Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF A FUZZY LOGIC DC LINK CONTROL FOR ADAPTIVE NOTCH FILTER-BASED ACTIVE POWER FILTER

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Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

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Development of a fuzzy logic DC link control for Adaptive notch filter-based active power filter

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Supervisor Name : TS. Syahrul Hisham bin Mohamad @ Abd Rahman

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DEDICATION

I hereby would like to express my appreciation to my beloved mother and father for encouraging me for completing this project. The services provided by the supervisor "TS. Syahrul Hisham bin Mohamad @ Abd Rahman" also cannot be forgotten for the guidance that he provided for me.

ABSTRACT

Power quality (PQ) is an important matter for electrical power systems, and the system has a problem to get better power quality. Which are transient, overvoltage, Undervoltage, voltage interruption, voltage sags or dips, voltage swells voltage imbalance, and harmonics. This stated problem causes all the performance of power systems to degrade and give a negative impact on both electric utilities and end-users. In this report project, the shunt active power is used to eliminate the harmonics for power quality purposes. The circuit is designed to eliminate the harmonics which have the power filter consisting of DC link capacitor voltage as well as the use of PWM where the calculation of P-Q theory included in it. The PWM is the control strategies for this shunt active power filter to be working where the working principal is that it provides the i ref for the i s and the new signal go to the PWM that connected to the DC Link capacitor voltage that convert DC to AC back with the filtered signal. The fuzzy logic controller is used for this circuit design because it described by controlling the system by the sentences rather than by numbers. The FLC system usually takes the readings of the error and the rate change of error as the inputs and change in the control input signal as the output of the system. Overall, the system will be test under 3-phase system with 415 V and 50 HZ. The objective of this project is to test the functional of fuzzy logic controller on multiple type of load.

ABSTRAK

Kualiti kuasa (PQ) adalah perkara penting untuk sistem kuasa elektrik dan terdapat masalah dalam sistem untuk mendapatkan kualiti kuasa yang lebih baik. Yang bersifat sementara, overvoltage, undervoltage, gangguan voltan, voltan kendur atau penurunan, voltan membengkak ketidakseimbangan voltan dan harmonik. Masalah yang dinyatakan ini menyebabkan semua prestasi sistem kuasa merosot dan memberi kesan negatif kepada kedua-dua utiliti elektrik dan pengguna akhir. Dalam projek laporan ini, kuasa aktif shunt digunakan untuk menghapuskan harmonik untuk tujuan kualiti kuasa. Litar ini direka untuk menghapuskan harmonik yang mempunyai penapis kuasa terdiri daripada voltan kapasitor pautan DC serta penggunaan PWM di mana pengiraan teori P-Q termasuk di dalamnya. PWM ialah strategi kawalan untuk penapis kuasa aktif shunt ini berfungsi di mana prinsip kerjanya ialah ia menyediakan ref i untuk i s isyarat baharu pergi ke PWM yang disambungkan kepada voltan kapasitor Pautan DC yang menukarkan DC kepada AC. kembali dengan isyarat yang ditapis. Pengawal logik kabur digunakan untuk reka bentuk litar ini kerana ia diterangkan dengan mengawal sistem dengan ayat dan bukannya dengan nombor. Sistem FLC biasanya mengambil bacaan ralat dan perubahan kadar ralat sebagai input dan perubahan dalam isyarat input kawalan sebagai output sistem. Secara keseluruhan, sistem akan diuji di bawah sistem 3 fasa dengan 415 V dan 50 HZ. Objektif projek ini adalah untuk menguji kefungsian pengawal logik kabur pada pelbagai jenis beban.

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V	-	Voltage
Ω	-	Ohm
µ	-	micro
m	-	milli
F	-	farad
H	-	henry
S	-	Apparent power
P	-	Real power
T	-	Time
e	-	Error
θ	-	angle

LIST OF ABBREVIATIONS

PWM	-	Pulse-Width modulation
FLC	-	Fuzzy logic controller
MSRF	-	Modified synchronous reference frame
SRF	-	Synchronous reference frame
THD	-	Total harmonic distortion
APF	-	Active power filter
SAPF	-	Shunt active power filter
PCC	-	Point of common coupling
SPWM	-	sinusoidal pulse width modulation
SVPWM	-	space vector pulse width modulation
PLL	-	phase-locked loop
PID	-	Proportional-Integral-Derivative
ANF	-	Adaptive notch filter
VS	-	Voltage source
Ls	-	Voltage drops
DC	-	Direct current
AC	-	Alternative current
PQ	-	Power quality

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CHAPTER 1

INTRODUCTION

1.1 Background

Power quality (PQ) is important matter for electrical power systems and there is a problem in the system to get better power quality. Which is transient, overvoltage, undervoltage, voltage interruption, voltage sags or dips, voltage swells voltage imbalance and harmonics. This stated problem causes all the performance of power system to degrade and give negative impact to both electric utilities and end-users[1]

Harmonics is one of the power qualities issues that has an economic impact on electrical utilities and end-users. Electric utilities must spend a lot of money to buy or develop effective harmonic mitigation solutions because of the significant power loss caused by harmonics. As a result, their profit is reduced. Consumers may have to spend more money to repair or replace damaged devices. As a result, their expenses and daily lives are disrupted. As a result, harmonics have become the focus of this study. This research focuses on the effects of harmonic currents rather than the effects of harmonic voltages. Because the terminal voltage of the point of common coupling (PCC) is kept within the conventional range of voltage sags and harmonic voltages, this is the case[2].

Harmonic impacts in the electrical system are determined by the harmonic source, the power system's location, and network features that facilitate harmonic propagation. The primary cause of harmonic production is the utilization of non-linear loads such as[3]

- An office facility that been use regularly like computers and electronic stuff.
- Discharge lamps.

- Transformer depletion and magnetic currents
- Frequency converter, arc furnaces, welding, and voltage regulator.
- High-capacity semiconductor switching devices like rectifiers and inverters can be the cause of distortion current.

Harmonics cause the voltage and current waveform in the electrical system to be disrupted, which is usually no longer a pure sine waveform. The waveform of the line voltage is normally adequate, but harmonic distortion develops in the line current. In power electronic drives, harmonic distortion in the waveform of the current due to magnetic saturation in the core of the transformer or eddy current or switching action of the thyristor. Each distorted sine wave has its own harmonic. Pure sine wave will only be used for the fundamental components. The following are the harmonic effects[3][4].

- Capacitor bank failure.
- Defects in power line carrier systems can make long-haul switching device operations, load control, and metering less accurate.
- Heat loss in induction and synchronous machinery.
- The current and voltage range of a previous period.
- The induction watt-hour meter has an error.
- In solid state and microprocessor systems, the relay and the interference signal are both broken.

The existence of unwanted harmonic current is mainly the reason why there is a supply current been distorted. Harmonic currents are effectively mitigated using passive filters and shunt active power filters (SAPFs). Based on past research, both filters produce good results in terms of filtering capability, albeit with some limitations. But SAPs have been identified as the most effective and adaptable filters for simultaneously correcting multiple harmonic currents.[4].

1.2 Problem Statement

Under recent development of electrical and electronics, the application of non-linear loads has increases extraordinary. In non-linear loads, power supplies draw current in sudden pulses rather than a smooth sinusoidal wave. It denotes a skewed or abruptly changing answer. Modern electronic/electrical equipment, for example, which includes rectifying, charging/discharging, and phase control circuits.

Electrical power systems are prone to a variety of issues. One of the illnesses is harmonic. Harmonics result from the usage of non-linear loads that cause the sine wave of current or voltage to be inverted, deformed, or contaminated, as detailed in section 1.1.

Harmonic difficulties in industry can be broken down into two categories: current and voltage. Harmonic currents are the source of the first issue. The following are some of the issues that could arise. The imbalanced current in the neutral conductor will increase due to overload induced by harmonic multiples of 3 with a phase shift of less than 120. It also produces transformer overload, which is mostly caused by eddy currents, with the overall loss at full load rising drastically in direct proportion to the number of harmonics. The third harmonic (multiples of 3) will also rotate around the delta winding, increasing the losses. Due to the mayhem on the ground fault, it also causes circuit breakers to trip. When there is a significant degree of noise associated with the harmonic generating equipment, this occurs[5].

The harmonic voltage is the subject of the next issue. The existence of voltage distortion caused by interference generated by the harmonic current, resulting in a voltage drop in the source impedance, damaged the sinusoidal wave of voltage, disrupting all forms of loads, including linear loads, and causing harmonic currents to be generated. Current losses and transformer losses will both rise as a result. As a result, further losses will occur as the harmonic attempts to turn the motor at a different speed. When harmonic currents are generated in an industrial load, the voltage drop is equal in terms of source impedance and current.

1.3 Project Objective

The main purpose of this project is to propose a systematic and effective methodology to see the effectiveness of fuzzy dc link controller of active power filter for multiple type of loads. Specifically, the objective as follows:

1. To monitor the DC link control for APF system.
2. To simulate the proposed algorithm under different loads variation by using MATLAB.
3. To simulate the effectiveness of fuzzy based DC-link control for SAPF for multiple type of loads by using MATLAB.

1.4 Scope of Project

The scope of this project are as follows:

a) The system will be test under 3-phase system 415V, 60Hz.
b) The system also will be test with multiple type of loads.
c) The type of load is a non-linear load to study the function of SAPF with the existence of harmonic in non-linear load. For this system, the universal diode is used to create the non-linear load connected with resistance, inductance, and capacitor.
d) IGBT is used to do the filtering process connected with DC link capacitor function as a converter of AC to DC responsible for injecting or absorbing into the AC power system to compensate for unwanted harmonics or other power quality issues.