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Investigation On Dynamic Voltage Restorers With Two Dc Links And Series Converters For Three-Phase Four-Wire Systems

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ABSTRACT

This paper investigates a dynamic voltage restorer (DVR) composed of two conventional three-phase inverters series cascaded through an open-end winding (OEW) transformer, denominated here DVR-OEW. The DVR-OEW operating with either equal or different dc-link voltages are examined. The proposed topology aims to regulate the voltage at the load side in the case of voltage sags/swells, distortion, or unbalance at the grid voltage. A suitable control strategy is developed, including space-vector analysis, level-shifted PWM (LSPWM) and its equivalent optimized single-carrier PWM (SCPWM), as well as the operating principles and characteristics of the DVR. Comparisons among the DVR-OEW and conventional configurations, including a neutral-point clamped (NPC) converter based DVR, are furnished.

The main advantages of the DVROEW compared to the conventional topologies lie on: i) reduced harmonic distortion, ii) reduced converter losses, and iii) reduced voltage rating of the power switches.

INTRODUCTION

Power quality has a hard impact on distribution power systems (DPS). Every year, it is estimated that the industry and commerce sectors lose billions of dollars due to issues related to low power quality. Such problems are directly associated with voltage sag. Even considering other types of troubles (i.e., flickers, harmonic currents, etc) that can lead the DPS to a poor power quality, voltage sag is still reported as the major power-quality problem. Voltage sag correction is required for applications that range from a few hundred watts to several megawatts. One of the most popular circuits employed to solve this kind of problem is the dynamic voltage restorer (DVR). Such compensator is a power-electronic based device, connected in series with the grid, which aims to protect critical loads (sensitive loads) from the supply-side disturbances.

It should be noted that ΔY transformers are often used to prevent zero sequence components from propagating to

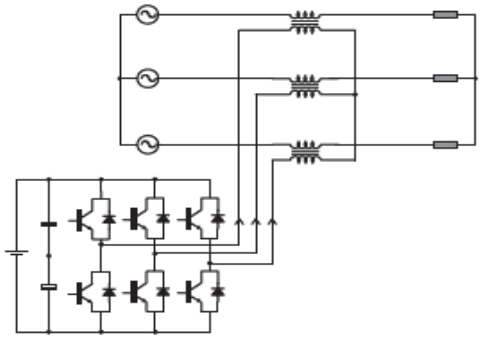
the secondary side of the transformer during an unbalanced fault in an upstream point of the distribution system. The DVR is basically composed of injection transformers, protection circuit, bypass thyristor, passive filters, voltage source inverter (VSI) and energy storage. The last component is commonly implemented by either ac-dc rectifiers or rechargeable storage systems. In fact, the energy storage is based on one of these technologies: battery energy storage system (BESS), ultra-capacitors (UCAP), superconducting magnet energy storage (SMES) or flywheel energy storage system (FESS).

EXISTING SYSTEM:

This work investigates three options for a Dynamic voltage restorer (DVR), topology on 3P4W systems application based on the concept open-end winding (OEW). Configuration 4L4L, is based on two four-leg (4L) inverters connected to injection transformers.

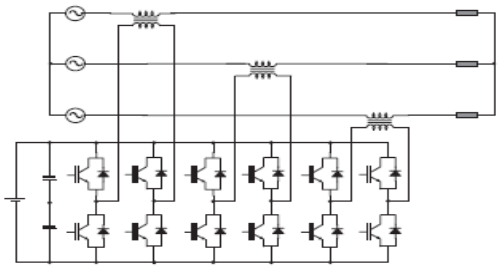
Configuration 4L2C consists of a four-leg (4L) inverter connected at one side and split capacitor at the other side .The third one, configuration 2C2C is composed of two split capacitor (2C) configurations connected to an injection transformer in an OEW arrangement.

They use more power switches than conventional ones, but enables the converter to operate with: i) lower dc-link voltage rating which reduces the switch blocking voltages and ii) lower harmonic distortion at the injected voltages by the DVR due to operation with asymmetrical dc-link voltage. Such features are the main benefits of the proposed configurations.



(a)

Fig: Conventional two-level three-leg (2L)



(b)

Fig:Three-level six-leg power converter (3L)

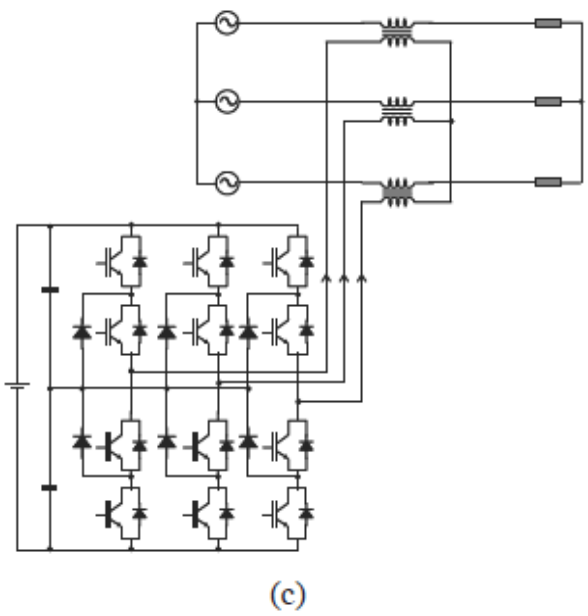


Fig: Three-level three-leg neutral-point clamped (NPC)

PROPOSED SYSTEM

The DVR-OEW operating with either equal or different dc-link voltages are examined. The proposed topology aims to regulate the voltage at the load side in the case of voltage sags/swells, distortion, or unbalance at the grid voltage. A suitable control strategy is developed, including space-vector analysis, level-shifted PWM (LSPWM) and its equivalent optimized single-carrier PWM (SCPWM), as well as the operating principles and characteristics of the DVR.

The DVR-OEW can be considered as two conventional three-leg inverters (inverters A and B) series connected through three single-phase transformers in an open-end winding arrangement. Notice that each dc link has a storage energy that can be implementing with rectifiers (controlled or non-controlled). An ideal equivalent circuit can be observed in Fig. 4(b). Notice that each inverter is composed of power switches $q1x$, $q1x$, $q2x$, $q2x$ $q3x$ and $q3x$ (with $x = a$ for converter A or $x = b$ for converter B). The conduction state of all switches is represented by an homonymous binary variable, where $qx = 1$ indicates a closed switch while $qx = 0$ an open one.

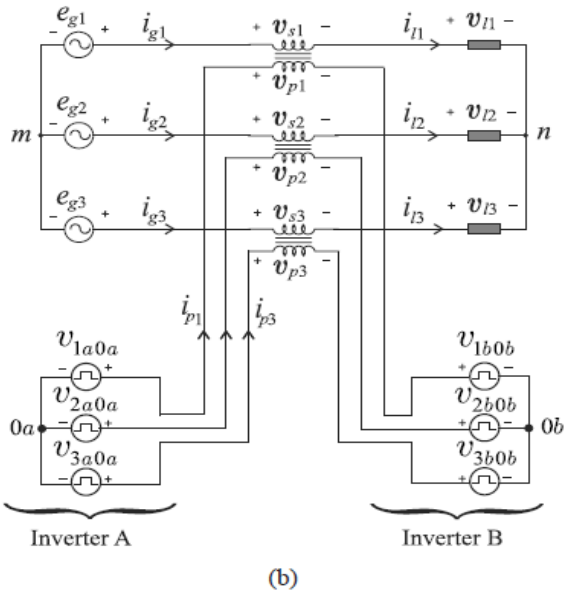


Fig: Ideal equivalent circuit.

CONCLUSION

A dynamic voltage restorer (DVR) obtained by means of the series connection of two three-phase inverters through an

open-end winding transformer was presented. Two equivalent implementations with either level-shifted carrier PWM (LSPWM) or single-carrier PWM (SCPWM) strategy approaches were presented. Two equivalent implementations with either level-shifted carrier PWM (LSPWM) or single-carrier PWM (SCPWM) strategy topology, compared to conventional configurations with three legs and NPC (*i*) reduced harmonic distortion (operating at the same switching frequency), (*ii*) reduced converter losses (operating with the same harmonic distortion), (*iii*) reduced converter losses (with the same switching frequency) and (*iv*) reduced voltage rating of the power switches employed in the DVR.

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