

**An Adaptive Low DC-Voltage Controlled LC
Coupling Hybrid Active Power Filter in
Three-Phase Four-Wire Power Systems**

by

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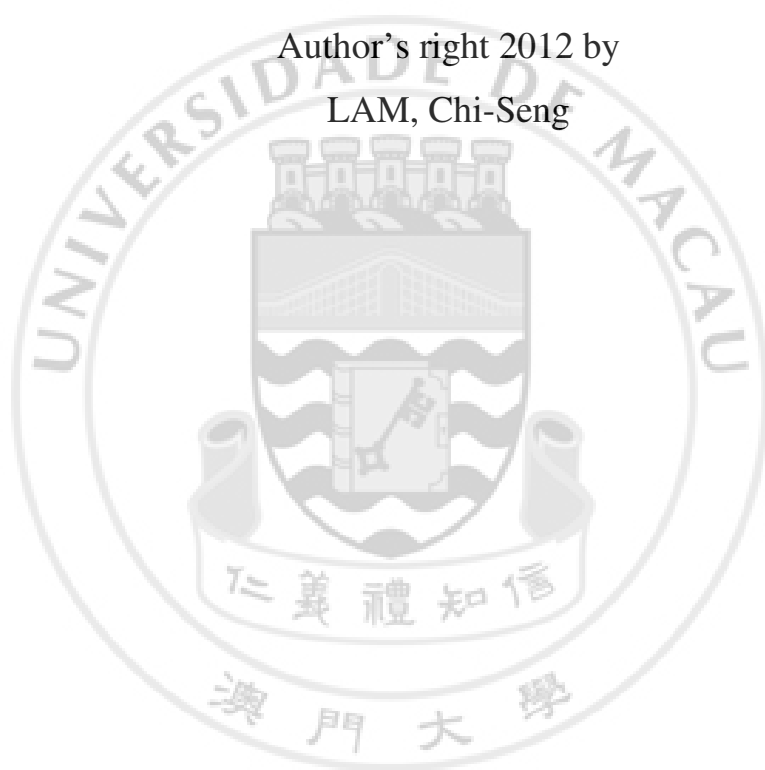
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ABSTRACT

With the increase use of power electronics devices (nonlinear loads) and motor loadings, low-cost low-loss high-performance shunt current quality compensators (SCQCs) are highly demanded by power customers to solve current quality problems caused by those loadings. With the comprehensive consideration of the cost, performance, loss and anti-resonance capability, hybrid active power filter (HAPF) can be applied. Based on HAPF literatures review, a LC coupling HAPF (LC-HAPF) is chosen because it can offer the lowest initial cost, size, weight and has potential to provide dynamic reactive power compensation capability.

However, based on the state-of-the-art LC-HAPF systems recently, the following points have not been investigated and discussed:

- 1) Operation criteria of pulse width modulation (PWM) techniques for LC coupling voltage source inverter (VSI) (i.e. LC-HAPF) has not been studied at this moment, as the existing PWM techniques were traditionally developed based on linear L coupling VSI.
- 2) Existing LC-HAPFs do not provide dynamic reactive power compensation.
- 3) To reduce the LC-HAPF system switching loss, the usual method is to apply soft-switching technique. However, this would increase the system initial cost.
- 4) The minimum inverter rating analysis of the LC-HAPF is lack of study.

In this thesis, the three-phase four-wire LC-HAPF linear operation region requirement under hysteresis PWM control is proposed. Then the LC-HAPF dynamic reactive power control is investigated. To reduce its switching loss and switching noise during dynamic reactive power compensation, a novel adaptive dc-link voltage control scheme is proposed. By adding a tuned coupling neutral inductor, it is possible

to further reduce its minimum dc-link voltage (rating) requirement, so as further reducing switching loss and switching noise. Finally, an adaptive low dc-link voltage 220V-10kVA three-phase four-wire LC-HAPF experimental prototype for dynamic reactive power, current harmonics and neutral current compensation is developed, built and tested, which verified all the analyses and proposed solutions, in which the inverter rating of the LC-HAPF can be reduced by more than 75% of the minimum inverter rating requirement of the active power filter (APF).



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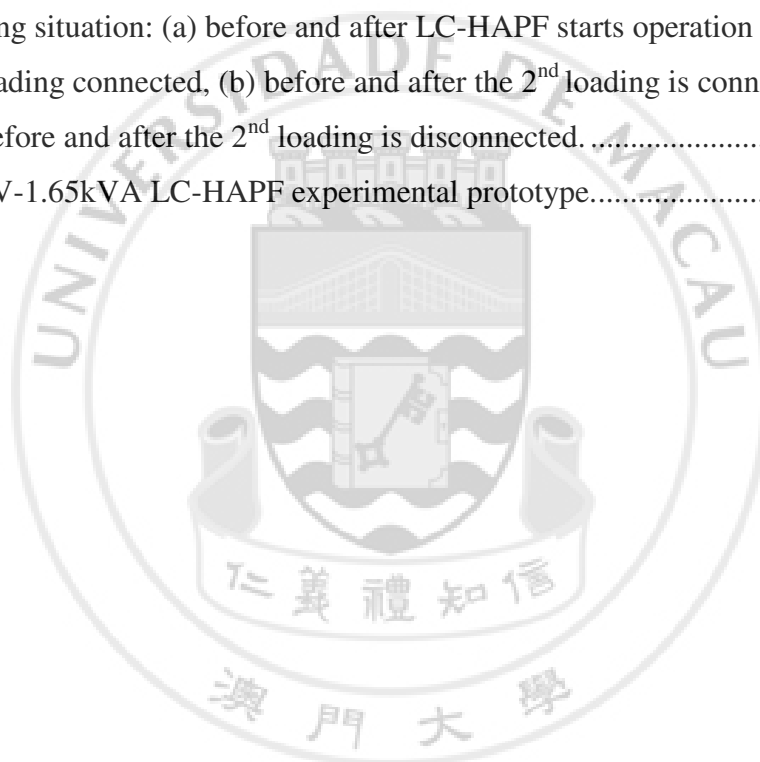
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LIST OF ABBREVIATIONS

A: AMPERES

AC: ALTERNATING CURRENT

A/D: ANALOG-TO-DIGITAL

APF: ACTIVE POWER FILTER

DC: DIRECT CURRENT

DFACTS: DISTRIBUTION FLEXIBLE AC TRANSMISSION SYSTEM

DSP: DIGITAL SIGNAL PROCESSOR

HAPF: HYBRID ACTIVE POWR FILTER

IGBT: INSULATED GATE BIPOLAR TRANSISTOR

IPM: INTELLIGENT POWER MODULE

PCB: PRINTED CIRCUIT BOARD

PPF: PASSIVE POWER FILTER

PWM: PULSE WIDTH MODULATION

STATCOM: STATIC SYNCHRONOUS COMPENSATOR

THD: TOTAL HARMONIC DISTORTION

RMS: ROOT MEAN SQUARE

V: VOLTS

VSI: VOLTAGE SOURCE INVERTER