Elimination of the DC Bus Sixth Harmonic Component in Integrated Modular Motor Drives Using Third Harmonic Injection Method

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***Abstract*—In this paper, a novel method to eliminate the harmonic component occurring on the DC bus which is six times the grid frequency is proposed. This harmonic component is present due to natural commutation of the passive diode bridge rectifier in motor drive applications. In conventional drives, bulky LC filters are utilized to reduce the effect of this harmonic component to the motor drive inverter. With this method, DC bus capacitance requirement can be minimized which will enhance the power density and decrease the cost of the overall system. Third harmonic injection is used with modular inverters in an integrated modular motor drive application. Both rectifier and inverter side analytical models are presented, the elimination of the sixth harmonic component is described analytically, and verified by simulations performed on MATLAB/Simulink. The possible adverse effects of third harmonic injection method are also discussed.**

I. Introduction

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II. Analytical Model of the Rectifier

Rectifier model, 6th harmonic component injection, LC filter characteristics

A conventional motor drive application block diagram is shown in Fig. 1. The DC link decouples the inverter and rectifier such that, its characteristics is effected from both sides. Most studies consider only one side for DC link characterisation or filter component optimization, although they should be considered simultaneously. This research aims at modeling the system as a whole, investigating the effect of harmonic components injected to the DC link from both sides and eliminating the low frequency harmonic due to the rectifier side by using the modular structure of the inverter side.

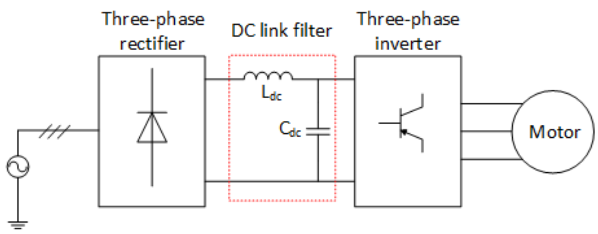

Fig. 1: A conventional motor drive block diagram

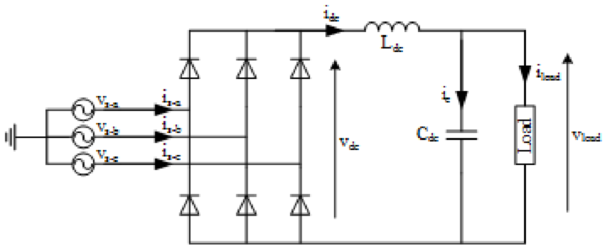

Fig. 2: Diode bridge rectifier circuit diagram

Diode bridge rectifier is a natural-commutated converter, circuit schematic of which is shown in Fig. 2.

A set of voltage and current waveforms are also shown in Fig. 3, for 400V line-to-line grid voltage at 50 Hz, filter inductance of 1 mH, filter capacitance of 3 mF and load resistance of 10 Ω. The three-phase rectifier output voltage and current has large harmonic components frequency of which is six times the grid frequency. This component is filtered by a second order LC filter resulting in a much smoother load voltage and current. Since the harmonic frequency is relatively low in comparison with conventional switching frequencies, large inductance and capacitance values are needed on the DC link filter. Those passive elements constitute a large portion of overall volume and cost, hence it is aimed to minimize their values.

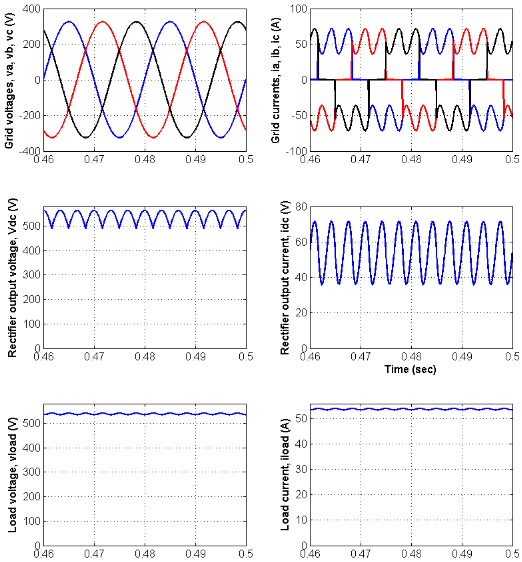

Fig. 3: Diode bridge rectifier input and output waveforms

III. Description of the Proposed Method

Proposed method: Sixth harmonic creation on the DC link with third harmonic injection (analytical)

IV. Implementation of the Method and Practical Issues

New IMMD scheme for third harmonic injection, practical considerations, effects on other components, torque ripple, copper loss etc.

V. Results

Simulation results

VI. Conclusion

The conclusion goes here.

Acknowledgment

The authors would like to thank...

References

[1] H. Kopka and P. W. Daly, *A Guide to LaTeX*, 3rd ed. Harlow, England: Addison-Wesley, 1999.