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Review Paper on a Dynamic Performance of Variable-Speed Drives with Modular Multilevel Converter

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Abstract- The main objective of this paper control scheme for the modular multilevel converter (MMC) to drive a variable-speed ac machine, especially improving dynamic performance. Theoretically, the energy balance in the MMC cell capacitors is unstable at start-up and low-frequency operations.hence the MMC topology requires advanced control strategies to balance energy and suppress the voltage pulsation of each cell capacitor. This paper proposes a control strategy for the robust dynamic response of MMC even at zero output frequency employing leg offset voltage injection. The leg offset voltage for balancing the arm energy is produced by direct calculation without the circulating current control loop controller. Thanks to the highly dynamic leg offset voltage from direct calculation and not conventional circulating current controller, the dynamic performance of an MMC at low speeds has conspicuously improved. The ac machine has been driven from stand still to rated speed without excessive cell capacitor voltage ripples utilizing this proposed strategy.

Index terms- *arm energy balancing, dynamic performance, motor drive, modular multilevel converter,*

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I. INTRODUCTION

A Modular Multilevel Converter (MMC) is one Of promising topologies in high power conversion system Without bulky reactive components such as line-transformer, harmonic filter, and DC link reactor. the MMC has modular structure which is made up of identical converter cells. Therefore, it has advantages easy adaptation to higher voltage level, easy maintenance and assembly, and fault tolerance. Due to these merits of the MMC, the researches applying MMC to HVDC system have been widely carried out and MMC has been used for high voltage DC transmission system . Theoretically, the voltage pulsation of the capacitor of each cell is proportional to output phase current and inversely proportional to operating frequency. So, it is inherently difficult to drive AC machine by MMC, that requires a starting torque and low speed steady state operation. In the recent studies, however, several control schemes of MMC have been introduced for variable speed AC motor drive application.

Fig. 1 shows the circuit configuration of an MMC. This topology needs to be controlled by extra balancing strategies. As shown in Fig. 1, since the upper and lower arm currents flow through cells in each arm, the corresponding arm currents cause fundamental periodic pulsations of cell capacitor voltages. The voltage pulsation of each cell's capacitor is mostly affected by the output phase current and output frequency. Theoretically, the magnitude of the cell voltage fluctuation is proportional to magnitude of the output phase current and inversely proportional to operating frequency. For this reason, special effort is demanded to drive the ac machine through MMC, which requires considerable starting torque and low-speed steady state operation. In recent studies and , the principles and algorithms for ac motor drives with the MMC have been introduced. However, they did not address the actual control strategies, such as changing output frequency, including standstill and covering load torque disturbance.

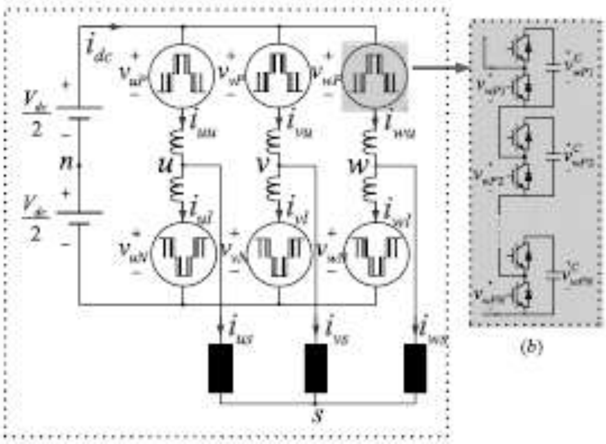

Fig. 1.Circuit configuration of the MMC.

The main issues of an MMC system is energy balancing. The energy balancing controls of an MMC that uses circulating current control and modulation scheme have been introduced. To improve the balancing performance by increasing bandwidth of the balancing controller.

II. LITRATURE REVIEW

[1]M. Hagiwara, I. Hasegawa, and H. Akagi - This paper describes startup and low-speed operation of an electric motor driven by a modular multilevel cascade inverter based on double-star chopper-cells (MMCIDSCC). This paper proposes a square-wave method to suppress the peak circulating current. Theoretical analysis developed in this paper reveals that the peak circulating current when using the square-wave method gets smaller by 50% than that when using the sinusoidal-wave method proposed in the previous work. Experimental results obtained from a 400-V 15-kW downscaled system verify that stable operation is achieved at an ultra-low speed of 17 min□1 with a load torque of L = 40%, as well as "three-phase" dc-current feeding operation. Moreover, the motor can start up from a standstill without producing any overvoltage or overcurrent.

[2]A. Antonopoulos, L. Angquist, S. Norrga, K. Ilves- Modular multilevel converters (M2Cs) are shown to have a great potential in the area of medium-voltage drives. Low-distortion output quantities, combined with low average switching frequencies for the semiconductor devices create the ideal combination for high-efficiency drives, both from an electric motor and an inverter point of view. In this paper, principles for converter operation with high torque in the whole speed range, from standstill to rated speed will be investigated. The converter-control method utilizes estimation of the capacitor voltage variation, based on equations describing steady-state conditions. Experimental results from a down-scaled 12 kVA prototype converter running a loaded motor from zero up to the rated speed are provided in the paper.

[3]J.-J. Jung, H.-J. Lee, and S.-K. Sul- This paper presents a control strategy of the entire frequency range operation for Modular Multilevel Converter (MMC), especially focusing on variable speed drive of an AC machine. The structure of MMC essentially requires energy balancing control so as to mitigate the voltage pulsation of each cell capacitor in converter arms. In the proposed control strategy, two operation modes are employed. One is a low frequency operation mode for start-up and low speed operation of the AC machine, and the other is a normal frequency operation mode from medium to rated speed of the AC machine. To reduce the pulsation, this paper proposes the energy balancing control strategies at each operation mode.. With the proposed control scheme, the speed control range of the AC machine driven by MMC can be down to zero speed without instability of voltage of the cell capacitors. Experimental results for the energy balancing control are shown to demonstrate the effectiveness of the proposed control strategy.

III. PROPOSED METHODOLOGY

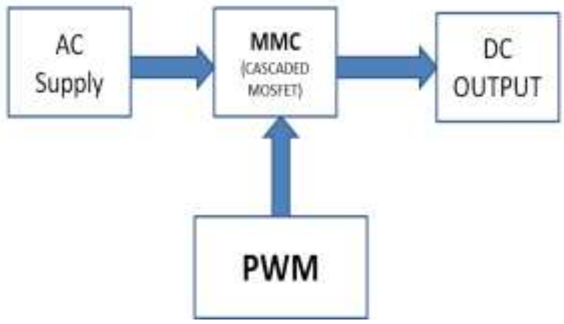

Fig. Proposed Block diagram of MMC

In this diagram three phase AC supply produced from permanent magnet synchronous machine and then cascaded MMC topology convert it into ac supply to dc supply with the help of PWM technic. DC output fed to the inverter.Inverter convert into AC supply and given to the induction motor.

IV. BALANCING CONTROL SCHEME

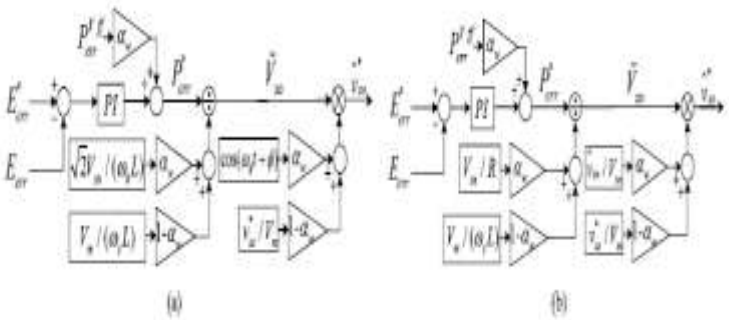

Fig. 2. Proposed control scheme for variable-speed drives. (a) Sinusoidal wave voltage injection method. (b) Square wave voltage injection method

V. OVERALL CONTROL SCHEME FOR VARIABLE SPEED DRIVES

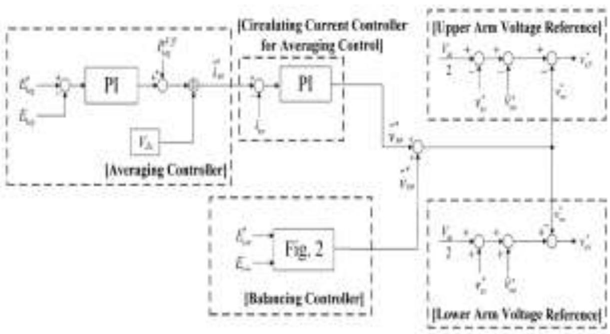

Fig. 4.Proposed overall control scheme for variable-speed drives.

Fig. 4 shows the overall controller for the entire frequency operation from standstill to normal frequency mode. First, the averaging controller carries out regulating the leg power, which is the difference between dc-link input power and ac output power. As shown in Fig. 4, the balancing controller directly makes the leg offset voltage without the circulating current controller to eliminate the energy difference between upper and lower arms. By reason of this fact, the balancing controller has a wider bandwidth, and can achieve a better transient response compared with the control scheme based on the inner circulating current regulation loop.

VI. CONCLUSION

Control strategy for variable-speed ac motor drives based on MMC has been presented. To overcome the difficulties of the power balance between cells and arms of MMC over wide operation speed ranges, a direct leg offset voltage injection method has been devised. Based on the simulation , it can be noted that the control performance of the upper and lower arm energy ripple by the proposed leg offset voltage injection method is better than that by the conventional circulating current injection method withthe inner loop. In addition, the variable speed ac motor drive has been proven to work based on the switchover tactic by testing the overall speed including standstill

REFERENCES

[1] Jae-jung ,hak-jun Lee and seung-ki sul "Control strategy for improved dynamic performance of variable speed drives with modular multilevel converter"in IEEE journal of selected topic in power electronics,VOL.03 NO. 2, june 2015

[2] M. Hagiwara, I. Hasegawa, and H. Akagi, "Start-up and low-speed operation of an electric motor driven by a modular multilevel cascade inverter," IEEE Trans. Ind. Appl., vol. 49, no. 4, pp. 1556–1565, Jul./Aug. 2013.

[3] A. Antonopoulos, L. Angquist, S. Norrga, K. Ilves, and H.-P. Nee, "Modular multilevel converter AC motor drives with constant torque form zero to nominal speed," in Proc. IEEE ECCE, Sep. 2012, pp. 739–746..

[4] D. Peftitsis, G. Tolstoy, A. Antonopoulos, J. Rabkowski, J.-K. Lim, M. Bakowski, L. A¨ ngquist, and H.-P. Nee, "High-power modular multilevel converters with SiC JFETs," in Proc. IEEE Energy Convers. Congr. Expo., Sep. 2010.

[5] M. Hiller, D. Krug, R. Sommer, and S. Rohner, "A new highly modular medium voltage converter topology for industrial drive applications," in Proc. Eur. Conf. Power Electron. Appl., Sep. 2009.

[6] A. Antonopoulos, K. Ilves, L. A¨ ngquist, and H.-P. Nee, "On interaction between internal converter dynamics and current control of high performance high-power ac motor drives with modular multilevel converters," in Proc. IEEE Energy Convers. Congr.Expo., Sep. 2010.

[7] M. Hagiwara, K. Nishimura, and H. Akagi, "A medium-voltage motor drive with a modular multilevel PWMinverter," IEEE Trans. Power Electron., vol. 25, no. 7, pp. 1786–1799, Jul. 2010.

[8] A. J. Korn, M. Winkelnkemper, and P. Steimer, "Low output frequency operation of the modular multi-level converter," in Proc. IEEE Energy Convers. Congr.Expo., Sep. 2010.

[9] M.Winkelnkemper, A. Korn, and P. Steimer, "A modular direct converter fortransformerless rail interties," in Proc. IEEE Int. Ind. Electron. Symp., Jul. 2010.

[10] L. A¨ ngquist, A. Haider, H.-P. Nee, and H. Jiang, "Open-loop approach to control a modular multilevel frequency converter," in Proc. Eur. Conf. Power Electron. Appl., Aug./Sep. 2011.