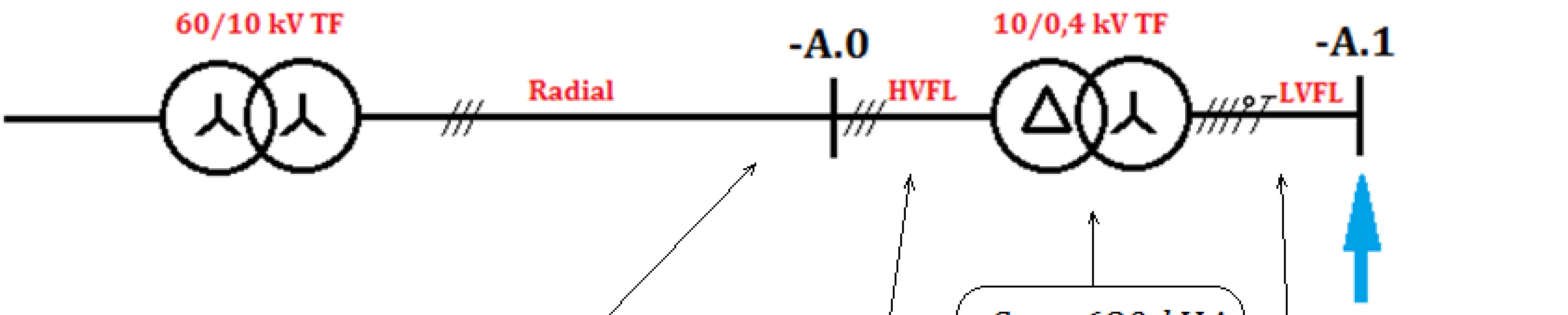
Ækvivalent skema:



Beregning af den 1 fasede kortslutningsstrøm:

Beregningseksempel

En stregs skema:



Kortslutningseffekten oplyses af netselskabet til, at være følgende lige før transformerstationen:

$S_K = 150\ MVA$
$R/X = 0{,}2$

$R_{HVFL} = 15\ m\Omega$
$X_{HVFL} = 5\ m\Omega$

$S_N = 630\ kVA$
$e_r = 1\ \%$
$e_k = 4\ \%$

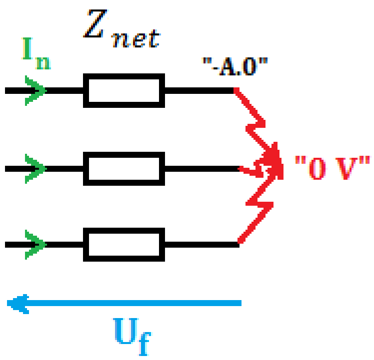
$R_{LVFL} = 12\ m\Omega$
$X_{LVFL} = 9\ m\Omega$

Netimpedans & transformerimpedans (Beregningseksempel)

Netimpedansen beregnes:

$S_K = 150\ MVA$

$R/X = 0,2$



Netimpedansen:

$$S_K = 3 \cdot U_f \cdot I_n \quad \Leftrightarrow$$

$$S_K = 3 \cdot \frac{U_n}{\sqrt{3}} \cdot I_n \quad \Leftrightarrow$$

$$S_K = \sqrt{3} \cdot U_n \cdot I_n \quad \Leftrightarrow$$

$$S_K = \sqrt{3} \cdot U_n \cdot \frac{U_f}{Z_{net}} \quad \Leftrightarrow$$

$$S_K = \sqrt{3} \cdot U_n \cdot \frac{U_n}{\sqrt{3} \cdot Z_{net}} \quad \Leftrightarrow$$

$$S_K = \frac{U_n^2}{Z_{net}} \quad \Leftrightarrow$$

$$Z_{net} = \frac{U_n^2}{S_K}$$

Transformerimpedansen beregnes:

$S_N = 630\ kVA$

$e_r = 1\ \%$

$e_k = 4\ \%$

Transformerimpedansen:

$$Z_T = \frac{U_f}{I_n} \cdot \frac{e_k}{100} \quad \Leftrightarrow$$

$$Z_T = \frac{U_n}{\sqrt{3} \cdot I_n} \cdot \frac{e_k}{100} \quad \Leftrightarrow$$

$$Z_T = \frac{U_n \cdot U_n}{\sqrt{3} \cdot I_n \cdot U_n} \cdot \frac{e_k}{100} \quad \Leftrightarrow$$

$$Z_T = \frac{U_n^2 \cdot e_k}{S_N \cdot 100}$$

Henføring af impedanser (Beregningseksempel)

Vi har nu følgende impedanser:

$Z_{net} = 0{,}667\,\Omega \angle 78{,}7\,°$

$R_{HVFL} = 15\ m\Omega$
$X_{HVFL} = 5\ m\Omega$

$Z_T = 10{,}2\ m\Omega \angle 75{,}5\,°$

$R_{LVFL} = 12\ m\Omega$
$X_{LVFL} = 9\ m\Omega$

Henføringsprincip:

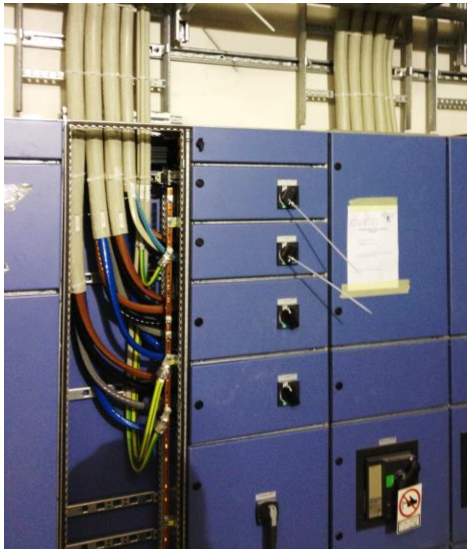
$$n = \frac{U_{N1}}{U_{N2}} = \frac{10000}{400} = 25$$

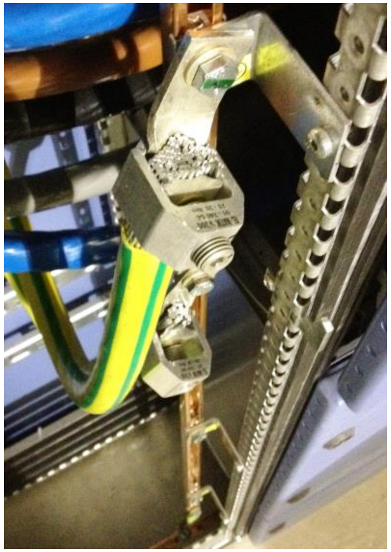
$$Z_1 = \frac{U_1}{I_1}$$

Henføring af netimpedans og impedans af HVFL til 400 V niveau:

Faktor 1,5 x R på lavspændingskabler (Beregningseksempel)

- Opvarmning af leder er <u>primær</u> årsag til faktor 1,5
- Samlingsresistans i kabelmuffer o.l. er <u>sekundær</u> årsag til faktor 1,5





Kortslutningsstrømmene (Beregningseksempel)

Den 3 fasede kortslutningsstrøm i tavle –A.1:

Den 2 fasede kortslutningsstrøm i tavle –A.1:

Den 1 fasede kortslutningsstrøm i tavle –A.1:

Spændingsfaktor c

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1.3.15

voltage factor *c*

ratio between the equivalent voltage source and the nominal system voltage U_n divided by $\sqrt{3}$. The values are given in table 1

NOTE The introduction of a voltage factor *c* is necessary for various reasons. These are:

- voltage variations depending on time and place,
- changing of transformer taps,
- neglecting loads and capacitances by calculations according to 2.3.1,
- the subtransient behaviour of generators and motors.

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Table 1 – Voltage factor *c*

Nominal voltage U_n	Voltage factor *c* for the calculation of maximum short-circuit currents c_{max} [1]	Voltage factor *c* for the calculation of minimum short-circuit currents c_{min}
Low voltage 100 V to 1 000 V (IEC 60038, table I)	1,05[3] 1,10[4]	0,95
Medium voltage >1 kV to 35 kV (IEC 60038, table III)	1,10	1,00
High voltage[2] >35 kV (IEC 60038, table IV)		

[1] $c_{max}U_n$ should not exceed the highest voltage U_m for equipment of power systems.

[2] If no nominal voltage is defined $c_{max}U_n = U_m$ or $c_{min}U_n = 0{,}90 \times U_m$ should be applied.

[3] For low-voltage systems with a tolerance of +6 %, for example systems renamed from 380 V to 400 V.

[4] For low-voltage systems with a tolerance of +10 %.

Tabel over spændingsfaktor c findes også i bog 6 side 28

Spændingsfaktor c (Beregningseksempel)

Den 3 fasede kortslutningsstrøm i tavle –A.1 med spændingsfaktor c:

$$I_{K3F\,max} = \frac{U_n \cdot c}{\sqrt{3} \cdot (\bar{Z}'_{net} + \bar{Z}'_{HVFL} + \bar{Z}_T + \bar{Z}_{LVFL})} = \frac{400 \cdot 1{,}10}{\sqrt{3} \cdot 0{,}0248} = \underline{10{,}2\ kA}$$

$$I_{K3F\,min} = \frac{U_n \cdot c}{\sqrt{3} \cdot (\bar{Z}'_{net} + \bar{Z}'_{HVFL} + \bar{Z}_T + \bar{Z}_{LVFL})} = \frac{400 \cdot 0{,}95}{\sqrt{3} \cdot 0{,}0248} = \underline{8{,}85\ kA}$$

3 faset KS uden c faktor:

$$I_{K3F} = 9{,}29\ kA$$

Den 2 fasede kortslutningsstrøm i tavle –A.1 med spændingsfaktor c:

$$I_{K2F\,max} = \frac{U_n \cdot c}{2 \cdot (\bar{Z}'_{net} + \bar{Z}'_{HVFL} + \bar{Z}_T + \bar{Z}_{LVFL})} = \frac{400 \cdot 1{,}10}{2 \cdot 0{,}0248} = \underline{8{,}87\ kA}$$

$$I_{K2F\,min} = \frac{U_n \cdot c}{2 \cdot (\bar{Z}'_{net} + \bar{Z}'_{HVFL} + \bar{Z}_T + \bar{Z}_{LVFL})} = \frac{400 \cdot 0{,}95}{2 \cdot 0{,}0248} = \underline{7{,}66\ kA}$$

2 faset KS uden c faktor:

$$I_{K2F} = 8{,}05\ kA$$

Den 1 fasede kortslutningsstrøm i tavle –A.1 med spændingsfaktor c:

$$I_{K1F\,max} = \frac{U_n \cdot c}{\sqrt{3} \cdot (\bar{Z}'_{net} + \bar{Z}'_{HVFL} + \bar{Z}_T + 2 \cdot \bar{Z}_{LVFL})} = \frac{400 \cdot 1{,}10}{\sqrt{3} \cdot 0{,}0395} = \underline{6{,}43\ kA}$$

$$I_{K1F\,min} = \frac{U_n \cdot c}{\sqrt{3} \cdot (\bar{Z}'_{net} + \bar{Z}'_{HVFL} + \bar{Z}_T + 2 \cdot \bar{Z}_{LVFL})} = \frac{400 \cdot 0{,}95}{\sqrt{3} \cdot 0{,}0395} = \underline{5{,}55\ kA}$$

1 faset KS uden c faktor:

$$I_{K1F} = 5{,}85\ kA$$

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