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Partial Discharges in Insulation Systems Subjected to Multilevel Converters

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Ubiquitous involvement of power electronics devices in the power conversion applications on various voltage levels makes new challenges for the design of insulation systems. The fast switching processes produces complex stresses and high frequency phenomena interplaying with charge behavior in dielectric insulating materials. The converters and inverters utilize usually the most widely accepted technique based on pulse width modulation. These kinds of stresses on insulation systems result in new approach to the intensity, dynamics of working electric field strength and degradation processes being assessed mostly by partial discharges. However, most of the research studies, devoted so far to electrical insulation aspects, were based on one- or two-levels converters. Recently more and more often multilevel converters are implemented in industrial applications, due to their advantages for example in efficiency, harmonic distortion and filtering strategies. Paper presents analysis of partial discharges in electrical insulation system subjected to high voltage waveform obtained from multilevel converter. The experiments have been performed on specially prepared model samples. The programmable voltage source modular multilevel converter was used in the tests. The topology of power electronics building blocks and control approach is described. The flexible configuration allows for adjustment of the number of voltage levels and switching frequency of the modulated subperiods. Partial discharges were detected by high frequency transformer, galvanically separated from the power path. The comparison of number of levels and modulation frequency on partial discharge inception and intensity are presented. The partial discharges were acquired in form of phase-resolved patterns and correlated with multilevel voltage waveforms on the slopes and constant voltage parts. In addition partial discharges on individual levels in multilevel sequence were evaluated.

Author: Dr FLORKOWSKI, Marek (ABB Corporate Research)

Co-authors: Mr BLASZCZYK, Pawel (ABB Corporate Research); Dr KLIMCZAK, Pawel (ABB Corporate Research)

Presenter: Dr FLORKOWSKI, Marek (ABB Corporate Research)

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