Calculating the short-circuit current across the terminals of a synchronous generator

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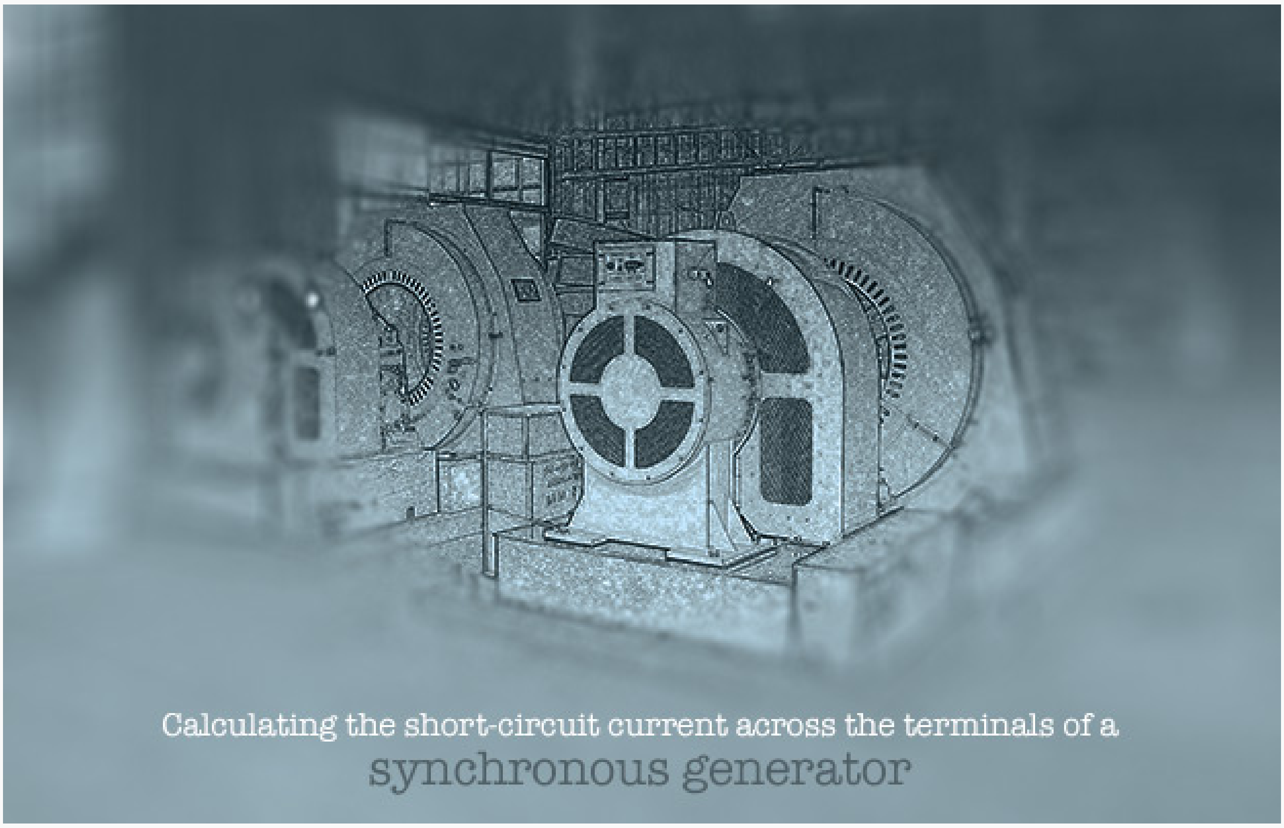


Calculating the short-circuit current across the terminals of a synchronous generator

Alternators and motors

Calculating the short-circuit current across the terminals of a synchronous generator is very complicated because the internal impedance of the latter varies according to time.

When the power gradually increases, the current reduces passing through three characteristic periods:

1. ***Subtransient*** (enabling determination of the closing capacity of circuit breakers and electrodynamic contraints), average duration, 10 ms
2. ***Transient*** (sets the equipment's thermal contraints), average duration 250 ms
3. ***Permanent*** (this is the value of the short-circuit current in steady state).

The short-circuit current is calculated in the same way as for transformers but the different states must be taken account of.

The short-circuit current is given by the following equation:

$\mathbf{I_{sc} = I_r / X_{sc}}$

$\mathbf{X_{sc}}$ - Short-circuit reactance c/c

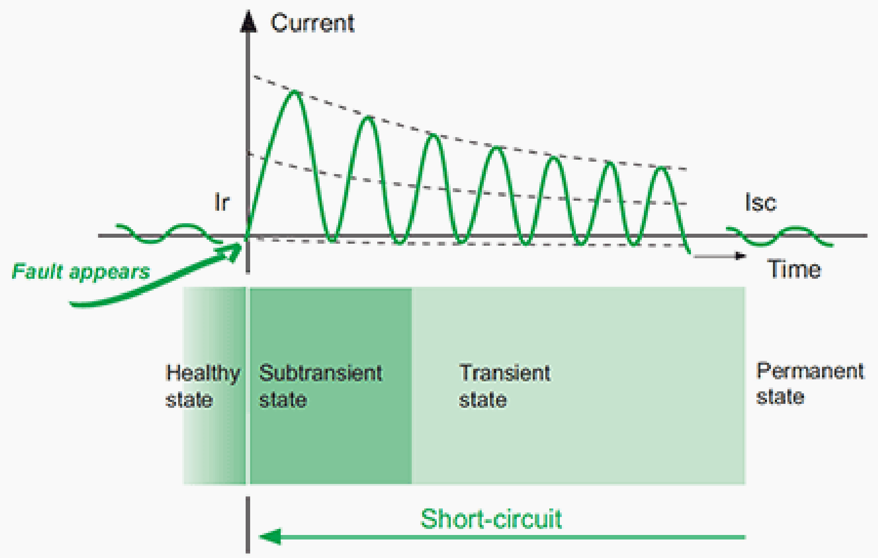
The most common values for a synchronous generator are:

State	Subtransient X"d	Transient X'd	Permanent Xd
X_{sc}	10 – 20%	15 – 25%	200 – 350%

Example

Calculation method for an alternator or a synchronous motor.

- Alternator 15 MVA
- Voltage U = 10 kV
- X'd = 20%



Short-circuit current – three characteristic periods

All electrical installations have to be protected against short-circuits, without exception, whenever there is an electrical discontinuity; which more generally corresponds to a change in conductor cross-section.

The short-circuit current shall be calculated at each stage in the installation for the various configurations that are possible within the network, in order to determine the characteristics of the equipment that has to withstand or break this fault current.

$$I_r = \frac{S_r}{\sqrt{3} \cdot U} = \frac{15}{\sqrt{3} \cdot 10000} = 870\ A$$

$$I_{sc} = \frac{I_r}{X_{sc}\ trans} = \frac{870}{20/100} = 4350\ A = 4.35\ kA$$

Reference: *Medium voltage design guide – Schneider Electric*

Source:

http://electrical-engineering-portal.com/calculating-the-short-circuit-current-synchronous-generator