Generic Control Method of Multileg Voltage-Source-Converters for Fast Practical Implementation

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***Abstract*—A generic and simple control method is suggested for any multileg voltage-source-converter. A specific coding yields an inversion table allowing a fast practical implementation. Phase-to-phase voltage references have to be defined for such a table. This original control strategy is validated by experimental results for two-leg, three-leg, four-leg, and five-leg structures supplying balanced and unbalanced multiphase loads.**

***Index Terms*—DC–AC converters, digital control, multileg converter, PWM.**

I. Introduction

In the last few decades numerous works have been developed to optimize the control of voltage-source-inverters (VSI) [1]–[4]: third harmonic injection, space vector strategy, flat-top modulation… Most of these inverters are three-leg structures for supplying ac machines. Indeed, these drives are more and more used in industrial applications thanks to dynamic machine controls [5].

But other inverter structures are now being studied: four-leg inverters for three-phase four-wire systems [6], [7], four-leg inverters feeding two induction machines [8], [9], five-leg inverters for a two-induction machine drive [10], [11] and for 5-phase reluctance machines [12], [13]… Studies of multi-machine multiconverter systems are also being developed for other original solutions [14]. Moreover, power converter manufacturers take a great interest for practical implementations, which make fast modifications possible for fault operating structures. Polyphase ac machines, which need multileg supplies [15]–[17], nowadays have an increasing interest for their reliability. For each of these nonclassical structures, specific and complex controls have been developed.

A global control method has already been presented for three-leg, four-leg and five-leg voltage-source-inverters [18]. Only simulation results were provided for open loop operating. Moreover the practical implementation of such a strategy has not often been discussed.

In this paper, this generic and simple control method is extended to be applied to any multileg voltage-source-converter with closed-loop current controls. It can be used to supply balanced and unbalanced loads. The aim of this new control technique is to have a generic algorithm, which can be rapidly implemented and easily modified if the inverter topology changes. Experimental results for different structures validate this practical implementation of the multileg converter control.

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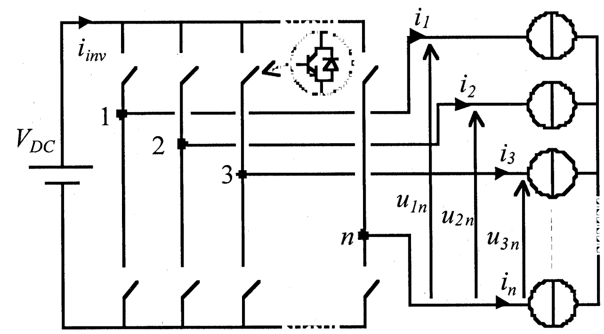

Fig. 1. Structure of the multileg VSI.

II. Modeling of a Multileg Converter

A. Structure of the Studied Power Converter

The studied converter links a dc voltage source V_{dc} to n ac current sources $i_1 \dots i_n$. (Fig. 1). It is composed of n legs of two power switches, which are assumed to be turn-on and turn-off controlled. As they connect a dc voltage source with ac current sources, each switch is made of a parallel diode-transistor association.

Because the leg no. n is arbitrarily chosen as potential reference, the converter leads to $n-1$ modulated phase-to-phase voltages $u_{1n} \dots u_{(n-1)n}$ between the current-sources. The inverter yields a modulated current i_{inv} to the dc voltage-source.

As this inverter structure is reversible, this control method can also be applied to multileg current source rectifiers.

B. Power Converter Modeling

A switching function, s_{ij} is defined for each power switch. This function represents the ideal switching order and takes the values 1 when the switch is closed and 0 when it is opened

$$s_{ij} \in \{0,1\} \tag{1}$$

with

$$\begin{cases} i \in \{1,\dots,n\} \text{ no. of the leg} \\ j \in \{1,2\} \text{no. of the switch in the leg.} \end{cases}$$

Because ideal power switches are considered, the switches of a same leg are in complementary states

$$s_{i1} + s_{i2} = 1 \quad \forall\, i \in \{1,\dots,n\}. \tag{2}$$

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