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Delayed current zero in doubly-fed induction generator application

A3-PS1, Q1

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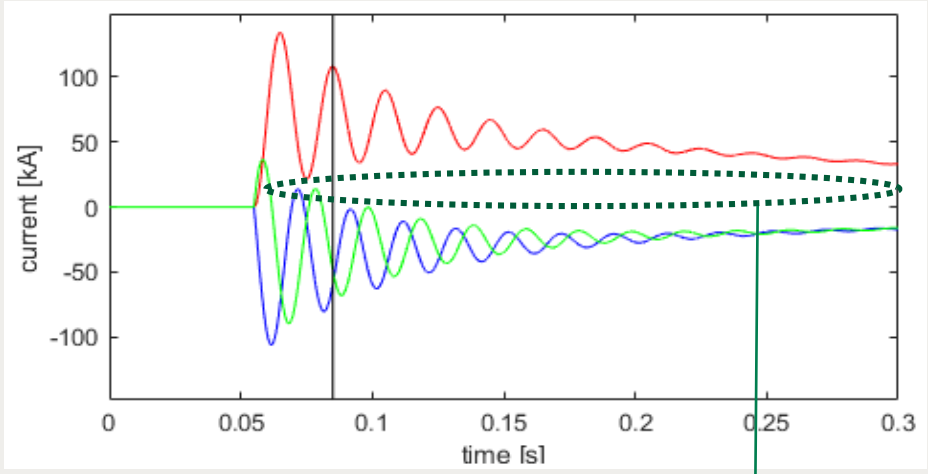
Case Study
Fault currents of DFIGs – Influence of Crowbar Resistor

- *In power stations with two-winding step-up transformers fault currents exhibiting delayed current zeros can usually occur in case of:*
  - Generator-source short-circuit currents
  - Out-of-phase fault currents
- *Extremely severe interrupting conditions for generator circuit-breaker*
- *Proper selection of GCB is of utmost importance*

Generator-source short-circuit current; fault initiation at voltage zero in one phase at t = 55 ms; Rcb = 11.4 mΩ (Referred to stator)



AC Component decays faster than DC component

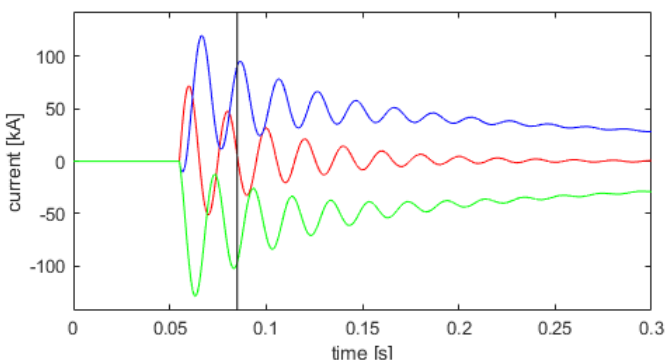
No zero crossing ! Extremely long arcing time

Interruption of fault current

Generator terminal fault

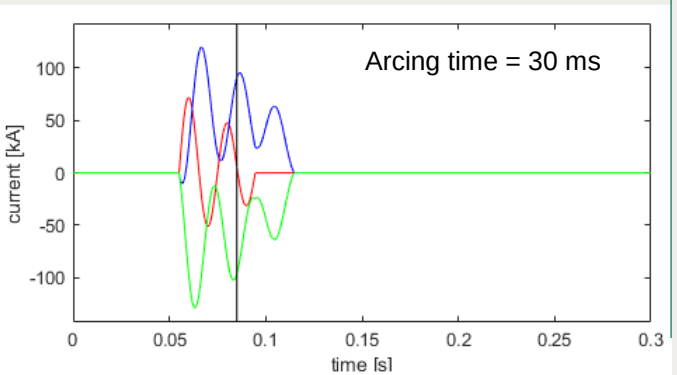
(generator-unloaded prior to fault)

Fault initiation at voltage maximum in one phase at t = 55 ms: contact parting time = 30 ms



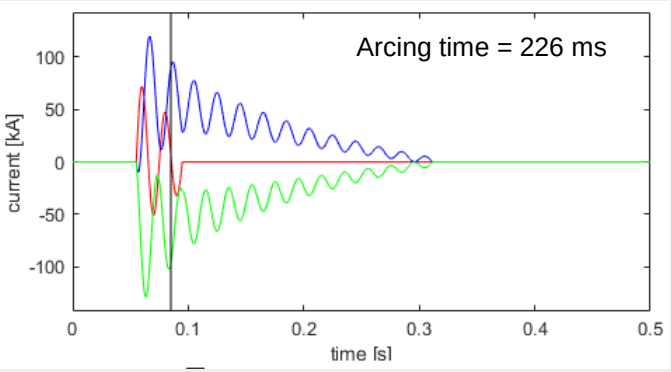
Influence of SF_6 arc-voltage

SF_6 GCB arc-voltage: the arc-voltage model derived from tests is used



Influence of vacuum arc-voltage

vacuum GCB arc-voltage: a constant arc-voltage of 100 V is used



- **<u>In the studied case</u>**, **generator-source short-circuit current** in case of generator unloaded prior to fault leads to the **most severe interrupting conditions with respect to the asymmetry of current and the arcing time**. Also out-of-phase conditions lead to very long arcing times for vacuum GCB. Arcing times with this vacuum GCB might result in unsuccessful interruption.
- A fault clearing time in range of 200 ms could also lead to undesirable consequences on all connected power system assets and might cause transient instability in the network.

Summary

- The capability of a GCB to interrupt a short-circuit current with delayed current zero crossings shall be ascertained by calculations (see IEC/IEEE 62271-37-013 9.103.6.3.6.3) taking into account arc-voltage model derived from appropriate tests (see IEC/IEEE 62271-37-013 7.105).

- **Annex K of IEC/IEEE 62271-37-013** does not specify any test duty related to delayed current zeros. It provides **comprehensive and clear guidance to verify the suitability of GCBs for application with DFIGs**.

- In case of faults which exceed the overvoltage and/or overcurrent handling capability of rotor-side converter, crowbar is immediately activated to protect the rotor-side converter. Remote grids faults might be handled by converter control without triggering the crowbar, but these are typically not the worst-case conditions for sizing a GCB which is intended to interrupt the worst-case generator-source short-circuit current, system-source short-circuit current and out-of-phase fault current.

Thank you for your attention !