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A Review on Modular Cascade Inverter Techniques for an Induction Motor with Speed Sensorless Start-Up Method

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Abstract: *A modular multilevel cascade inverter based on double star chopper cells (MMCI-DSCC) has been expected as one of the next generation medium voltage multilevel pulse width modulation (PWM) inverters for such motor drives. For the sake of simplicity, the MMCI-DSCC is referred to as the "DSCC" in this paper. Each leg of the DSCC consists of two positive and negative arms and a center tapped inductor sitting between the two arms. Each arm consists of multiple bidirectional dc/dc choppers called as "chopper cells." The low voltage sides of the chopper cells are connected in cascade, while the electrically floating high-voltage sides of chopper cells are equipped with a dc capacitor and a voltage sensor. A synergy effect of lower voltage steps and phase shifted PWM leads to lower harmonic voltage and current, as well as lower EMI emission, as the count of cascaded chopper cells per leg increases. The power conversion circuit of the DSCC is so flexible in design that any count of cascaded chopper cells is theoretically possible.*

When a DSCC is applied to an ac motor drive, the DSCC would suffer from ac voltage fluctuations in the dc capacitor voltages of each chopper cell in a low speed range, because the ac voltage fluctuation gets more serious as a stator current frequency gets lower. Hence, the fluctuation should be attenuated satisfactorily to achieve stable low speed and start up performance. Several papers have exclusively discussed startup methods for DSCC based induction motor drives.

Keywords: *Medium voltage induction motor drives, minimal stator current, modular multilevel cascade inverters, speed sensorless startup method.*

1. INTRODUCTION

This paper presents theoretical and experimental discussions on a practical speed sensorless startup method for an induction motor driven by a modular multilevel cascade inverter based on double star chopper cells (MMCI-DSCC) from standstill to middle speed. This motor drive is suitable, particularly for a large capacity fan or blower like load. The load torque is proportional to a square of the motor mechanical speed. The start-up method is characterized by combining capacitor-voltage control with motor-speed control. The motor-speed control with the minimal stator current plays a crucial role in eliminating a speed sensor from the drive system and in reducing an ac voltage fluctuation occurring across each dc capacitor. The simulation results obtained from the 400V 15kW downscaled system with no speed sensor verify that the motor speed control proposed for the DSCC based drive system can enhance the start up torque by a factor of three under the same ac voltage fluctuation. Several start up waveforms show stable performance from standstill to middle speed with different load torques.

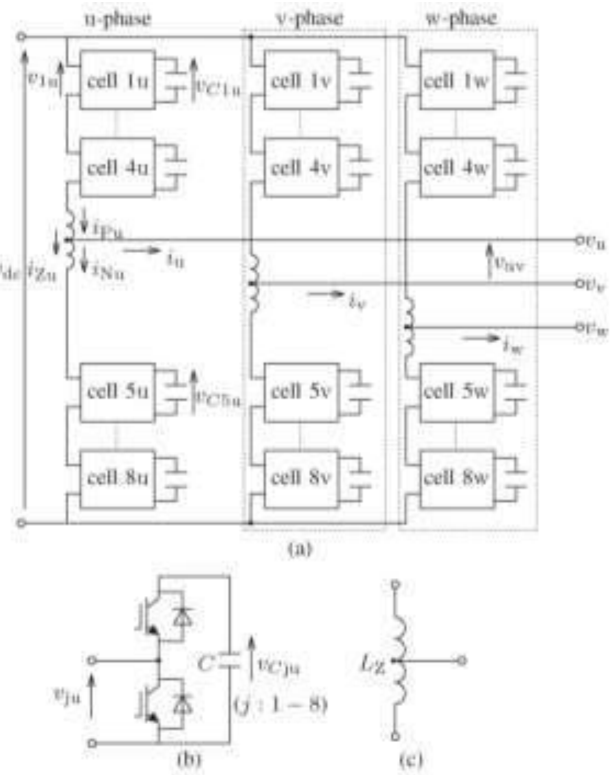

Figure 1: *circuit configuration*

2. LITERATURE SURVEY

Device using A modular multilevel cascade inverter based on double star chopper cells (MMCI - DSCC).This technique would used to maintain the magnetizing current of Induction Motor. The following is some of the prospective. A modular multilevel cascade inverter technique schemes reported recently.

M. Hagiwara, I. Hasegawa, and H. Akagi[1], propose Startup and low speed operation of an adjustable speed motor driven Other start up methods from standstill were discussed for DSCC driven induction motors, where each of the motors was equipped with a speed sensor by a modular multilevel cascade inverter (MMCI). The fluctuation should be attenuated satisfactorily to achieve stable low speed and start up performance. Several papers have exclusively discussed startup methods for DSCC based induction motor drives. The individual ac components included in the three phase circulating currents cancel each other out, so that no ac component appears in either motor current or dc link current

A. Lesnicar and R. Marquardt[2], propose The power conversion circuit of the DSCC is so flexible in design that any count of cascaded chopper cells is theoretically possible.

M. Hagiwara and H. Akagi[3], propose When a DSCC is applied to an ac motor drive, the DSCC would suffer from ac voltage fluctuations in the dc capacitor voltages of each chopper cell in a low-speed range, because the ac voltage fluctuation gets more serious as a stator current frequency gets lower

M. Hagiwara, K. Nishimura, and H. Akagi[4], proposed a simple start up method with no speed sensor, in which a DSCC continued to be operated at an appropriate constant frequency.

A. Antonopoulos, L. Angquist, S. Norrga, K. Llves, and H. P. Nee[5], propose Modular multilevel converter ac motor drives with constant torque from zero to nominal speed and start-up methods from standstill were discussed for DSCC-driven induction motors, where each of the motors was equipped with a speed sensor

B. J. Korn, M. Winkelnkemper, and P. Steimer[6], Low output frequency operation of the modular multilevel converter, A serious ac-voltage fluctuation in a low-speed range can be mitigated by injecting a common-mode voltage and superimposing a circulating current on each leg of the DSCC.

Following table shows the work done by related authors along with respective years:

Author	Proposed Work	Year
M.Hagiwara, I.Hasegawa, and H. Akagi	Propose Startup and low speed operation of an adjustable speed motor driven Other start up methods from standstill.	2013
A. Lesnicar and R. Marquard	Propose the power conversion circuit of the DSCC is so flexible in design.	2003
M. Hagiwara and H. Akagi	Propose When a DSCC is applied to an ac motor drive.	2009
M. Hagiwara, K. Nishimura, and H. Akagi	Proposed a simple start up method with no speed sensor	2010
A. Antonopoulos, L. Angquist, S. Norrga, K. Llves.	Propose Modular multilevel converter ac motor drives	2012
A. J. Korn, M. Winkelnkemper, and P. Steimer	Low output frequency operation of the modular multilevel convert	2010

3. ANALYSIS OF PROBLEM

In analysis the fluctuation should be attenuated satisfactorily to achieve stable low speed and start up performance. And start up torque is enhanced by a factor of three, without additional stress on arm currents and dc capacitor voltages. This paper employs two kinds of existing capacitor voltage control techniques for regulating the mean dc voltage of each dc capacitor and for mitigating the ac voltage fluctuation at the stator-current frequency. The slip frequency control can provide a faster torque response than the *V/f* control because of the existence of a feedback control for the motor mechanical speed. An over current protection for each chopper cell has been implemented, in which the DSCC is disconnected from the ac mains.

4. CONCLUSION

This paper will propose a practical start up method for a DSCC driven induction motor with no speed sensor from standstill to middle speed. This start up method is characterized by combining capacitor voltage control and motor speed control. The motor speed control with the minimal stator current under a load torque is based on the combination of feedback control of the three phase stator currents with feed forward control of their amplitude and frequency. The arm current amplitudes and ac voltage fluctuations across each of the dc capacitors can be reduced to acceptable levels.

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