SR 컨버터의 분류 및 특성해석

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Classification and Characteristics Analysis of SR Converters

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ABSTRACT

Abstract - This paper reviewed and analyzed converters for SRM drive. SR converter has two parts, front ends and power converter. Since the capacitive front-end is widely used in voltage source converter, this paper focuses on topologies with the front-end. A novel classification of power converters for SR drives based on the commutation type is also introduced and analyzed.

1. Characteristics of SR Converter

One of the key topics for research in SR drives is the converter topology design. The performance of the SR drive is highly affected by the performance and characteristic of the converters. Conventional SRM converters are commercially available, so the phase independence and unipolar current is applied widely in industrial and domestic applications. In the last 30 years, many varieties of converter topologies have been presented[1-4]. Many different topologies have emerged with a reduced number of power switch, faster excitation time, faster demagnetization time, high efficiency, high power factor and high power through continued research.

2. Analysis of Converter

2.1 Classification by SR Converter

One of the well-known classifications of SRM converters only considering the number of power switches and diodes, is introduced[2]. Different from the classification, a novel classification of SRM converters, which focuses on the characteristics of converters, is proposed in this paper.

2.2 SR converter by Commutation

Another switched reluctance drive converter classification was proposed in [4]. The three types in the classification were presented as: extra commutation, half bridge and self commutating. In the extra commutation circuit, the capacitive circuit, the magnetic circuit and dissipative circuit is included.

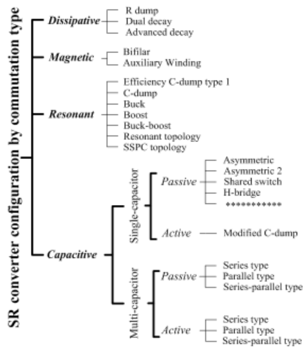
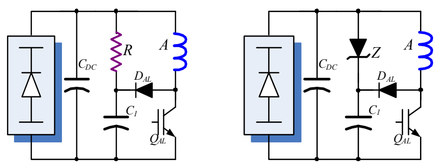


Fig. 1 SR converter by commutation type

2.2.1 Dissipative Converter

The dissipative type of SRM converter dissipates some or all of the stored magnetic energy using a phase resistor or an external resistor or both of them. The remaining energy is transformed to mechanical energy. Therefore, none of the stored magnetic energy in the phase winding is returned to DC-link capacitor or source. The advantage of this type converter is that it is simple, has a low cost and has a low count of semiconductor components.

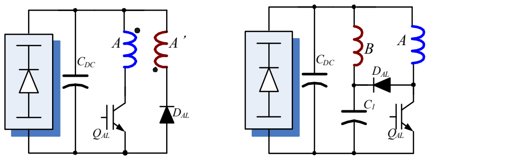


(a) R-dump (b) Zener-dump

Fig. 2 Two types of dissipative SR conveter

2.2.2 Magnetic Conveter

The magnetic type of SR converter is where the stored magnetic energy is transferred to a closely coupled second winding. Of course, that energy could be stored in DC-link capacitor or used to energize the incoming phase for multi-phase motors or use special auxiliary winding. The major advantage of this converter is a simple topology. The one switch per phase power circuit can be used.

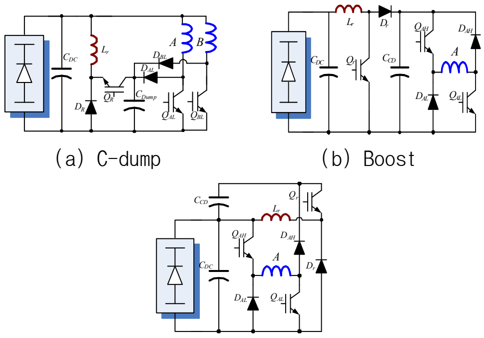


(a) Bifilar (b) Single controllable sw.

Fig. 3 Two types of magnetic SR conveter

2.2.3 Resonant Converter

The resonant type has one or more external inductances for buck or boost or resonant purposes. Conventionally, the inductance, the diode and the power switch are designed as a snubber circuit. So the dump voltage can easily to controlled, and the lower voltage is easy to boost.



(a) C-dump (b) Boost

(c) High demagnetization

Fig.4 Three types of resonant SR converter

2.2.4 Capacitive Converter

The capacitive SR converters are feed the magnetic energy directly back to the boost capacitor or the DC-link capacitor or both of the capacitors. Compared to the dissipative converters, magnetic converters, and resonant converters one component is added in the main circuit.

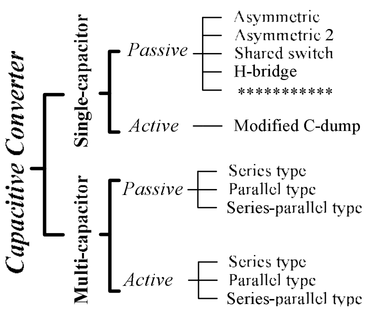


Fig. 5 Classification of capacitive SR converter

1) Single-capacitor Converter

Single capacitor converters have simple structure, which makes them very popular. One capacitive converter has as a simple front-end. This capacitor should be large enough to remove the voltage ripple of the rectifier and store the magnetic energy. Since the DC-link capacitor voltage, during charging and discharging, is uncontrollable, this type of converter is defined as a passive converter.

2) Multi-capacitor Converter

Multi-capacitors SRM converters includes two or more capacitors in the converter topology to obtain boost voltage. Extra capacitors may make the topology of converter more complex. In this paper, different converter topologies, which includes two capacitors are considered.

3. Conclutions

This paper has addressed and analyzed converters for SR drive. Power converters for SR drive can be devided as three parts: the utility interface, the front-end circuit and the SRM converter. Based on overview of conventional SR drive, the most important characteristics of the power converter is determined by the topology with front-end. Since the capacitive front-end is widely used in voltage source converters, this paper focuses on topologies for the front-end. The topology of purely capacitive front-ends in SR drives is classified as either passive front-ends and active front-ends. Also, the concept of a series-parallel connection of two capacitors is described. A novel classification of power converters is introduced based on the commutation type of SR drives.

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References

[1] S. Vukosavic and V.R. Stefanovic, "SR motor inverter topologies: a comparative evaluation", IEEE IAS, pp.946-958, 1990.

[2] T.J.E. Miller, "Electronic control of switched reluctance machines", Newnes, 2001

[3] A. Ayob, V. Pickert, H. Slater, "Overview of low cost converters for single-phase switched reluctance motors", Power Electronics and Applications, European Conference. pp. – 10, 2005.

[4] M. Barnes, and C. Pollock, "Power electronic converters for switched reluctance drives", IEEE Trans. Power Electronics, Vol. 13, Issue 6, pp.1100-1111, 1998.

[5] D.H. Lee, J. Liang, T.H. Kim, J.W. Ahn, "Novel passive boost power converter for SR drive with high demagnetization voltage", International Conference on Electrical Machines and Systems, 2008, pp.3353-3357, 17-20 Oct. 2008.