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A Review Paper on Performance Analysis of Direct Power Control with SVPWM for Shunt Active Power Filter

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Abstract: *We have discussed this paper proposes a combination of direct power control with space vector modulation used in shunt active power filter. For this reason, from the beginning, every effort will be directed towards developing a control strategy that achieves the best results by reducing current THD and power ripple. The approach is based on the replacement of switching table and hysteresis controllers by a vector modulator and PI controllers to ensure operation at a constant switching frequency.*

Keywords: *Shunt Active Power Filter (SAPF), Direct Power Control (DPC), Space Vector Modulation SVM, Total Harmonic Distortion (THD), Fuzzy logic controller.*

1. Introduction

The widespread usage of power electronic devices, especially static power converters, has resulted in a major decrease in electrical power quality during the previous few decades. These electrical devices are referred to as "deforming charges." Non-sinusoidal currents are consumed by non-linear loads such as diode as well as thyristor rectifiers, dimmers, computers as well as their accessories, and air conditioning and lighting systems based on fluorescent tubes. They absorb non-sinusoidal currents, even if they have been supplied by a sinusoidal voltage, and therefore cause harmonic pollution in the electrical distribution networks' voltage and current. [1]
Traditional compensatory methods, such as capacitor banks and passive filters, are one way to deal with this scenario. This technique, unfortunately, has significant drawbacks, such as the possibility of a resonance between the supply network's inductance as well as the capacitor bank's inductance. As a result, other solutions involving different compensating techniques like active power filter have been studied for many years. Active filters have various advantages over conventional compensation techniques, including the ability to adjust to changes in the load, reduce the likelihood of resonance, as well as balance line currents in the case of imbalanced loads. Various strategies for controlling the APF have been given in the literature, the most often utilized of which is the HCC (Hysteresis Current Controller), which is simple and precise. The main disadvantage is that the inverter components must operate at a high switching frequency. Researchers have been focusing on direct power control technique (DPC) in recent years due to its notable characteristics: no internal current loops, good dynamics, & efficiency. [2] This study demonstrates how to use the DPC-SVM command to create a fuzzy logic driven active power filter. The research is done in MatLab/Simulink and tested on a test bench.

1.1 Active Power Filters

Active power filters were created to improve harmonic compensation dynamic management. In this field of harmonic filtering, advancements in solid state switching devices as well as their control mechanisms had a key influence. Active power filters (APF) are classed according to the type of converter and connection utilised in their circuit (i.e. Shunt or Series). As indicated in the diagram shown in figure, APFs can be classed as shunt, series, or hybrid. [3]

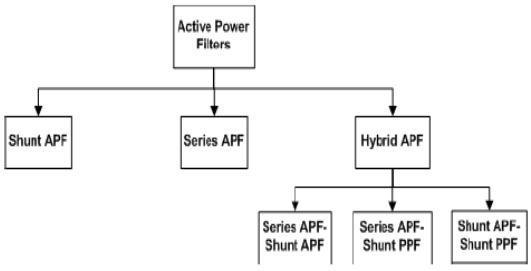

Figure 0 Classification of active power filters configurations

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The generalised block diagram as shown in figure represents a typical APF configuration, comprising components and their interconnections. The reference current estimator receives the transmitted harmonic current in the main line, which is created by the nonlinear load. This pattern uses an appropriate interface to regulate the power circuit. As described in APFs classification, the power circuit in the generalised block diagram can be connected in series or shunt. [4]

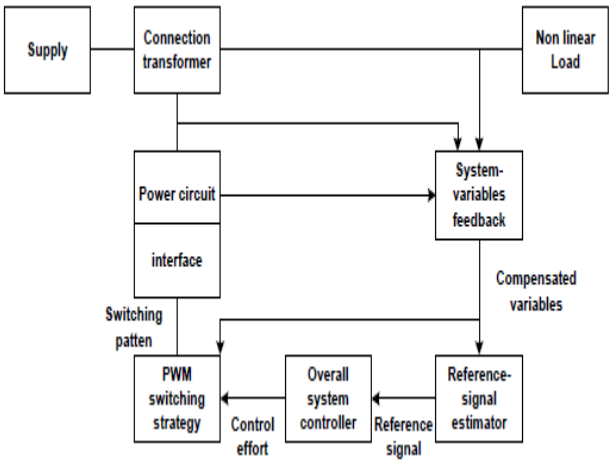

Figure 2 Generalized block diagram for Active Power Filters

1.2 Space vector modulation

Space Vector Modulation (SVM) has become a standard for switching power converters, and much study has been done on the subject. In the previous ten years, research reports as well as patents have been created, and the idea of Space Vector Modulation has been well developed. Various implementation methods were explored, as well as some dedicated computer pieces based on this notion were built. The application of Space Vector Modulation to novel three-phase topologies such as Resonant Three-Phase Converters, AC/DC Voltage Source Converters, AC/AC Matrix Converters, AC/DC or DC/AC Current Source Converters, and so on has broadened the early usage of Space Vector Modulation at three-phase voltage-source inverters. [5]

SVM (space vector modulation) is a pulse width modulation control method (PWM). It's used to make alternating current (AC) waveforms; most typically, it's being used to drive three-phase AC motors at different speeds from DC using multiple class-D amplifiers. SVM comes in a variety of flavours, each with its own set of quality as well as computational needs. The decrease of total harmonic distortion (THD) caused by the rapid switching inherent in these algorithms is one current area of research [6].

2. Methodology

2.1 Fuzzy Logic Controller

The DC side capacitor voltage must be measured and compared to a reference value in order to implement the control algorithm of a shunt active filter. Fuzzy processing has two inputs: error and error change. The control action of a fuzzy controller is determined by a set of linguistic rules. It has the advantage of not requiring a mathematical model and working with erroneous inputs.[7]

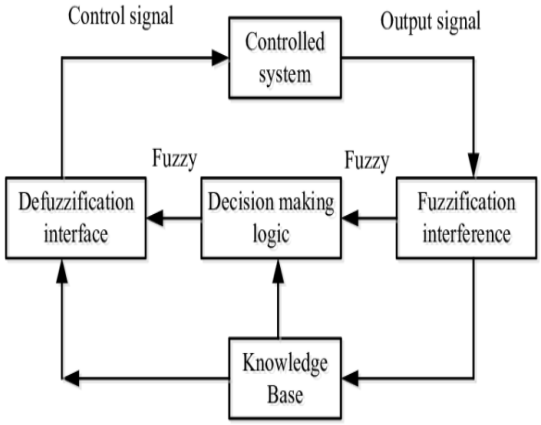

Figure 5 Block diagram of Fuzzy Logic Controller

2.2 Fuzzification

Instead of numerical variables, language variables are used in fuzzy logic control. Positive small (PS), Positive Medium (PM), Positive Big (PB), Negative Small (NS), Negative Medium (NM), Negative Big (NB), as well as Zero are the different types of errors between the reference and output signals (ZE). For fuzzification, a triangular membership function is being used. Fuzzification is the conversion of a numerical variable to a verbal variable. [8-11]

Rule Elevator:

Fuzzy logic uses linguistic variables instead of numerical variables. The fuzzy set rules to control the system are,

Defuzzification:

The resulting output in linguistic variables follows fuzzy logic rules; linguistic variables are translated to crisp values. The choice is between precision and computational power. As a result, the fuzzy control action, i.e. the output inferred from the fuzzy control algorithm, should be defuzzified.

Rule Base:

Rule base stores the linguistic control rules required by rule elevator. The rules used in the controller are shown in below table.

3. Conclusion

In this study, a shunt active power filter was explored and designed for reducing overall harmonic reduction in the source current utilizing PI and Fuzzy logic controller. It has been discovered that a shunt active power filter enhances power quality by removing load current harmonics. When compared to a PI controller, a fuzzy logic controller-based active power filter performs better.

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