PID # 330988

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Title: **Numerical Analysis of Low-Voltage Circuit-Breakers under Short-Circuit Conditions**

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Abstract:

Short-circuits in electrical networks come along with severe mechanical and thermal stresses not only to loads and systems, but also to the installed protection devices. Combined analytical simulations have been performed for analyzing and optimizing the behavior of low-voltage circuit-breakers. Especially circuit-breakers with electronic tripping units have been scrutinized.

The elaborated analytical model includes the electronic tripping unit using the new Cubical Criterion as short-circuit detection algorithm. An actuating-system, consisting of an analytical model for Thomson drives and a rigid-body model for the latching mechanism, is comprised in the simulation. A realistic simulation of the breaker's behavior is achieved by the mechanical model including both dynamic and constriction forces. A simple but effective model of the switching arc represents the current limitation. The electrical network is calculated for different kinds of loads.

Finally the short-circuit detection algorithm (Cubical Criterion) has been implemented into an FPGA. Hardware-in-the-Loop and Hardware Co-Simulations have been performed to optimize the behavior of the algorithm, especially under bad power quality conditions e.g. by using industrial network measurements as input for the algorithm. The main results of these simulations are better current-limitation under different short-circuit conditions and the reliable tripping behavior.