A Sliding Mode approach into Constant Switching Frequency Direct Power Control of a Grid Connected Voltage Source Converter

Bechir Bouaziz, Faouzi Bacha, and Moncef Gasmi

Computer lab for industrial systems, National Institute of Applied Sciences and Technology,
Centre Urbain Nord, BP 676, 1080 Tunis Cedex, Tunisia
bechir.bouaziz@gmail.com

Abstract: This paper presents a control method which combines sliding mode approach of direct power control and operates with constant switching frequency. This novel scheme Sliding Mode Constant Switching Frequency Direct Power Control (SM-CSF-DPC) employs a nonlinear sliding mode control (SMC) approach to directly calculate the required converter's control voltage. The constant switching frequency (CSF) is achieved by using space vector modulation (SVM). In this novel scheme, the extra current control loops are eliminated, which simplifies the system design and enhances the transient performance. The improved strategy is tested on a simulation model of a two level VSC and compared with the conventional switching table direct power control (ST-DPC) strategy. The proposed SM-CSF-DPC methods have very good results both in steady-state and transients. It is shown that the proposed DPC exhibits several features, such as a simple algorithm, constant switching frequency, robust to power step change, step change of referenced DC voltage and is capable of providing enhanced transient performance in case of line voltage sags.

Index Terms: Sliding Mode Control; Direct Power Control; Voltage Source Converter; Space vector modulation

1. Introduction

The three-phase pulse width modulation (PWM) voltage source converter (VSC) has become increasingly popular in industrial applications due to its many advantages such as the bidirectional power flow, sinusoidal line current, and adjustable power factor and dc link voltage [1]. With the rapid development of renewable energy and electric power systems, such as the wind and solar power conversion, the power electronics plays a crucial role in the integration for example of the variable-speed wind power into the power system [2],[3].

The power electronic converters are used to match the characteristics of the distributed generators to such grid operation characteristics as frequency, voltage, active and reactive power, power quality, protection. In this sense it should be noticed that the introduction of power converters in a variable speed wind turbine has been mainly associated with the possibility of controlling the powers flows. The voltage source converters (VSCs) are often found in motor drivers, uninterruptible power supplies (UPS), active rectifiers and static compensators (STATCOM). VSCs are regularly used to transfer power from a DC system to an AC system or make back-to-back connection to AC systems with different frequencies such as wind turbines (WTs) and solar generation units [4],[5].

As is well-known, grid-connected voltage source converter based systems are able to control the power flow providing high efficiency and reliability levels. Generally, the control techniques which are commonly used could be classified as direct or indirect control strategies. The indirect control type Voltage Oriented Control is mainly utilized [6]. On the other hand, direct control techniques establish a direct relation between the behavior of the controlled variable and the state of the converter's switches. Direct power control (DPC) was developed for the control of grid-connected voltage-sourced converters, [7], [8].

As the grid-connected VSC is a Variable Structure System, it is a natural candidate for Sliding Mode Control (SMC). The different applications of the sliding-mode control theory

Received: February 5th, 2013. Accepted: March 10th, 2015

DOI: 10.15676/ijeei.2015.7.1.4