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Space Vector Modulation For Dc-Link Current Ripple Reduction In Back-To-Back Current-Source Converters For Micro Grid Applications

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ABSTRACT

The objective of this paper is to reduce the current ripple of back-to-back current source converter by optimizing the gate pattern of space vector modulation (SVM). A large ripple will cause the electromagnetic interference, undesirable high-frequency losses, and system instability. Conventionally, with a given switching frequency and rated voltage, the current ripple can be reduced by increasing the dc-link inductor, but it leads to bulky size, high cost and slow dynamic response. In order to solve this problem, this paper reveals that the current ripple can be significantly reduced by adjusting the gate patterns of space vector modulation (SVM) between the rectifier and inverter in a back-to-back converter.

INTRODUCTION

Typically, the back-to-back voltage source converters are used to interconnect the micro-grids. However, the voltage source converters require bulky and temperature-limited electrolytic capacitors. The failure in electrolytic capacitors is one of the main causes of breakdowns, and degrades the whole system's lifetime. Besides, there is a potential risk of over-current due to the phase-leg short circuit, which reduces the system reliability. On the other hand, the current source converters have the inherent current limiting capability and thus enhance the reliability. Furthermore, they allow forbidden states in the case of voltage source converters that may cause short-circuit, being in case of current source a desirable possibility to achieve soft-switching operation. However, one of their disadvantages is the large dc-link inductor, which increases the system volume and limits the dynamic response.

An alternative solution is to use the small inductor, but it suffers from a large current ripple. Therefore, the solution to reduce the current ripple in case of small dc-link inductor value needs further investigation. The objective of this paper is to reduce the current ripple of back-to-back current source converter by optimizing the gate pattern of space vector modulation

(SVM). First, the relationship between dc-link current ripple and different SVM pulse patterns. It is revealed that the gate pattern arrangement has a significant effect on the dc-link current ripple. By coordinating the SVM gate patterns of both rectifier and inverter, the current ripple can be greatly reduced, thus a small dc-link inductor can be used. The experimental tests on a back-to-back converter are carried out to verify the proposed optimization method.

The current source converter (CSC); has several features that make it attractive in many industrial applications, such as high-power electric drives and distributed generation systems as an interface between the utility grid and distributed power sources. These features include easy regenerative capabilities, inherent short-circuit protection, adjustable power factor at ac side, etc. Moreover, the CSC can increase its dc-link voltage toward ac mains, resulting in a boost-type inverter for dc-to-ac power conversion or a buck-type rectifier for ac-to-dc power conversion. In particular, for some distributed energy system such as photovoltaic modules and fuel cell stacks which usually supply a dc voltage that is lower than the peak grid voltage, the CSC can directly boost the dc voltage to the grid voltage.

Consequently, the CSC features a single-stage structure that converts dc power into grid-connected ac power and at the same time injects three controllable sinusoidal currents into the grid. Since the dc-link current in the CSC is maintained almost constant, one summarized constraint for the switches must be met, i.e., only one top/bottom switch must be closed at any time. This means that the incoming switch should be turned on before the outgoing switch is turned off, and hence, overlapping periods are necessary to ensure that there is a path for the dc-link current during commutations or, else, overvoltage spikes across two commutating switches will take place. However, overlapping periods will bring on some bad effects such as reduced line currents, increased harmonics, etc. In particular, with overlapping periods increased, their effects will become more serious.

Until now, several modulating strategies have been presented for the CSC, such as selective harmonic elimination pulse width modulation (PWM), carrier-based sinusoidal PWM (also called as conventional SPWM), space-vector PWM, and so on. However, few of them have technically addressed the issues about current commutations.

The natural soft commutation occurs in the instance that, during the commutation process, the incoming switch has a positive collector-to-emitter voltage while the outgoing switch has a negative collector-to-emitter voltage. Based on this understanding, a natural soft-commutation PWM scheme is developed also referred to as twelve-step direct PWM (TS-DPWM) scheme in this study. With the TS-DPWM, most switching transitions in the CSC can achieve natural soft commutations without using any additional resonant snubbers. The application of nonlinear loads can lead to distribution system harmonic pollutions.

To overcome distribution system harmonic issues, a number of active power filtering methods have been developed. At the same time, renewable energy source (RES)-based distributed generation (DG) units are increasingly integrated into the power distribution system, and the power electronics converters with *LCL* filters are employed as efficient interfaces between RESs and the grid.

As the interfacing converters normally have much higher control bandwidth compared to distributed synchronous generators, they can also actively regulate the distribution system power quality without using any additional harmonic filtering equipment**.** For instance, the robust current control scheme effectively mitigates resonances in the grid-tied converters. In addition, the robust hysteresis controller realizes rapid selective harmonic compensation with reduced computational load in the inverter controller. Considering that CCM may have difficulties when DG units switch to autonomous islanding operation, VCM has been considered as an attractive solution for dual-mode (grid-connected mode and islanding mode) micro-grid applications. In addition, the combination of DG virtual impedance shaping and droop control (real power–frequency droop and reactive power–voltage magnitude droop) further ensures an enhanced islanding micro-grid load sharing without using any communication links between DG units.

EXISTING SYSTEM:

Wind power conversion systems are a widespread renewable energy source and, as such, have been studied intensely over the past two decades. Wind energy conversion system is connected to the electrical grid through a power converter, an LC filter and a step-up transformer. It is necessary to know the efficiency of the whole energy transfer system and to know the efficiencies of each individual part of that system, i.e. converter, filter and transformer efficiencies, in order to achieve a high-efficiency energy conversion system

PROPOSED SYSTEM

A method to reduce the dc-link current ripples based on the steady-state current balancing control by proper selection of the redundant switching states of small vectors and optimized switching sequence.

CONCLUSION:

Balanced dc-link, currents with low ripples are essential for the operation of direct parallel CSCs. This paper presents a clear explanation of the generation mechanism of unbalanced dc-link currents.

A method to balance the dc-link currents in steady state is proposed by proper selection of the redundant switching states. The reduction of current ripple is based on the dc-link current balancing in steady state.

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