Voltage Sag Compensation with Energy Optimized Dynamic Voltage Restorer

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Abstract: The compensation capability of a dynamic voltage restorer (DVR) depends primarily on the maximum voltage injection ability and the amount of stored energy available within the restorer. A new phase advance compensation (PAC) strategy for the DVR is proposed in order to enhance the voltage restoration property of the device. The scheme requires only an optimum amount of energy injection from the DVR to correct a given voltage sag. Supply voltage amplitude and phase detection scheme as well as a phase advance determination scheme are also included. The resulting DVR design is shown to be superior in terms of lower storage energy need compared to the conventional in-phase boosting method. The analytical results are validated by laboratory tests carried out on a prototype of the restorer. The efficacy of the proposed method is illustrated.

Keywords: Power quality.

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Algorithms for Characterizing Measured Three-Phase Unbalanced Voltage Dips

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Abstract: This paper addresses the problem of estimating the characteristics of three-phase unbalanced voltage dips from measured phase voltages. This is important for obtaining statistics on voltage dips and for obtaining information about the underlying event (e.g., the fault type). Two different algorithms are compared. The "six-phase algorithm" is computationally simple and easy to interpret. However, large phase-angle jumps lead to wrong estimations. The "symmetrical component algorithm" gives a correct value in almost all cases. Exceptions are events with very severe load influence on the voltages during the fault. The latter algorithm is studied in more detail through a measurement example and through a study of a range of synthetic events. The conclusion is that both algorithms have their specific application areas.

Keywords: Electromagnetic compatibility (EMC), power quality, power quality monitoring, power system faults, voltage dips (sags).

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Impact of EV Battery Chargers on the Power Quality of Distribution Systems

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Abstract: A summary of the actual state of battery charger harmonics is presented. The effect of harmonic distortion on the distribution system, especially on distribution transformers, is analyzed. A program was developed that allows the consideration of the transformer life consumption as a function of the battery charger characteristics and charging algorithm. The program is considered to be a distribution planning and management tool. The proposed tool can be easily applied to determine the optimum charging time as a function of the existing load, ambient temperature, and time of day. From the study it can be deduced that a direct connect-and-charge scheme can be detrimental to the transformer life, especially under high temperature and large load. Calculations show the existence of a quadratic relationship between the transformer life consumption and the total harmonic distortion (THD) of the battery charger current. Furthermore, the current THD should be limited to 25 - 30% in order to have a reasonable transformer life expectancy.

Keywords: Power quality, electric vehicle, battery charger, harmonics, power distribution system, transformer derating.

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Torsional Interaction Studies on a Power System Compensated by SSSC and Fixed Capacitor

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Abstract: In this paper a static synchronous series compensator (SSSC) along with a fixed capacitor is used to avoid torsional mode instability in a series compensated transmission system. A 48-step harmonic neutralized inverter is used for the realization of the SSSC. The system under consideration is the IEEE first benchmark model on SSR analysis. The system stability is studied both through eigenvalue analysis and EMTDC/PSCAD simulation studies. It is shown that the combination of the SSSC and the fixed capacitor improves the synchronizing power coefficient. The presence of the fixed capacitor ensures increased damping of small signal oscillations. At higher levels of fixed capacitor compensation, a damping controller is required to stabilize the torsional modes of SSR.

Keywords: SSSC, torsional interaction, IEEE first benchmark model, eigenvalue analysis.

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Simulation Studies to Improve Design for Midlife 275 kV Cable Refurbishment

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Abstract: Simulation studies to reduce the number of link positions on an existing 275 kV cable route due for refurbishment are presented. This reduction in the number of link positions will effectively reduce the overall cost of maintenance and will also improve reliability. It is shown that the proposed layout and bonding arrangement can produce sheath voltages of up to 200 V during load conditions, 3 kV during external faults, and 6.4 kV during internal faults. Transient sheath to ground voltages of up to 100 kVp during lightning and up to 95 kVp during faults can be experienced. These voltages will be acceptable in normal service. The capital efficiency of the refurbishment, which reduces the number of link positions, should also reduce the risks of subsequent failure and the cost of maintenance.

Keywords: ATP, cables, EMTP, sheath voltage, sheath voltage limiter, transients.

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Voltage Recovery After Unbalanced and Balanced Voltage Dip in Three-Phase Systems

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Abstract: This paper studies the recovery of the voltage after a voltage dip due to a fault in a three-phase system. The instant of voltage recovery corresponds to the instant of fault clearing. For single-phase and phase-to-phase faults a single point-on-wave of voltage recovery can be defined. For two-phase-to-ground and three-phase faults the recovery takes place in two or three steps. The voltage recovery is described in a systematic way by using a classification of three-phase unbalanced voltage dips. The voltage recovery needs to be modeled correctly for studies of equipment immunity against voltage dips.

Keywords: Power quality, voltage dips (sags), power transmission and distribution, equipment immunity.