Conductive EMI Noise Analysis for Switched Reluctance Motor Drive

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Abstract — The paper presents the conductive electromagnetic interference noise measurement of three-phase Switched Reluctance motor drive with the function of separated common-mode noise and differential-mode noise. The EMC filter is adopted to enhance its electromagnetic compatibility capability based on tested the results of CM noise and DM noise.

I. INTRODUCTION

The Switched Reluctance motor drive consists of the reluctance motor, the power converter and the controller has the advantages in firm structure of the motor and the power converter, the high starting torque with the low starting current, the well fault tolerance capability [1]-[7]. The main impediment of the Switched Reluctance drive in applications is the electromagnetic interference. There is metal shell outside the power converter and the controller. The shell of the Switched Reluctance machine is also metal, so that the radiant electromagnetic interference noise can be shielded. The conductive electromagnetic interference noise of the Switched Reluctance drive followed the supplied leads is the main part. The conductive electromagnetic interference noise of Switched Reluctance drive is caused by the no sinusoid supply power from the power converter to the reluctance machine. It can effect the operation of other electrical equipments through the supplied leads. It is important to analyze conductive electromagnetic interference noise of the Switched Reluctance motor drive and enhance its electromagnetic compatibility capability.

II. STRUCTURE OF THE DRIVE SYSTEM

The Switched Reluctance motor drive is a three-phase Switched Reluctance motor drive shown in Fig.1., which is made up of the three-phase 12/8 structure double salient reluctance motor, the three-phase asymmetric bridge power converter and the digital controller.

III. CONDUCTIVE EMI NOISE ANALYSIS

Common-mode (CM) noise and differential-mode (DM) noise can be separated by the discrimination network, which are displayed in the spectrum analyzer. The input of the Switched Reluctance motor drive is connected to the input of the diagnosis system. The schematic of the conductive electromagnetic interference noise measurement equipment is shown in Fig. 2.

The required frequency band of conductive EMI noise test in GB standard is 150KHz to 30MHz so that all the test equipment should meet this frequency requirement. A LISN is placed between the DC power source and the three-phase Switched Reluctance motor drive. The rated output of the drive is 500W, the voltage of the DC power source is 24 V. The inputs of Mini-Circuits power splitter are connected to LISN's RF output V_L and V_N, and its output is linked to a spectrum analyzer.

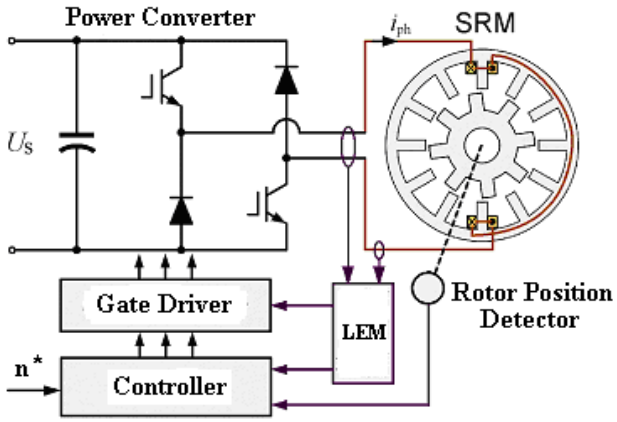


Fig. 1. Sketch diagram of the three-phase 12/8 structure Switched Reluctance motor drive

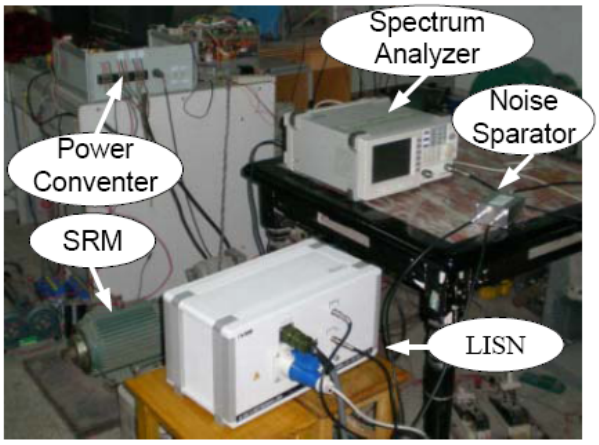


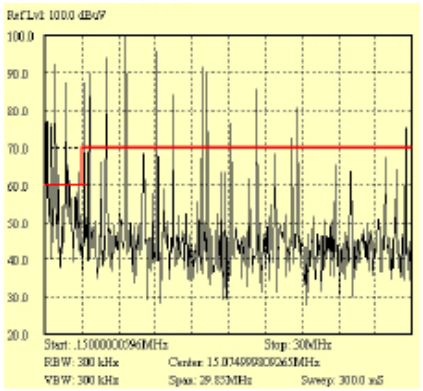
Fig. 2. Photograph of the conductive electromagnetic interference noise measurement equipment with Switched Reluctance motor drive

The CM and DM noise can be derived from the sum and subtraction of the interference voltage in "+" line V_L & the interference voltage in "-" line V_N as follows,

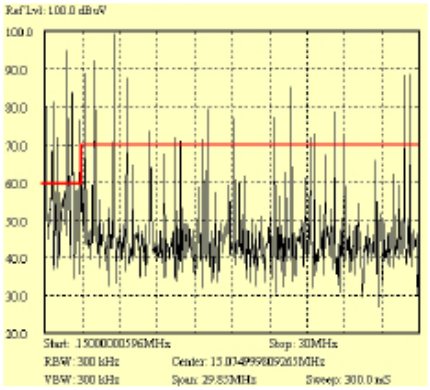
$$|V_{DM}| = \frac{|V_L - V_N|}{2} \quad (1)$$

$$|V_{CM}| = \frac{|V_L + V_N|}{2} \quad (2)$$

The tested CM noise and DM noise are shown in Fig. 3.



a) CM noise



b) DM noise

Fig. 3. Tested CM and DM noise

IV. Effect of EMC Filter

Based on the separated CM noise and DM noise, an EMC filter is designed and applied in the system shown in Fig. 4 . The tested CM noise and DM noise with EMC filter are shown in Fig. 5.

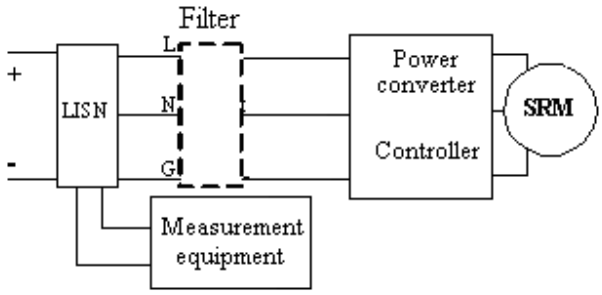
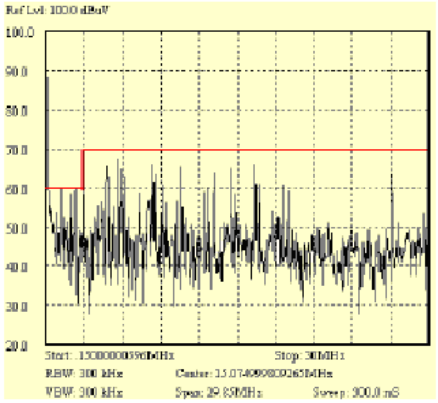


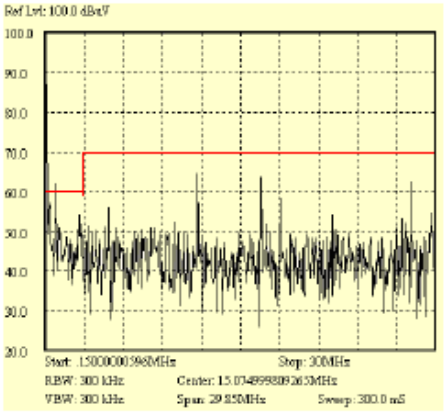
Fig. 4. Schematic of EMI noise analysis system with EMC filter

V. Conclusion

The common-mode noise and differential-mode noise being separated contribute to design the common-mode filter and the differential-mode filter. Conductive electromagnetic interference noise is the main part in the Switched Reluctance motor drive.



a) CM noise



b) DM noise

Fig. 5. Tested CM and DM noise with EMC filter

VI. Acknowledgments

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VII. References

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