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Design of a Versatile Half-Bridge Converter Able to Drive 6x6, 6x4, 8x6, 12x8 Switched Reluctance Generators and Motors Using Arduino

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Abstract. This paper presents the studies required for the design and constrution of a versatile Half-Bridge converter. This converter can drive a wide variety of machines – from one to four phases. The converter was designed mainly to drive Variable Reluctance Machines in 6x4, 6x6, 8x6 and 12x8 topologies, working as both motor and generator. The versatility of the proposed converter is its main advantage, as in both academic and industrial applications, this feature can generate financial and production time savings. An analysis was carried out among the main converter topologies to justify the choice of the Half-Bridge topology followed by a project detailing of the chosen converter. For the design and construction of this converter, only commercially available devices were considered. To control the triggering keys, the Arduino platform was used due to its easy access and low cost. After the converter power circuit definition, the circuit for communication between the sensor (encoder), the controller (Arduino), and the switches (IGBT) is presented, and the project assembly is shown at the end.

Keywords. Design, Half-Bridge Converter, Versatility, Switched Reluctance Machine, Arduino.

1. Introduction

The Switched Reluctance Machine (SRM) is an electromechanical energy converter that uses direct current excitation to drive its coils. It consists of a double projecting laminate structure that is constructively simple, cost-effective and robust [1]. It was one of the first electric machines manufactured around 1838 [2]. It presents nonlinear electromagnetic behaviour, torque ripple, and the need for electronic switching [9]. The study of the use of these machines has proven to be advantageous in recent decades due to constant developments in semiconductor technology. Currently, SRM research is focusing primarily on activities that require variable speed. Aeronautics, hybrid cars and wind power are the main areas of interest [3] [4] [10] [11]. One of the main steps for SRM operation is to switch the excitation of its coils correctly. This is done with the converter. In this paper, a generic converter is introduced as a versatile tool for the use of many of the mentioned applications.

1. Choice of Converter Topology

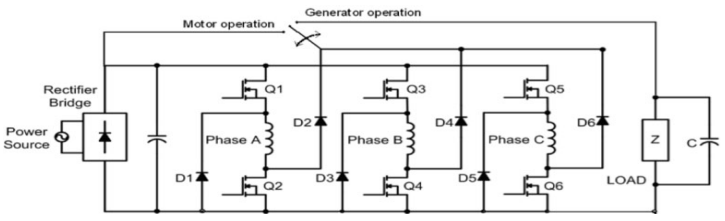

Fig.1. HB Converter with a Key for Switching Between MR and GR [8].

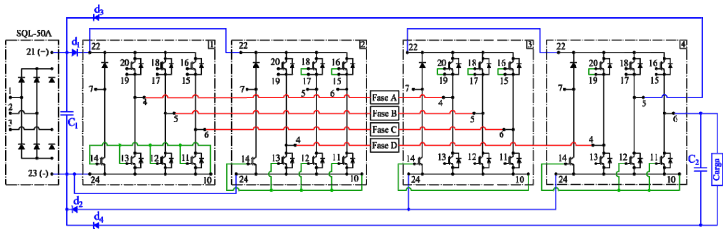

Fig.2. Four-Arm HB Converter General Diagram.

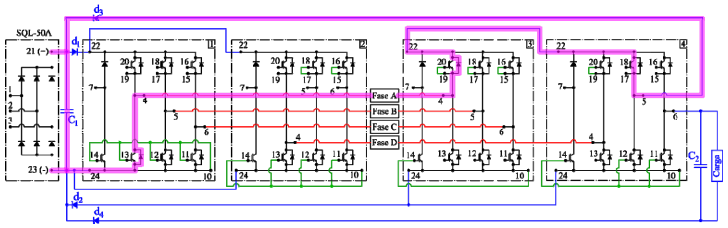

Fig.3. Four-Arm HB Converter General Diagram.

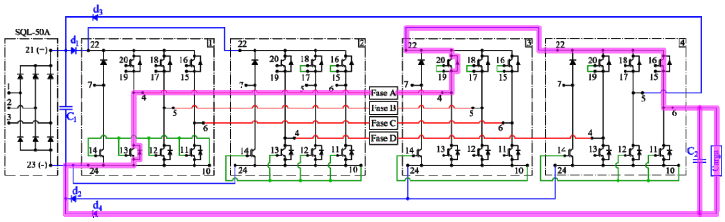

Fig.4. Active Circuit in the Regeneration Step for Reluctance Generator.

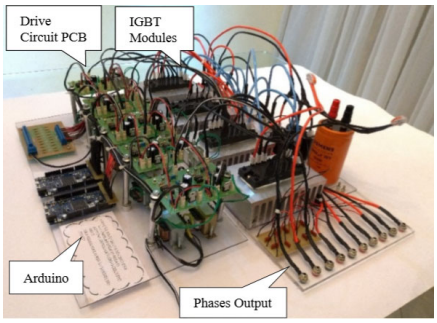

Fig.5. Converter Assembly.

3. Conclusion

Understanding the operation of the designed circuit required analysis on all possible current paths. Through these analyses, have reached the design of the circuits specified in Figures 3 and 4. For the construction, it was observed the voltage and current levels that this converter can be submitted, given the various machines that it can drive, resulting in the built circuit in Figure 5. In addition, its command is executed through the Arduino platform, known for its simplicity and easy access. The built-in converter was tested and is considered ready for operation of the many applications specified. The designed converter opens up countless possibilities: for academic applications, it is very cost-effective, since a single converter allows to drive a wide variety of machines, as well as the study of the control of these machines. For industrial applications, whether in applications such as motor or generator, the converter is robust and has high fault tolerance and can be used in both wind power generation and hybrid car technologies. It is evident, therefore, that the versatility of the converter proposed here is its main feature, as it can drive switched reluctance machines with single-phase or polyphase of up to four phases, both as motor and generator.

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