SHORT CIRCUIT

Calculation of Currents

ÍNDICE **PÁG.**

1 - PURPOSE

The purpose of this technical information is to calculate the three-phase short circuit currents, using the MVA method, developed by Moon H. Yuen and published in IEEE Transactions on Industry Applications, Vol. IA-10, No. 2, March/April 1974. This post is available to those who wish to delve into the subject.

This method is very simple and practical because, without memorizing formulas and using some simple calculations, one can determine the values of short circuit currents at different points of the system.

2 - REQUIRED DATA

To calculate short circuit currents, it is necessary to know the short power value of each component of the system.

2.1 - Power Supply System

The necessary power supply system data is:

$\boldsymbol{P_{Scc}}$ System short circuit power (MVA)

2.2 - Generator

The necessary generator data is:

P_{Gn} Rated generator power (MVA)

X''_{Gn} Subtransient reactance of generator (pu)

$$\boldsymbol{P_{Gcc} = \frac{P_{Gn}}{X''_{Gn}}}$$

Where $\boldsymbol{P_{Gcc}}$ is the short circuit power of the generator (MVA).

2.3 - Transformer

The required transformer data is:

P_{Tn} Rated power of transformer (MVA)

Z_{Tn} Transformer impedance (pu)

$$\boldsymbol{P_{Tcc} = \frac{P_{Tn}}{Z_{Tn}}}$$

Where $\boldsymbol{P_{Tcc}}$ is the short circuit power of the transformer (MVA).

2.4 - Feeder

The required feeder data is:

Z_A Feeder impedance (Ω)

V_{An} Rated voltage of feeder circuit (kV)

$$\boldsymbol{P_{Acc} = \frac{{V_{An}}^2}{Z_A}}$$

Onde $\boldsymbol{P_{Acc}}$ é a potência de curto circuito do alimentador (MVA)

2.5 - Points for Calculations

The necessary data from the point where we want to calculate the short circuit current are:

V_{Pn}Rated voltage at point (kV)

$$I_{Pcc} = \frac{Pcc_T}{\sqrt{3}V_{Pn}}$$

Where:

Pcc_T Total short circuit power at point (MVA)

I_{Pcc} Short circuit current at the desired point (kA)

3 - BASIC CONCEPT

In this calculation method it is demonstrated that the short circuit power at one point is calculated by the following formulas:

3.1 - Parallel Sources

The short circuit powers of the parallel sources are added to the short point considered. So:

$$Pcc_T = Pcc_1 + Pcc_2 + Pcc_3 + \cdots + Pcc_n$$

Where:

Pcc_T Total short circuit power at point (MVA)

$Pcc_{1,2,3..n}$ Short circuit power of parallel sources (MVA)

3.2 - Serial Sources

The short circuit power of the serial sources, at the short point considered, is given by the formula:

$$Pcc_T = \frac{1}{\frac{1}{Pcc_1} + \frac{1}{Pcc_2} + \frac{1}{Pcc_3} + \cdots + \frac{1}{Pcc_n}}$$

Where:

Pcc_T Total short circuit power at point (MVA)

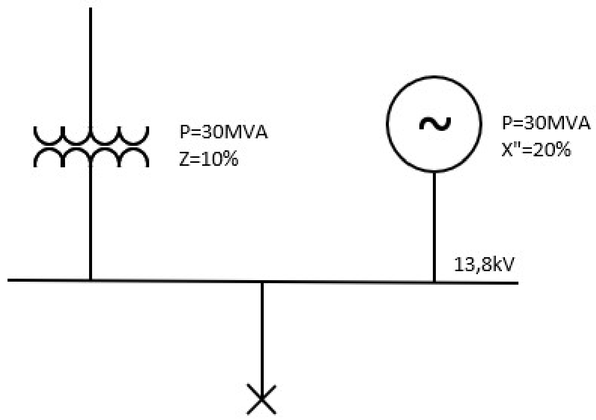
$Pcc_{1,2,3..n}$ Short circuit power of serial sources (MVA)

4 - APPLICATIONS

The following are some typical examples, of basic applications, that can be used on any system.

4.1 - Parallel Sources

Considering the scheme below:

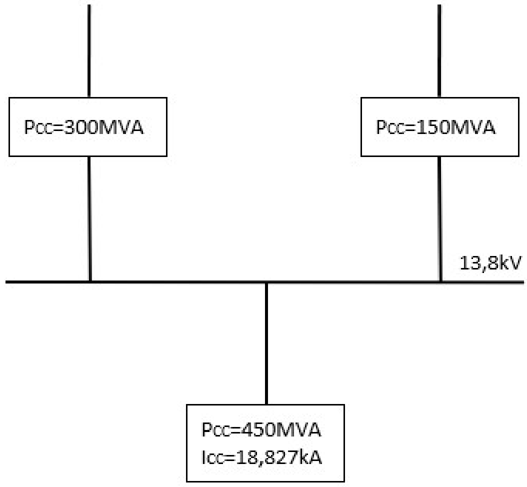


$$P_{Tcc} = \frac{P_{Tn}}{Z_{Tn}} = \frac{30}{0.1} = 300MVA$$

$$P_{Gcc} = \frac{P_{Gn}}{X"_{Gn}} = \frac{30}{0.2} = 150MVA$$

$$Pcc_T = P_{Tcc} + P_{Tcc} = 450MVA$$

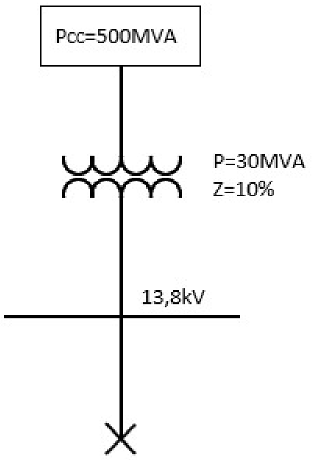
$$I_{Pcc} = \frac{Pcc_T}{\sqrt{3}V_{Pn}} = \frac{450}{\sqrt{3}.13.8} = 18.827kA$$



4.2 - Serial Sources

4.2.1 - Example 1

Considering the scheme below, where the short circuit power of the source supply is defined at 500MA:

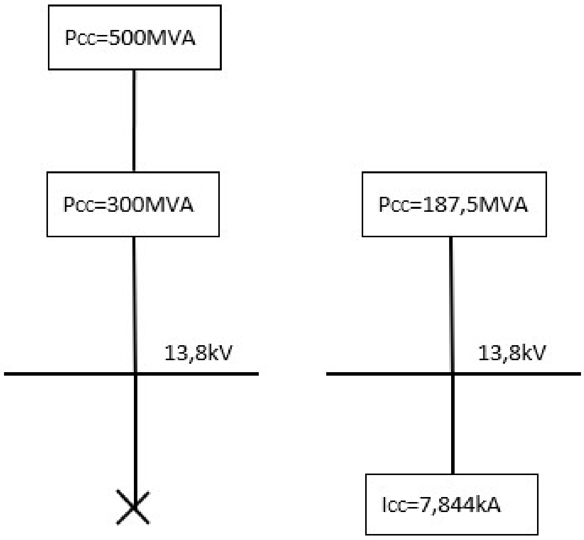


$$P_{Fcc} = 500MVA$$

$$P_{Tcc} = \frac{P_{Tn}}{Z_{Tn}} = \frac{30}{0.1} = 300MVA$$

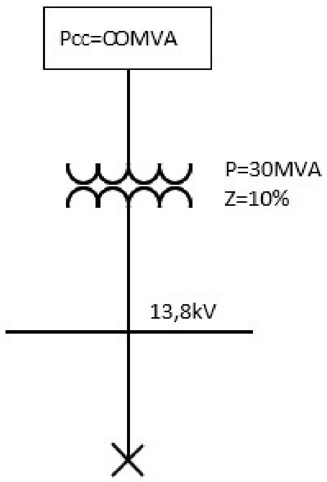
$$Pcc_T = \frac{1}{\frac{1}{P_{Fcc}} + \frac{1}{P_{Tcc}}} = \frac{1}{\frac{1}{500} + \frac{1}{300}} = 187.5MVA$$

$$I_{Pcc} = \frac{Pcc_T}{\sqrt{3}V_{Pn}} = \frac{187{,}5}{\sqrt{3}.13{,}8} = 7{,}844kA$$



4.2.2 - Example 2

Considering the diagram below, where the short circuit power of the source is defined at infinite:

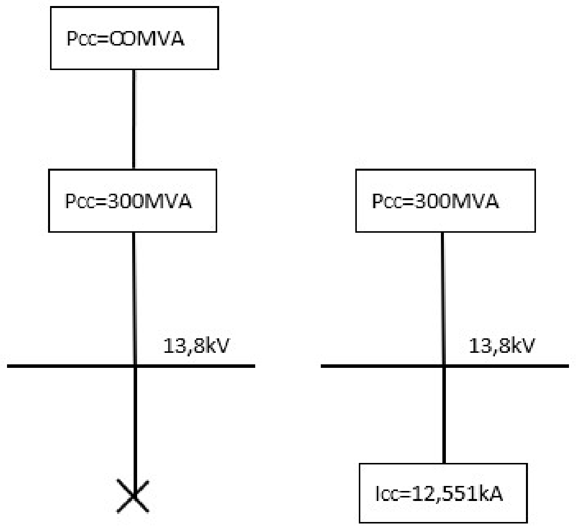


$$P_{Fcc} = infinite$$

$$P_{Tcc} = \frac{P_{Tn}}{Z_{Tn}} = \frac{30}{0.1} = 300MVA$$

$$Pcc_T = \frac{1}{\frac{1}{P_{Fcc}} + \frac{1}{P_{Tcc}}} = \frac{1}{\frac{1}{infinite} + \frac{1}{300}} = \frac{1}{0 + \frac{1}{300}} = 300MVA$$

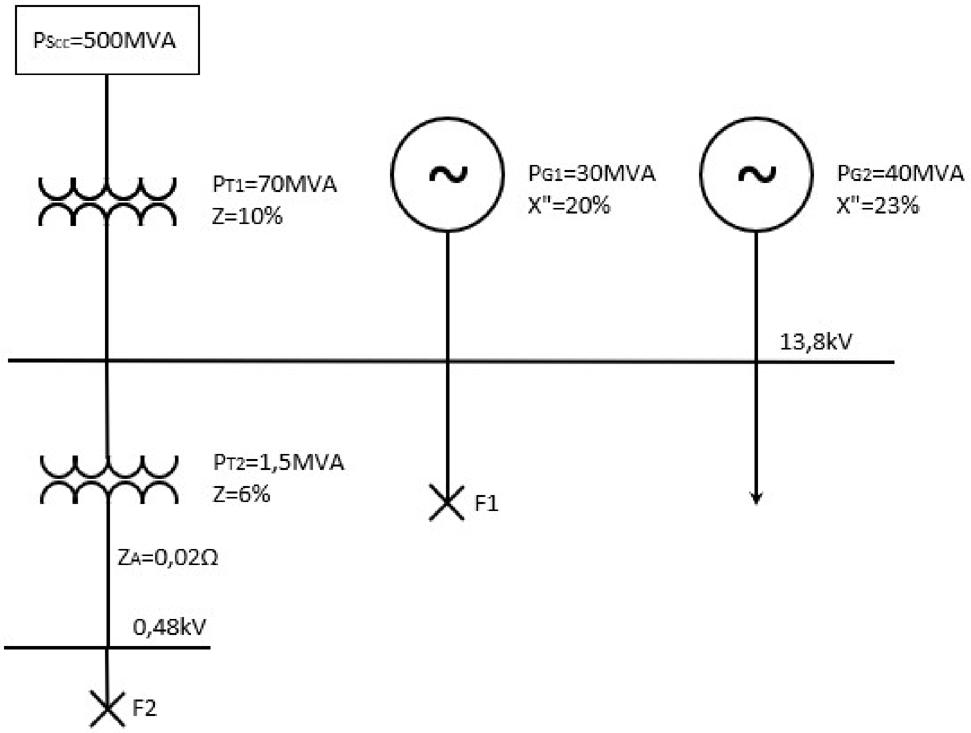
$$I_{Pcc} = \frac{Pcc_T}{\sqrt{3}V_{Pn}} = \frac{300}{\sqrt{3}.13.8} = 12.551kA$$



4.2.3 - Example 3

The combination of fonts in series and parallel is valid for any number of fonts and types. The solution will be to convert the sources to a single source, following the same criteria as those adopted above.

We will consider the following circuit as a more complete example:



$$P_{Scc} = 500MVA$$

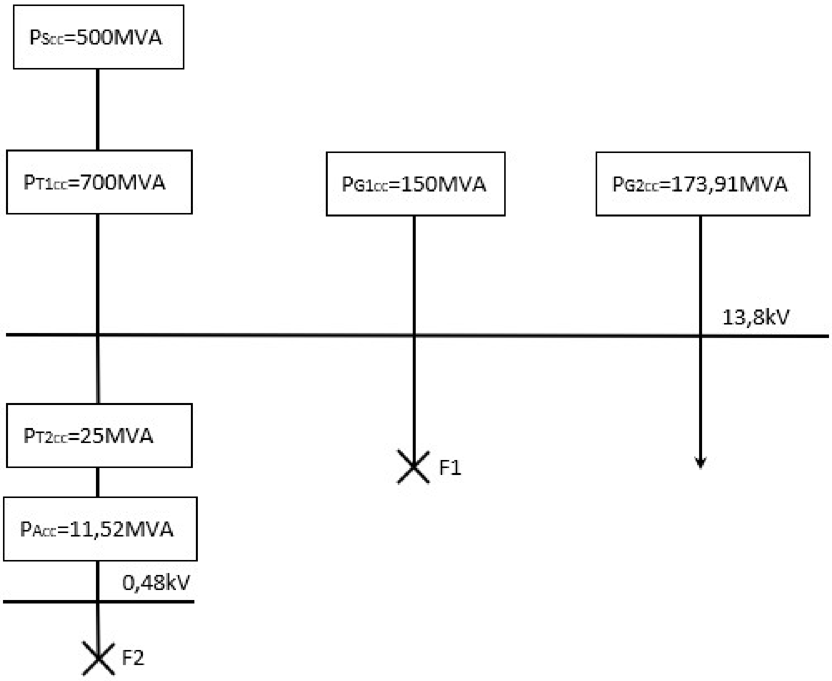
$$P_{T1cc} = \frac{P_{Tn}}{Z_{Tn}} = \frac{70}{0.1} = 700MVA$$

$$P_{T2cc} = \frac{P_{Tn}}{Z_{Tn}} = \frac{1.5}{0.06} = 25MVA$$

$$P_{G1c} = \frac{P_{Gn}}{X"_{Gn}} = \frac{30}{0.2} = 150MVA$$

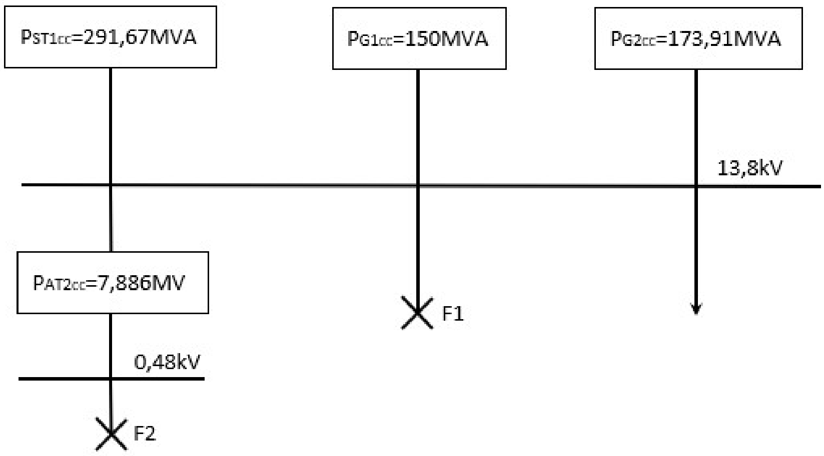
$$P_{G2cc} = \frac{P_{Gn}}{X"_{Gn}} = \frac{40}{0.23} = 173{,}91MVA$$

$$P_{Acc} = \frac{{V_{An}}^2}{Z_A} = \frac{0.48^2}{0.02} = 11.52MVA$$

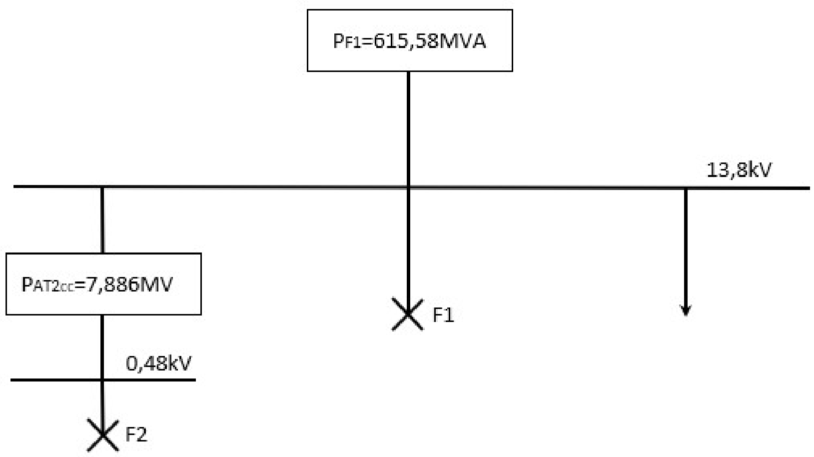


$$P_{ST1cc} = \frac{1}{\frac{1}{P_{Scc}} + \frac{1}{P_{T1cc}}} = \frac{1}{\frac{1}{500} + \frac{1}{700}} = 291{,}67MVA$$

$$P_{AT2cc} = \frac{1}{\frac{1}{P_{Acc}} + \frac{1}{P_{T2cc}}} = \frac{1}{\frac{1}{11{,}52} + \frac{1}{25}} = 7{,}886MVA$$



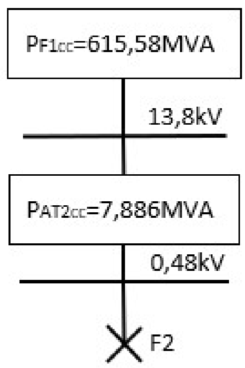
$$P_{F1} = P_{ST1CC} + P_{G1CC} + P_{G2CC} = 291{,}67 + 150 + 173{,}91 = 615{,}58MVA$$



The short circuit current in F1 will be:

$$I_{F1CC} = \frac{P_{F1CC}}{\sqrt{3}.13.8} = \frac{615.58}{\sqrt{3}.13.8} = 25.75kA$$

The short circuit power in F2 point will be:



$$P_{F2cc} = \frac{1}{\frac{1}{P_{F1cc}} + \frac{1}{P_{AT2c}}} = \frac{1}{\frac{1}{615.58} + \frac{1}{7.886}} = 7{,}786MVA$$

The short circuit current in F2 will be:

$$I_{F2CC} = \frac{P_{F2CC}}{\sqrt{3}.0{,}48} = \frac{7{,}786}{\sqrt{3}.0{,}48} = 9{,}365kA$$