An Advanced Controller for Harmonic Mitigation in Eight Switch Conditioner
Thota.Sivaparvathi1, K. Praveen Kumar2
PG Scholar1, Assistant professor2
Department of EEE
Sphoorthy Engineering College, Nadargul, Hyderabad, Telangana, India

Abstract:
Power quality is an issue that is becoming increasingly important to electricity consumers at all levels of usage. Sensitive power electronic equipment and nonlinear loads are widely used in industrial, commercial and domestic applications leading to distortion in voltage and current waveforms. As a result, harmonics are generated from power converters or nonlinear loads. This causes the power system to operate at low power factor, low efficiency, increased losses in transmission and distribution lines, failure of electrical equipments, and interference problem with communication system. So, there is a great need to mitigate these harmonic, reactive current components and poor voltage regulation. This project emphasis enhancement of power quality by using eight switch power conditioner for current harmonic compensation and voltage sag mitigation with fuzzy logic controller (FLC) and proportional integral (PI) controller the main purpose of the proposed (FLC) is capable of providing good static and dynamic performances compared to PI controller. The performance of the proposed controllers has been evaluated through Matlab/simulink.

Keywords: Fuzzy Logic Controller, Power Conditioning, Power Quality.

I. INTRODUCTION:
The power quality has become a challenging issue in our day to day life. The term power quality has become one of the most prolific buzzwords in the power industry since the late 1980s [1]. As the consumers requirement increases day by day, the quality of the power supply has also to be improved accordingly. Both the electric utilities and end users of electric power are becoming increasingly concerned about the quality of electric power. In recent years, the development of power electronics devices has been led for the implementation of electronic equipment which is suitable for electrical power systems. The non-linear loads produce harmonics and reactive power related problems in the utility systems. The harmonic and reactive power cause poor power factor and distort the supply voltage at the customer service point. The presence of harmonics in power lines results in greater power losses in the distribution system, interference problems in communication systems and, sometimes, in operation failures of electronic equipments, which are more and more sensitive since they include microelectronic control systems, which work with very low energy levels. Because of these problems, the issue of the power quality delivered to the end consumers is, more than ever, an object of great concern. Ideally, voltage and current waveforms are in phase, the power factor of load equals to unity, and the reactive power consumption is zero. This situation enables the most efficient transport of active power, leading to the attainment of the cheapest distribution system. In the past, the solutions to mitigate as fixed compensation, resonance with the source impedance, and difficulty in tuning time dependence of filter parameters, these identified power quality problems were through conventional passive filters. However, their limitations, such have ignited the need for active and hybrid filters [2-3]. Under this circumstance, a new technology called Custom Power Devices (CPDs) emerged in distribution sector that power quality can be significantly improved. To reduce the power quality issues, it is important to eliminate the harmonics in the power systems. The harmonic elimination through Shunt Active Power Filter (SAPF) provides higher efficiency when compared with other filters. Non model- based controllers have been designed for the control of a SAPF to reduce the distortion which is created by the non-linear loads. An Artificial Neural Network (ANN) is becoming a deterioration technique in many control applications due to its parallel operation and high learning capability. Since its first introduction, static power converter development has grown rapidly with many converter topologies now readily found in the open literature. Accompanying this development is the equally rapid identification of application areas, where power converters can contribute positively toward raising the overall system quality. In most cases, the identified applications would require the power converters to be connected in series or shunt, depending on the operating scenarios under consideration. In addition, they need to be programmed with voltage, current, and/or power regulation schemes so that they can smoothly compensate for harmonics, reactive power flow, unbalance, and voltage variations. For even more stringent regulation of supply quality, both a shunt and a series converter are added with one of them tasked to perform voltage regulation, while the other performs current regulation back configuration to reduce its losses, component count, and complexity would still be favored, if there is no or only slight expected tradeoff in performance.
The eight-switch power conditioner is obtained by removing one switch of the third leg of the nine-switch converter and placing the output terminal C in the positive pole of the dc link. This is feasible because the capacitors of the LC filter block the dc components generated by the connection of one phase to the positive pole of the dc link. The complementary duty cycle expressions for the series converter are obtained by scaling the complementary duty cycles, as follows

\[ D_{\text{series}} = M_{\text{series}} D_R \]
\[ V^*_A \geq V^*_R \Rightarrow V^*_A + V^*_C \geq V^*_R. \]

With the removal of one switch for the shunt converter, the duty cycles of the remaining switches (i.e., DA and DB) should reflect the synthesis of the line-to-line voltages \( v^*_A \) and \( v^*_B \), instead of the phase voltages. A slightly different approach should be carried out for deducing the duty cycles of the eight-switch converter. Focusing only on the converter leg AR of the eight-switch converter, it is possible to find that switch SA controls the voltage \( v_{AC} \) as follows:

\[ v_{AC} = (S_A - 1)v_{dc}. \]
III. FUZZY BASED EIGHT SWITCH POWER CONDITIONER

Mamdani fuzzy logic controller

The most commonly used fuzzy inference technique is the so-called Mamdani method (Mamdani & Assilian, 1975) which was proposed, by Mamdani and Assilian, as the very first attempt to control a steam engine and boiler combination by synthesizing a set of linguistic control rules obtained from experienced human operators. Their work was inspired by an equally influential publication by Zadeh (Zadeh, 1973). Interest in fuzzy control has continued ever since, and the literature on the subject has grown rapidly. A survey of the field with fairly extensive references may be found in (Lee, 1990) or, more recently, in (Sala et al., 2005). In Mamdani’s model the fuzzy implication is modeled by Mamdani’s minimum operator, the conjunction operator is min, the t-norm from compositional rule is aggregation of the rules the max operator is used. In order to explain the working with this model of FLC will be considered the example from (Rakic, 2010) where a simple two-input one-output problem that includes three rules is examined:

Rule1: IF x is A3 OR y is B1 THEN z is C1
Rule2: IF x is A2 AND y is B2 THEN z is C2
Rule3: IF x is A1 THEN z is C3.

Similarly the charging currents IInvad, IInvbd, IInvcd and IInvnd on dc bus due to the each leg of inverter can be seen in the figures

The fuzzifier converts input data into suitable linguistic values by using fuzzy sets. The fuzzy sets are introduced with membership functions such as triangle, sigmoid or trapezoid. The knowledge base consists of a data base with the necessary linguistic definitions and control rule set. The rule set of knowledge base consists of some fuzzy rules that define the relations between inputs and outputs. Usually, fuzzy rules are expressed in the form of IFTHEN fuzzy conditional statements;

\[ R^i: \text{IF } u_m = A_m^n \text{ and } u_{m-1} = A_{m-1}^n \text{ THEN } v = B_i \]
where um is the mth input variable, v is the output, Amn is the nth membership set and Bi is the output membership set belongs to ith rule. Inference engine simulates the human decision process. This unit infers the fuzzy control action from the knowledge of the control rules and the linguistic variable definitions. Therefore, the knowledge base and the inference engine are in interconnection during the control process. Firstly active rules are detected by substituting fuzzified input variables into rule base. Then these rules are combined by using one of the fuzzy reasoning methods. Max-Min and Max-Product are most common fuzzy reasoning methods. The defuzzifier converts the fuzzy control action that infers from inference engine to a non fuzzy control action. Different defuzzification methods are used such as center of gravity, mean of maxima and min–max weighted average formula. Center of gravity is the most common defuzzification method and given in

\[
    z^* = \frac{\sum \mu(z).z}{\sum \mu(z)}
\]

Where \(\mu(z)\) is the grade of membership that obtained inference engine, z is the outputs of each rules and \(z^*\) is the defuzzified output.

Table.1. Fuzzy rule table

![Figure 9. Simulation circuit using the fuzzy logic controller](image)

![Figure 11. Sub circuit of shunt controller on source side](image)

![Figure 12. Sub circuit of series controller on load side](image)

![Figure 13. Dc link voltage Vdc after using the Fuzzy logic controller](image)

![Figure 14. Source voltages (volts)](image)

![Figure 15. Source and load side currents](image)
IV. CONCLUSION:
The eight switch power conditioner is being developed with the Mamdani Fuzzy logic system in the shunt controller which is connected on the source side. This could improve the performance characteristics of the entire system by having lower THD in voltages when compared to the former system and improved Reactive power characteristics and DC voltage regulation with min ripples after compensation

V. FUTURE SCOPE:
In this proposed work can be carried with ANN based approach to improve power quality parameters sag and THD further and further.

VII. REFERENCES:


Author Profile’s:

**T. Sivaparvathi**, Completed B.Tech in Electrical & Electronics Engineering in 2010 from narasaraopeta engineering college, narasaraopet, Guntur. Pursuing M.Tech form Sphoorthy Engineering College Affiliated to JNTUH, Hyderabad, Telangana, India. Area of interest includes Power Electronics. E-mail id: akula.sivaparvathi@gmail.com,

**K. Praveenkumar**, Asst. Professor, Sphoorthy Engineering College Affiliated to JNTUH, Hyderabad, Telangana, India. E-mail id: hrdianpraveen@gmail.com@gmail.com,