



Torque Ripple Minimization of 4 Phase 8/6 Switched Reluctance Motor Drive with Direct Instantaneous Torque Control

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Abstract: The switched reluctance motor drives has evolved as an alternative to conventional motors in variable speed drives because of advantages like simple and rugged structure, absence of rotor winding, adaptability to harsh environments like coal mining, high speed operation etc. Because of nonlinearity, torque ripple is high in the motor. This paper presents a high dynamic control technique called Direct Instantaneous Torque Control (DITC) where in the torque is maintained within a hysteresis band by changing the switching states of the phases. Thus torque ripple minimization and fast torque response is an inherent property of DITC. This paper analyses performance of the drive mainly in terms of the torque ripple during acceleration and steady state conditions with DITC in MATLAB/SIMULINK environment and results are discussed elaborately.

1. Introduction

The applications of SRM drive has increased in the recent past because of advantages such as simple mechanical structure, high torque/inertia ratio, adaptable to hazardous environment, high speed operation etc., [1,2]. The main drawback of the motor is that it has highly non linear torque characteristics and high torque ripple, which causes noise and vibrations. Different torque ripple reduction techniques have been proposed in the past. They can be classified as mechanical and electronic techniques. Both the above techniques can minimize the torque ripples considerably, but has the disadvantage of reduction in overall torque [3]. To overcome the above problems a novel technique called Direct Instantaneous Torque Control (DITC) [4-6] is proposed. In this method the converter switches are controlled in such a manner as to ensure that the estimated shaft torque is held at the reference torque within a hysteresis band. During single phase conduction, the state of the phase changes between 1, 0 or -1 depending on the instantaneous torque. During the phase commutation when two phases conduct, the states of the outgoing phase changes between 1, 0 or -1. The states of the incoming changes between 1 and 0 only. A novel fixed frequency DITC which decreases the vibration and torque ripple has been presented in [7]. A 4 level converter based DITC which has fast magnetization and demagnetization is discussed in [8].

This paper presents a modified Direct Instantaneous Torque Control of 4 phase 8/6 SRM in which states of the outgoing and incoming phases changes between 1, 0 or -1 during the phase commutation. This is the contribution of the paper.

2. Principles of DITC

The principle of DITC controller can be explained as follows. First the controller identifies the incoming and the outgoing phases based on the information obtained from the position sensor and on the turn-on and turn-off angles of the converter. Based on the present states of the incoming and outgoing phases, instantaneous torque and reference torque the controller decides the next states of the incoming and outgoing phases to maintain the torque within a hysteresis band. The Asymmetrical converter used to excite the phases of the motor has three possible voltage states. Figure 1(a) shows that when both the switches are turned ON, currents flows through two switches and winding and a positive voltage is impressed across the motor phase winding. The voltage state for the given phase is defined as state 1. When one switch is turned ON and the other switch turned

