Ain Shams University
Faculty of Engineering
Electric Power and Machine Department

Transformerless Dynamic Voltage Restorer for Medium Voltage Distribution Networks

M.Sc. thesis

by:

Eng. Ayman Bahgat Abd-El-Azim Ibrahim

A thesis submitted to the Faculty of Engineering –Ain Shams University
in partial fulfillments of the requirements for the M.Sc. degree in
Electrical Power and Machines Engineering

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STATEMENT

This thesis is submitted to Ain Shams University in partial fulfillment of the requirements for M.Sc. degree in Electrical Engineering.

The included work in this thesis has been carried out by the author at the Electrical Power and Machine Department, Ain Shams University. No part of this thesis has been submitted for a degree or a qualification at any other university or institution.

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ABSTRACT

Voltage disturbances are the most common power quality problems causing effects ranging from minor annoyance through equipment failure to the shutdown of complete production processes. The economic impact can be very large and can threaten the economic viability of a business. The Dynamic Voltage Restorer (DVR) is considered as the most effective and economic solution for all types of voltage disturbances.

This thesis introduces a proposed transformerless DVR structure that is suitable for medium voltage distribution networks. The proposed control system is capable of compensating all types of voltage disturbances like voltage sags, voltage swells, voltage flickers and long duration voltage variations; the disturbance compensation is done with minimum energy requirements.

The proposed DVR system is based on cascaded H-bridge multilevel inverter topology which enables to eliminate the insertion transformer; hence the cost and size of the DVR are effectively reduced. Different PWM switching techniques are discussed and simulated using the EMTDC/PSCAD simulation package. Simulation results are compared in order to adopt the best switching technique for the cascaded H-bridge multilevel inverter. Different compensating techniques are studied and simulated to demonstrate the advantages and disadvantages of each method.

The dynamic performance of the proposed transformerless DVR is studied which validate the accuracy of the proposed control technique. The ability of the proposed transformerless DVR to compensate voltage disturbance with minimum energy requirements is proved by using capacitors as energy storage elements instead of dc power supplies.

The proposed minimum energy control technique of the DVR is shown to be superior in terms of lower storage energy need and efficient compensation compared to the conventional pre-fault compensation technique and the existing minimum energy compensation techniques.

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