

University of Macau

Abstract

SHUNT POWER QUALITY COMPENSATOR BASED ON
3-LEG CENTER-SPLIT INVERTER

by Jing Tang

Thesis Supervisor: Professor Han Ying Duo
Co-Supervisor: Man-Chung Wong
Electrical and Electronics Engineering

The shunt power quality compensator is one of the most valid solutions of current quality issues. In the three-phase four-wire systems, 4-leg converter topology and 3-leg center-split converter topology are two main ways of providing a neutral connection. However, in the past researches, almost all the researches are focusing on the 2 dimensional PWM techniques, so the 4-leg converter topology is the most popular structure of the shunt power quality compensator. Very recently, the 3-Dimension PWM techniques are proposed for 3-leg center-split converter. It makes the 3-leg center-split converter can be more valid to be used in three-phase four-wire systems.

In this thesis, the researches are mainly focused on the 3-D PWM techniques in 3-leg center-split inverter as shunt power quality compensator to handling the current quality issues in three-phase four-wire systems. Based on the mathematical models of the 3-leg center-split inverters, the voltage vectors of 2-level, 3-level even multi-level systems in 3D techniques are studied. The main attentions are paid on the 3D Sign Cubical Hysteresis control method. Moreover, due to the knowledge of 3D technique and 3DSCH method, the Double-Band 3DSCH method in 5-level inverter system is proposed in this thesis. It is proved that the 3-leg center-split inverter as the shunt power quality compensator can compensate the harmonic currents, reactive power, unbalance and neutral current in three-phase four-wire systems. Compared with the conventional hysteresis method, the 3DSCH method has the higher performance in compensating zero-sequence current.

However, one of the drawbacks of the 3-leg center-split inverter is the d.c. voltage variation. In this thesis, the d.c. voltage variation is analyzed deeply and a valid control method, which called adaptive zero-shifting 3DSCH method, is proposed. It can handle not only the current quality issues but also control the d.c. voltage variation.

An experimental prototype of the shunt power quality compensator is designed and built. Detailed design steps and criteria including the 3-level 3-leg center-split inverter system structure design, D.S.P. control system design etc. are given. With 3DSCH control method, the experimental prototype has the ability to compensate the harmonic currents, reactive power, unbalance and neutral currents in steady state and dynamic state. The dynamic experiments perform its adaptability of load variance.

Key words: 3DSCH, PWM, shunt power quality compensator, voltage vectors