Energy Conversion and Management 96 (2015) 473–489

Contents lists available at ScienceDirect

Energy Conversion and Management

journal homepage: www.elsevier.com/locate/enconman

Isolated Wind Power Supply System using Double-fed Induction Generator for remote areas

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ARTICLE INFO

Article history:
Received 27 November 2014
Accepted 28 February 2015
Available online 19 March 2015

Keywords:
Wind Power Supply System
Isolated Double-fed Induction Generator
Rotor-front Voltage Source Converter Control
Voltage and frequency regulation
Load harmonics compensation
Load/stator-front Voltage Source Converter Control

ABSTRACT

This paper examines the application of the Double-fed Induction Generator for an isolated wind power system to supply the remote area. The isolated wind energy system using Double-fed Induction Generator is capable of supplying different loads such as balanced, unbalanced and nonlinear loads. The isolated wind energy supply is designed by using wound rotor induction generator and partial scale back to back connected voltage source converters at rotor side. The voltage source converters are called rotor-front voltage source converter and load/stator-front voltage source converter having the common capacitive direct current link. The presented study investigates the application stator/load side converter for load harmonics mitigation in isolated Double-fed Induction Generator based Wind Power Supply System. The shunt active power filter function is added in the convention control scheme of the load/stator-front voltage source converter to improve load harmonics. The control scheme proposed for stator/load side converter is based on the instantaneous active and reactive component of the load current method. Also a new and simple technique for rotor side converter is presented to regulate Voltage and Frequency at stator/load terminals. Different possible case studies are presented to show the effectiveness of both techniques proposed. Simulation results obtained from a 2 MVA Double-fed Induction Generator based wind power system, prototype in MATLab/Simulink, are given and discussed in this paper.

1. Introduction

Double-fed Induction Generators (DFIGs) have been extensively used in Wind Power Conversion System (WPCS) [1], as the numerous advantages such as reduced power converter rating, operation under variable speed, less losses with improved efficiency, decoupled regulated active and reactive power flow, and economical [2]. At present, the DFIG topology takes nearly 50% of the wind power market [3]. The DFIG based wind energy systems are commercially available in market with power in the range of 1.5–3 MW [4]. Traditionally, the DFIG is associated with the AC utility grid: the stator active and reactive power flow to & from the grid controlled by the Rotor-front Voltage Source Converter (RVSC) while the Grid-front Voltage Source Converter (GVSC) is coordinated with the grid irrespective the direction of power flow. By regulating the RVSC and GVSC, the characteristics of DFIG can be modified in accordance with desired objective. In the past recent years, mainly the operation and control of DFIG based WPCSs have been concerned toward grid-connected applications. The grid connected operation of DFIG based WPCSs are very well known. In [5], a sensorless control technique, based on modified phase locked loop method, was proposed for grid connected DFIG based wind energy system. A complete modeling and control of grid-connected DFIG based WPCS was presented in [6]. Field or stator flux oriented vector control for rotor-front converter was used to decouple control of the active and reactive powers generated by the DFIG. A variable speed WPCS using a wound rotor induction machine (WRIM) was proposed in [7]. Also a comparative study of the variable speed WRIM system with fixed/variable speed SCIG based WPCS, in terms of the main hardware components required, operating region, and energy output, was presented. A detailed modeling and control analysis of grid/power system connected DFIG based WPCS was presented under unbalanced grid/power system conditions in [8]. The positive and negative synchronous (d–q) reference frames

Abbreviations: IDFIG, Isolated Double-fed Induction Generator; DFIG, Double-fed Induction Generator; RVSC, Rotor-front Voltage Source Converter; GVSC, Grid-front Voltage Source Converter; LVSC, Load/stator-front Voltage Source Converter; WPCS, Wind Power/Energy Conversion System; WPSS, Wind Power Supply System; DC, Direct Current.

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http://dx.doi.org/10.1016/j.enconman.2015.02.084
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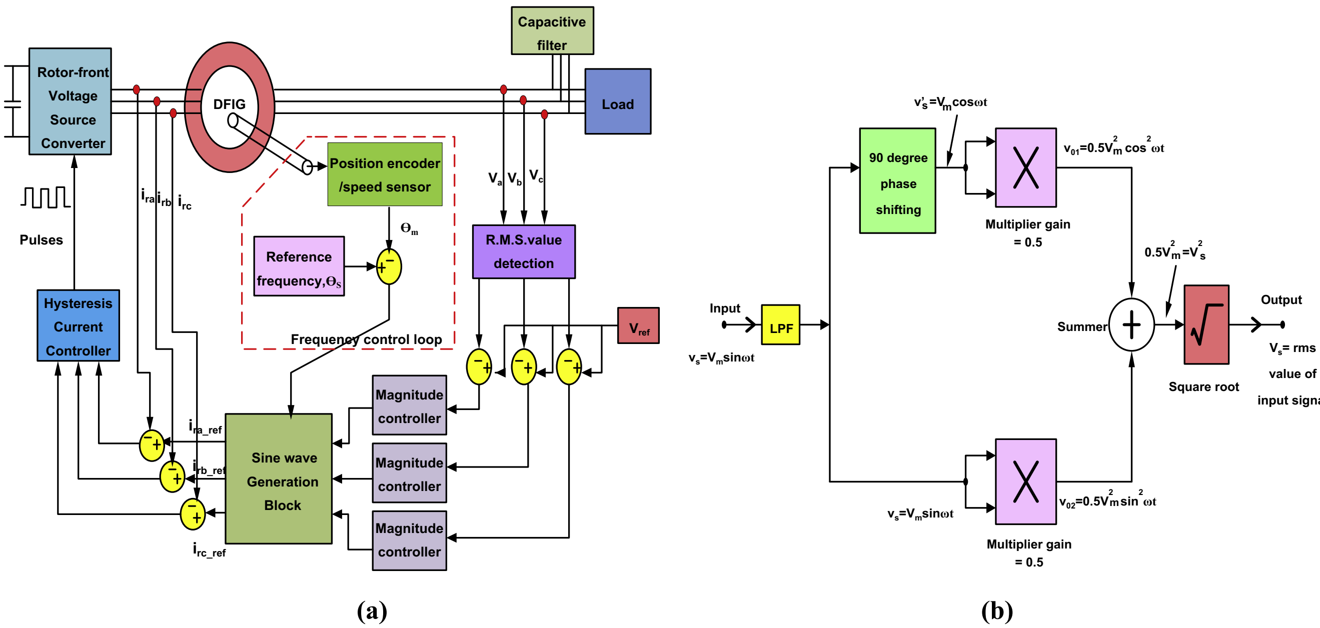

Fig. 1. (a) Proposed control technique via speed-sensor; (b) per phase block diagram R.M.S. detector.

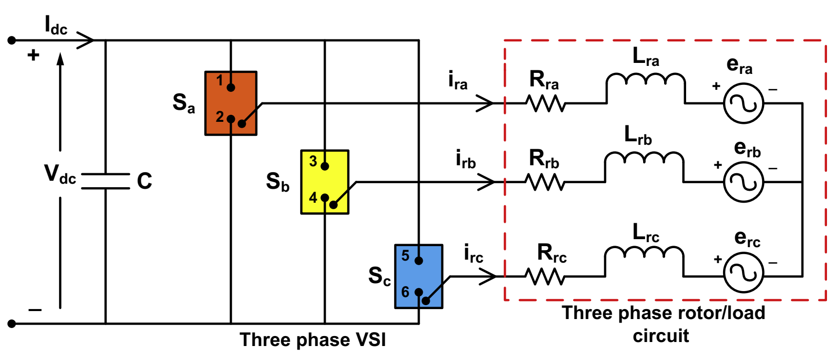

Fig. 2. PWM rotor-front VSC with DFIG rotor as a load.

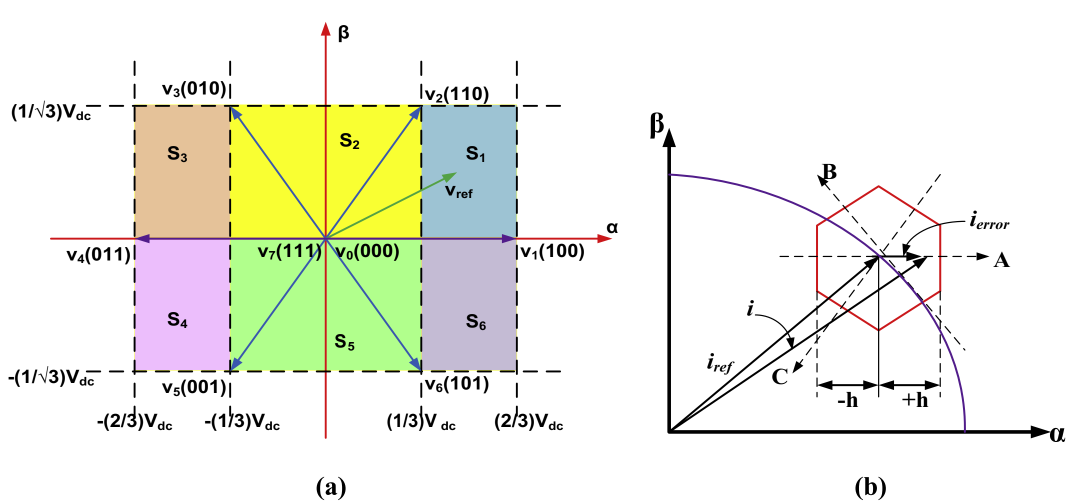

Fig. 3. (a) Block diagram of the switching states; (b) transformation of hysteresis band into hexagonal area in α–β coordinate system.