ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 12, December 2015

Capacitor Coupled Multilevel Custom Power Topology for the Refinement of Polluted Power System

Jibin Joseph[1], Ajan A[2]

Assistant Professor, Dept. of EEE, College of Engineering, Kidangoor, Kottayam, Kerala, India[1]

Assistant Professor, Dept. of EEE, College of Engineering, Kidangoor, Kottayam, Kerala, India[2]

ABSTRACT: This paper proposes a novel control strategy for a unified power quality conditioner integrated with a 7-level flying capacitor multilevel inverter to compensate the power quality problems in distribution system. Power quality problems have been increasing due to the wide use of nonlinear loads,which cause harmonic currents in networks and consequently distort the voltage and current at the point of common coupling. This distorted voltage and current harmfully affects the other loads connected at the PCC. To avoid this problem and protect loads from distortions, the harmonic components of the voltage and current must be fully compensated. UPQC is an efficient custom power device for enhancing the electric power quality at distribution levels, which is a combination of series and shunt active power filters sharing a common dc-link capacitor. In this paper the realization of shunt active power filteris carried out using a three-phase seven level flying capacitor multilevel inverterand the series active power filter is realized using a three-phase voltage source inverter. The flying capacitor multilevel inverter offers several advantages like, good power factor control due to the effect of large amount of storage capacitors, reduced harmonic current and different voltage levels etc. The control of shunt connected FCMLI is achieved by a new control strategy known as IARC control. The performance of the proposed system is analyzed through simulations with MATLAB SIMULINK software.

KEYWORDS: Flying Capacitor Multilevel Inverter (FCMLI), Unified Power Quality Conditioner (UPQC), Active Power Filter (APF), Instantaneous Active and Reactive Current Control (IARCC), Point of Common Coupling (PCC)

I. INTRODUCTION

It has been always a challenge to maintain the quality of electric power within the acceptable limits. In general, poor power quality may result into increased power losses, abnormal and undesirable behaviour of equipments, interference with nearby communication lines, and so forth. The widespread use of power electronic based systems has further put the burden on power system by generating harmonics in voltages and currents along with increased reactive current. All non-linear loads draw highly distorted currents from the utility system, with their third harmonics component almost as large as the fundamental. The increasing use of non-linear loads, accompanied by an increase in associated problems concerns both electrical utilities and utility customer alike.

To improve the power quality by connecting the series and shunt active power filter. There are two types of filters, one is passive filters and another one is active filters. In passive filters they are using L and C components are connected. By connecting passive filters the system is simplicity and cost is very low and so many disadvantages is there, that is resonance problems and filter for every frequency and bulky. That’s we are choosing the active filters. In active filters the power converter circuit using active components like IGBTs, MOSFETs, etc. In existing system Fuzzy and PID controllers are used. UPQC is one of the major custom power devices, capable of mitigating the effect of non-linear loads at the load end or at the Point of Common Coupling (PCC). UPQC can compensate almost all power quality problems such as;voltage harmonics, voltage unbalance,voltage flickers, voltage sags, voltage swells,Current harmonics, current unbalance, etc.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 12, December 2015

Series active filters are used for the voltage harmonic compensation, give high impedance path to harmonic currents; these are the main functions of series active filters. The inverter connected in shunt with the load acts as a current source for injecting compensating current, in which the shunt converter is responsible for regulating the common DC-link voltage.In proposed system three phase UPQC integrated with 7-level FCMLI is used.Multi-level inverters have many advantages over conventional two-level inverters such that high-power, high voltage capacity, low switching losses and low cost. In case of N-level, the multi-level inverters can increase the power (N -1) times than that of conventional two-level inverter because of using the series connection of power semiconductor devices. Comparing with conventional two-level inverter system under the condition of the same power rating, multi-level inverters have the advantages that harmonic components of line-to-line voltage fed to motor, switching frequency of device and EMI component could be significantly decreased. It has the capability of improving power quality at the point of installation and also on power distribution systems.The FCMLI requires a large number of capacitors to clamp the device voltage to one capacitor voltage level, provided all the capacitors are equal values. The size of the voltage increases between two consecutive legs of the clamping capacitors. Hence the size of voltage steps in the output waveform.Here the control strategy for FCMLI is implemented by using IARC control.

II. FCMLI INTEGRATED WITH UPQC

A UPQC consists of series and shunt connected inverters for the compensation of both voltage and current. Three phase UPQC should necessarily consist of three-phase series transformer in order to connect the inverters in the series with the line function as a controlled voltage source. Figure.1 shows three phase distribution system connected with FCMLI integrated UPQC.

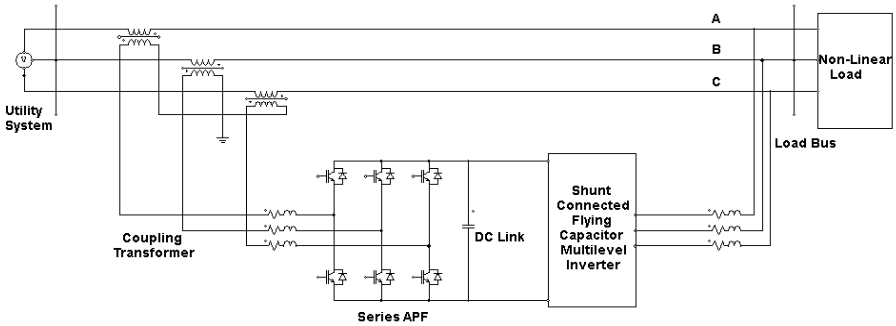

Figure.1.FCMLI integrated UPQC in Three Phasesystem

In series APF the Inverter injects a voltage in series with the line which feeds the polluting load through a transformer. Here the series inverter is a three leg voltage source inverter. The injected voltage will be mostly harmonics with a small amount of sinusoidal component which is in-phase with the current flowing in the line. The small sinusoidal in-phase (with line current) component in the injected voltage results in the right amount of active power flow into the Inverter to compensate for the losses within the Series APF and to maintain the D.C side capacitor voltage constant. Obviously the D.C voltage control loop will decide the amount of this in-phase component. Series active power filter compensate current system distortion caused by non-linear load by imposing a high impedance path to the harmonic current.

The flying capacitor multilevel inverter (FCMLI) is a multiple voltage level inverter topology intended for high-power and high-voltage operations at low distortion. It uses capacitors, called flying capacitors, to clamp the voltage across the power semiconductor devices.The active filter uses Power electronic switching to generate harmonic currents that cancel the harmonic currents from a non-linear load. In this configuration, the FCMLI is connected in parallel with the loadbeing compensated. Therefore the configuration is often referred to as an active parallel or shunt filter. Figure.2. illustrates the general view of One Phase Leg of a 7-Level FCMLI. This inverter uses dc capacitors as the supply and can switch at a high frequency to generate a signal that will cancel the harmonics from the non-linear load.

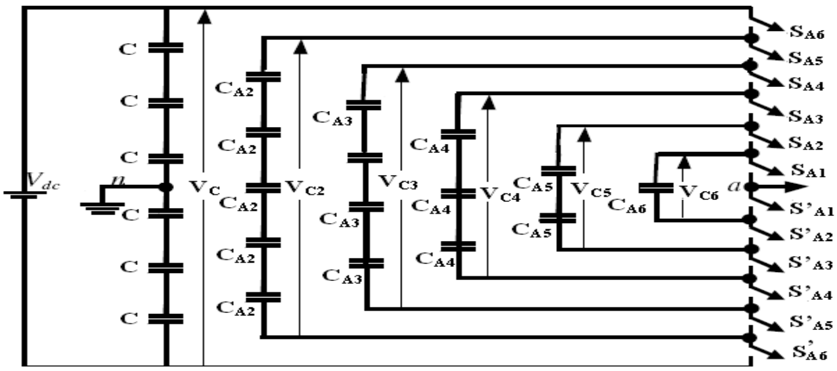

Figure.2.One Phase Leg of a 7-Level Inverter

Single phase of a 7-level inverter are shown in figure.4. In this figure each switch S_{A1} to S_{A6} and S'_{A1} to S'_{A6} consists of a power semiconductor device (e.g. GTO, IGBT) and an anti-parallel diode. Voltages V_C, V_{c2}, V_{c3}, V_{c4}, Vc_5, and V_{c6} are V_{dc}, 5/6 V_{dc}, 2/3 V_{dc}, V_{dc}/2, V_{dc}/3, and V_{dc}/6 respectively, as n = 7. The switch combinations are given to use synthesize the output voltage of phase-a, V_{an}, with respect to the neutral point *n*. The main dc capacitor combination, C is the energy storage element, while capacitors C_{A2},C_{A3}, C_{A4}, C_{A5} and C_{A6} are the flying capacitors that provide the multilevel voltage ability to the converter. The pairs of the switches (S_{A1}, S'_{A1}), (S_{A2}, S'_{A2}), (S_{A3}, S'_{A3}), (S_{A4}, S'_{A4}), (S_{A5}, S'_{A5}) and (S_{A6}, S'_{A6}) are closed in complementary manner. Thus if S_{A1} is ON, S'_{A1} is OFF and vice-versa. For any initial state of clamping voltage, the inverter output voltage is given by

$$V_{an} = S_{a1}(V_c - V_{c2}) + S_{a2}(V_{c2} - V_{c3}) + S_{a3}(V_{c3} - V_{c4}) + S_{a4}(V_{c4} - V_{c5}) + S_{a5}(V_{c5} - V_{c6}) + S_{a5}V_{c6} - V_c/2 \quad (a)$$

The voltage of main dc-link capacitor is $V_{dc}$and the voltage of the capacitor clamping of the innermost two devices are

$$\frac{V_{dc}}{n-1} \quad \text{(b)}$$

The voltage of the next innermost capacitor will be

$$\frac{V_{dc}}{n-1} + \frac{V_{dc}}{n-1} = \frac{2V_{dc}}{n-1} \quad \text{(c)}$$

Each next clamping capacitor will have the voltage increment of $\frac{V_{dc}}{n-1}$ from its immediate inner one. The voltage levels and the arrangements of the flying capacitor in the FCMLI structure assure the voltage stress across each main device is same. It is equal to $\frac{V_{dc}}{n-1}$ for an n- level inverter.

III. DESIGN OF UPQC CONTROLLERS

A. Controller for Series Active Filter

The control algorithm for series APF is based on PLL reference control generation scheme. The reference load voltage signals extracted for series APF are used instead of actual load voltage. The reference voltage signals for phase a, b, c can be represented as:

$$\begin{bmatrix} Vla \\ Vlb \\ Vlc \end{bmatrix} = \begin{bmatrix} Vl\ sin\omega t \\ Vl\ \sin(\omega t - 120) \\ Vl\ \sin(\omega t + 120 \end{bmatrix} \quad (1)$$

Here a PLL is used to generate the reference voltages. This Phase Locked Loop (PLL) system can be used to synchronize on a set of variable frequency, three-phase sinusoidal signals. These reference voltage signals are then compared with the voltage at the point of common coupling (PCC).The resulting signal is used to generate the gate pulses for series active filter, by using a relay. Figure 3 shows the block diagram of PLL reference control.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 12, December 2015

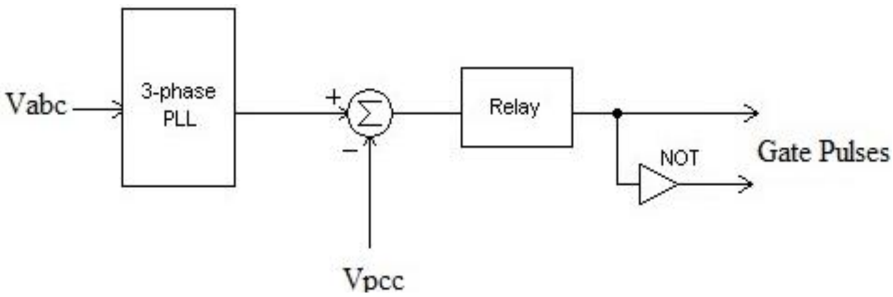

Figure.3. Block Diagram Representation of PLL Reference Control

B.IARCControl for Shunt connected FCMLI

The control strategy for shunt APF(IARC control) is based on Clarke's theory of αβ0 transformation. According to this theory, a single phase system can be defined as a pseudo two-phase system by giving π/2 lead or π/2 lag, which is each phase voltage and current of the original three phase systems. This resultant two phase systems can be represented in α-β coordinates, thus the active and reactive currents are calculated from these α-β components and are applied as reference signal for the shunt connected FCMLI.

The IARC control is based on the αβ0 transformation [Clarke (1943)], which consists in a real matrix to transform three-phase voltages and currents into theαβ0 stationary reference frame. The Clarke's Transform of phase voltages to α and β coordinates has the form:

$$\begin{bmatrix} V\alpha \\ V\beta \end{bmatrix} = \sqrt{2/3}\begin{bmatrix} 1 & -1/2 & -1/2 \\ 0 & \sqrt{3}/2 & -\sqrt{3}/2 \end{bmatrix}\begin{bmatrix} Va \\ Vb \\ Vc \end{bmatrix} \tag{2}$$

It is assumed that line voltages (*Va*, *Vb*, *Vc*) are referenced to an artificial zero, i.e., *Va*+ *Vb*+ *Vc*= 0. At such a condition, the Clarke'sTransform of phase voltages can be simplified to the form.

$$\begin{bmatrix} V\alpha \\ V\beta \end{bmatrix} = \begin{bmatrix} \sqrt{3}/2 & 0 \\ 1/\sqrt{2} & \sqrt{2} \end{bmatrix}\begin{bmatrix} Va \\ Vb \end{bmatrix} \tag{3}$$

Similarly, in three-wire systems *Ia+Ib+Ic*= 0, thus, the Clarke'sTransform of the line currents has the form

$$\begin{bmatrix} I\alpha \\ I\beta \end{bmatrix} = \begin{bmatrix} \sqrt{3}/2 & 0 \\ 1/\sqrt{2} & \sqrt{2} \end{bmatrix}\begin{bmatrix} Ia \\ Ib \end{bmatrix} \tag{4}$$

With voltages and currents transformed to the α and β co-ordinates, the instantaneous active (real) power is defined, according to IARCC

$$\begin{bmatrix} p \\ q \end{bmatrix} = \begin{bmatrix} V\alpha & V\beta \\ V\beta & -V\alpha \end{bmatrix}\begin{bmatrix} I\alpha \\ I\beta \end{bmatrix} \tag{5}$$

That is, real power, $p = V\alpha I\alpha + V\beta I\beta$ (6)

And reactive power, $q=V\alpha I\beta - V\beta I\alpha$ (7)

With these two, *p* and *q*, instantaneous powers, instantaneous active, and reactive currents are defined. The instantaneous active current, i_p, is defined in the α and β coordinates as;

$$I\alpha p = \frac{V\propto}{V\alpha^2+V\beta^2}\, p \text{ and} \tag{8}$$

$$I\beta p = \frac{V\beta}{V\alpha^2+V\beta^2}\, p \tag{9}$$

And the instantaneous reactive current, i_q, in the α and β co-ordinates is defined as;

$$I\alpha q = \frac{-V\beta}{V\alpha^2+V\beta^2}\, q \text{ and} \tag{10}$$

$$I\beta q = \frac{V\alpha}{V\alpha^2+V\beta^2}\, q \tag{11}$$

Respective compensating α, β current are:

$$Ic\alpha = I\alpha p + I\alpha q \tag{12}$$

$$Ic\beta = I\beta p + I\beta q \tag{13}$$

Line currents can be obtained from currents in the α and β coordinates with the inverse Clarke'sTransform:

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 12, December 2015

$$\begin{bmatrix} Ia \\ Ib \end{bmatrix} = \begin{bmatrix} \sqrt{2/3} & 0 \\ -1/\sqrt{6} & 1/\sqrt{2} \end{bmatrix} \begin{bmatrix} Ic\alpha \\ Ic\beta \end{bmatrix} \tag{14}$$

Then compare with the current at the point of common coupling. That resulting current is taken as the reference signal for the modulation scheme of 7-level FCMLI. Figure 4 reveals the block diagram of IARC control for reference current signal.

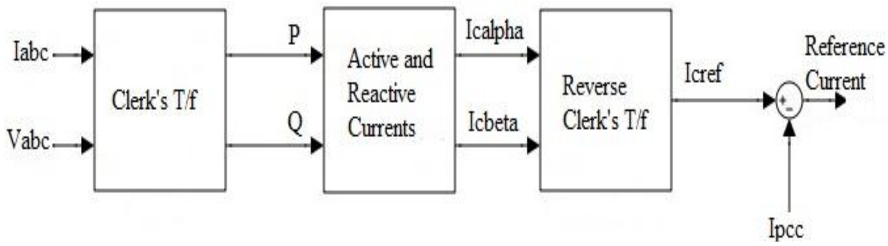

Figure.4. Block Diagram Representation of IARC Control

C. FCMLI Modulation Scheme

A 7-level inverter, a modulating signal and 6 carrier waves are required for each phase of the inverter as shown in figure 5. The modulating signal of each phase is displaced from each other by 120° all of the carriers have the same frequency fc and the same amplitude Ac, while the modulating signal has a frequency of *fm*and amplitude of *Am*. The *fc* should be in the multiples of three-times to that of *fm*. This is required such that all the modulating signal of all the three phases see the same carriers, as they are 120° apart.

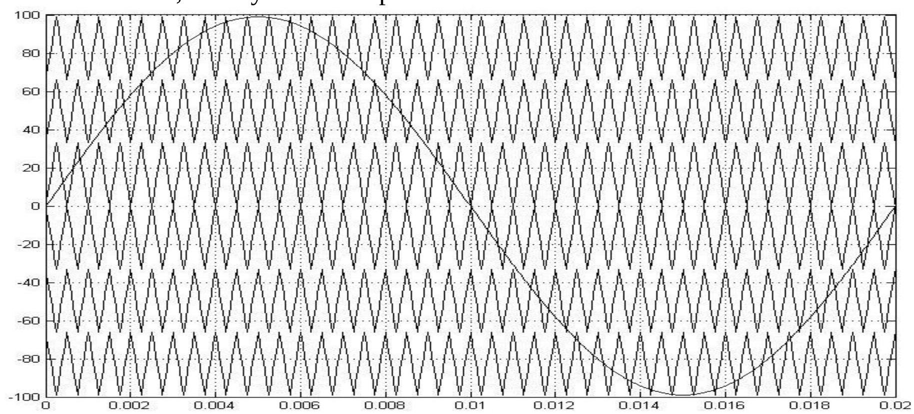

Figure.5. The Modulation Scheme for Seven-Level FCMLI.

The carrier waves and the modulating signals are compared and the output of the comparator defines the output voltage waveform. It is assumed that the modulating signal varies from +99 to –99. The amplitudes of the 6 carrier waves vary from 0 to 33, 33 to 66, and 66 to 99 in the positive half cycle of the modulating signal and from 0 to 33, and 33 to 66, 66 to 99 in the negative half cycle. In the positive half cycle the output will have the value + 33 if the amplitude of the modulating signal is greater than that of the carrier wave (0 to 33) and 0 otherwise. Similarly for the negative half cycle if the modulating signal is lower than the carrier wave (0 to –33), the output of the comparator is –33 and 0 otherwise. If the modulating signal is greater than two carrier waves in the positive half, the output is +66 similarly for the negative half cycle. If the modulating signal is greater than three carrier waves in the positive half, the output is +99, similarly for the negative half cycle. In this way 7 output levels (+99, +66, 33, 0, -33, -66, -99) are obtained. The outputs of each comparator for each phase are combined to produce the corresponding decision signals for the switches to synthesize the output voltage of that phase. This signal resembles with the output voltage waveform of the inverter and decides the voltage level, which is to be generated at a particular instant.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 12, December 2015

IV. SIMULATION RESULTS ANALYSIS

The simulation results for the proposed system utilizing FCMLI-UPQC are shown in below figures. The UPQC should maintain the system voltage at a desired value and free from distortion with the help of 7-level FCMLI. The series active power filter injects the required compensating voltages through series transformer, making the load voltage free from distortion and at a desired level. The shunt connectedFCMLI effectively compensates the current flowing toward the transformer neutral point.

The following typical functions of proposed system have been simulated and the results are presented.

- Compensation of unbalanced voltage and current
- Power factor correction
- Harmonic compensation
- Recovery from fault conditions

A.Without Compensator for Non-Linear Load and Three Phase Fault

In AC power distribution systems, harmonics occur when the normal electric current waveform is distorted by non-linear loads.

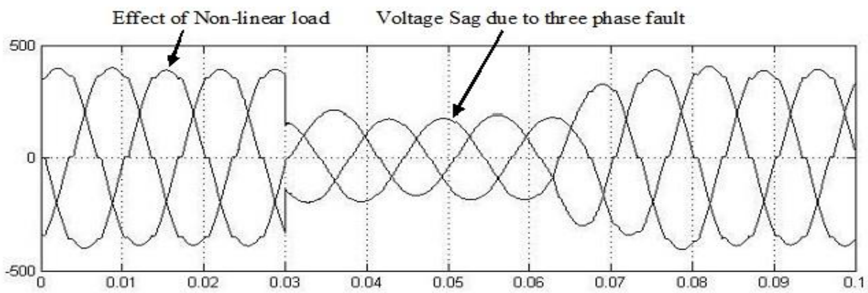

Figure.6 System Voltage without Compensator

In the above figures 6, we can see the distorted wave forms of voltage of the system without UPQC and also due to the effects of faults. From the figures 7&8 it is observed that current and power factor of the system is distorted, when the system is connected without UPQC and also due to the effects of faults.

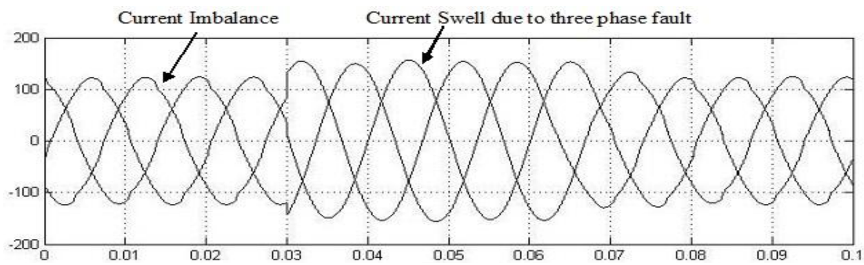

Figure.7 System Current without Compensator

With non-linear loads, the third harmonic on all three phases is exactly in phase and adds, rather than cancels, thus creating current and heat on the neutral conductor. Left un-treated, harmonic loads can reduce the distribution capacity and degrade the quality of the power of public utility power systems and result in equipment malfunctions such as communication errors and data loss, and also thethree phase faults cause sudden dips and variation in the normal waveforms.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 12, December 2015

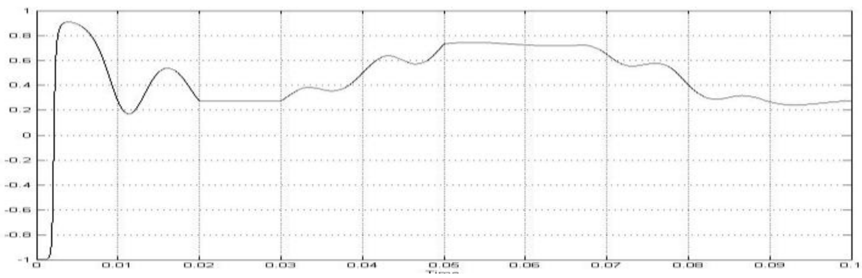

Figure.8Power Factor without Compensator

B. FCMLI Integrated UPQC with Non-Linear Load and Three Phase Fault

*Voltage and Current Compensation:*The simulation results shows that the voltage sag and current flickers formed due to the effect of three phase fault are compensated up to 95% by the action of proposed FCMLI-UPQC. We are applying a fault during the time interval 0.3 to 0.6, during that time the system remains almost balanced as shown in figure 9 and 10.

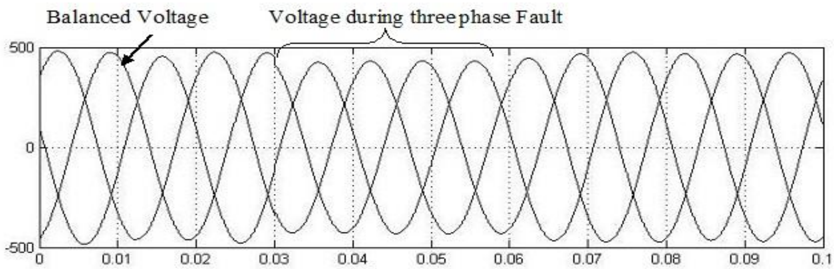

Figure.9Balanced Source Voltage

Due to power electronic load the current and voltage waveform are unbalanced and distorted. Figure 9 represents the three phase source voltage under unbalanced condition. The compensation is done using the UPQC device and which maintain the system voltage purely sinusoidal. The series injected voltage is used to compensate the voltage related problems on the system. Figure 10 shows the balanced and maintained system current. Current compensation is done by UPQC integrated with FCMLI with IARC Control.

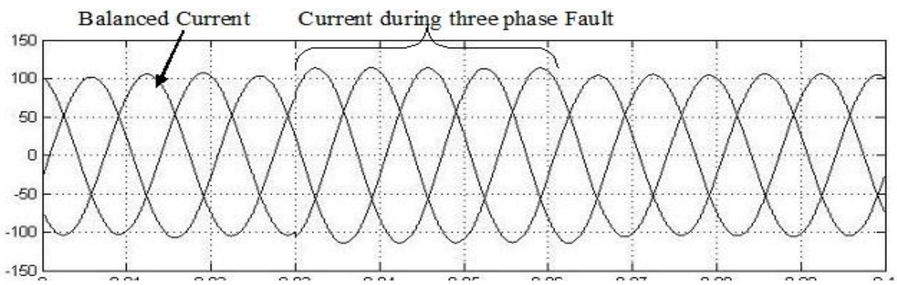

Figure.10 Balanced Source Current

*Power Factor Improvement:*In an electric power system, a load with a low power factor draws more current than a load with a high power factor for the same amount of useful power transferred. The higher currents increase the energy lost in the distribution system, and require larger wires and other equipment. Because of the costs of larger equipment and wasted energy, electrical utilities will usually charge a higher cost to industrial or commercial customers where there is

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 12, December 2015

a low power factor. A high power factor is generally desirable in a transmission system to reduce transmission losses and improve voltage regulation at the load. It is often desirable to adjust the power factor of a system to near 1.0, as in figure 11.UPQC is one of the effective custom power devices, which improves the power factor and also the combined effect of capacitors in FCMLI helps to improve the total system power factor.

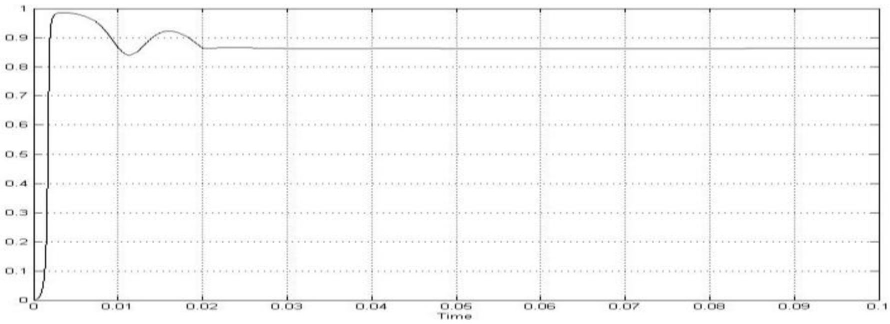

Figure.11 Improved System Power Factor

*THD Comparison:*Harmonics are sinusoidal voltages or current having frequency that are integer multiples of the fundamental frequency. Non-linear load draws harmonic currents, there for the system may get distorted. The dynamic behaviour of industrial loads such as rolling mills, arc furnaces, traction loads and large fluctuating single-phase loads draw wildly fluctuating amounts of reactive power from the supply systems. These loads cause unbalance on the system and leads to wide fluctuations in the supply voltage and effects like incandescent light flicker and malfunctioning computer equipments etc.The FFT analysis of the PID and Fuzzy based [8] system and proposed IARCC based FCMLI-UPQC Systemare compared. In PID based UPQC [8], Utility voltage and current are distorted with a THD of 0.34% and 5.34% respectively. In FLC based UPQC [8], Utility voltage and current are distorted with a THD of 0.33% and 0.76% respectively. The compensated utility voltage and current in IARCC based FCMLI-UPQC System profiles shown in figure 12&13has a THD of 0.29% and 0.17% respectively. Thus the IARCC based FCMLI integrated UPQC System should maintain the system voltage and current at a desired value and free from distortion.Table 1 showsthe THD comparison of these three systems.

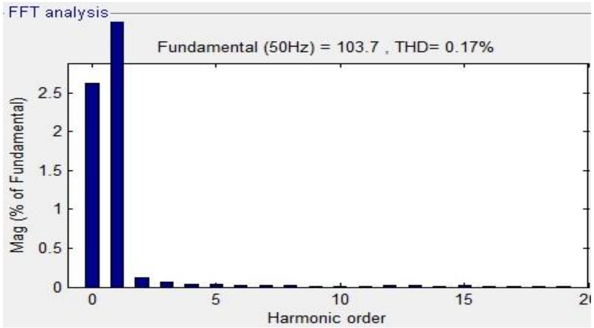

Figure.12Current Harmonic Analysis of IARC controlled FCMLI integrated UPQC System

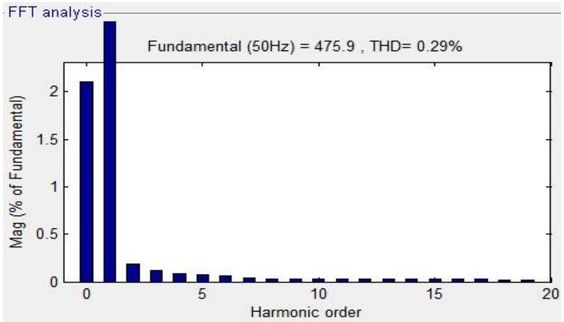

Figure.13Voltage Harmonic Analysis of IARC controlled FCMLI integrated UPQC System

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 12, December 2015

Table1. % THD Comparison of supply currents and voltages

THD	System with UPQC and PID	System with UPQCand FLC	System with IARC controlled FCMLI integrated UPQC
% THD in source current	5.634	0.76	0.17
% THD in source voltage	0.34	0.33	0.29

V. CONCLUSION

The FCMLI integrated UPQC considered in this paper is used to correct voltage and current fluctuation and to prevent the harmonic load currents entering in to the power system. Simulink model of UPQC is tested under non-linear load condition and three phase to ground fault condition. It is seen that UPQC is capable of maintaining voltage and current in permissible limit. Active filters are an up-to-date solution to power quality problems. Shunt active filters allow the compensation of current harmonics and unbalance, together with power factor correction. In this proposed system FCMLI is integrated with UPQC by taking 7-level inverter configuration. The flying capacitor multilevel inverter with seven-level having lower harmonics and better power factor when compared to other inverters. Results of this proposed 7-level FCMLI integrated with UPQC shows low losses, reduced harmonics, improved power factor, good stability and better power quality. Here we are using a methodology, IARCC as a suitable tool for the analysis of non-linear three-phase systems and for the control of active filters.The simulation results show that the proposed system absorbs almost all the power quality problems and reduced the total harmonic distortion in an efficient and simple way.

REFERENCES

[1] Pedro E. Melín, José R. Espinoza, Member, IEEE, Luis A. Morán, Fellow, IEEE, “Analysis, Design and Control of a Unified Power-Quality Conditioner Based on a Current-Source Topology”,*IEEE transactions on power delivery*, vol. 27, no. 4, pp 1727-1736, October 2012.
[2] Srinivas BhaskarKaranki, NageshGeddada, Mahesh K. Mishra, and B. Kalyan Kumar, “A Modified Three-Phase Four-Wire UPQC Topology With Reduced DC-Link Voltage Rating”, *IEEE Transactions On Industrial Electronics*, Vol. 60, No. 9, pp 3555-3566,September 2013.
[3] Su-ping Pei Department of Electronic Information Zhongyua University of Technology Zhengzhou, “The Control and Compensation Strategy Research of Unified Power Quality Conditioner”, *IEEE Explore*, 978-1-61284-459-6/11/$26.00 ©2011 IEEE.
[4] Mukhtiar Singh, Vinod Khadkikar, Ambrish Chandra, *IEEE*, and Rajiv K. Varma, *“*Grid Interconnection of Renewable Energy Sources at the Distribution Level With Power-Quality Improvement Features”, *IEEETransactions On Power Delivery*, Vol. 26, No. 1, pp 307-315, January 2011.
[5] B. Han, B. Bae, S. Baek, and G. Jang, *“*New Configuration of UPQC for Medium-Voltage Application”, *IEEE Transactions On Power Delivery*, Vol. 21, No. 3, pp 1438-1444, July 2006.
[6] Yash Pal1, A. Swarup1, and BhimSingh,“Performance of UPQC for Power Quality Improvement”, *IEEE Explore*, 978-1-4244-7781-4/10/$26.00 ©2010 IEEE.
[7] J. Monteiro, J. Fernando Silva, S. F. Pinto, and J. Palma, “Matrix Converter-Based Unified Power-FlowControllers: Advanced Direct Power Control Method”, *IEEE Transactions On Power Delivery*, Vol. 26, No. 1, pp 420-430, January 2011.
[8] RVD Rama Rao Assoc. Professor Narasaraopeta Engineering College, Chennai,India,“Enhancement of Power Quality by using Unified Power Quality Conditioner with PID and Fuzzy Logic Controller”*International Journal of Computer Applications (0975 – 8887) Volume 5– No.7*, pp 21-27,August 2010.
[9] Quoc-Nam Trinh and, University of Ulsan, Ulsan, Korea, “Novel Control Strategy for a UPQC under Distorted Source and Nonlinear Load Conditions”, *Journal of Power Electronics*, Vol. 13, No. 1, pp 161-169, January 2013.
[10]Leszek S., Czarnecki, “Instantaneous Reactive Power p-q Theory and Power Properties of Three-Phase Systems*” IEEE Transactions on Power Delivery*, Vol. 21, No.1, pp 362-367, Jan. 2006.
[11] T. A. Meynard and H. Foch, "Multl-level conversion:High voltage choppers and voltage-source inverter," in Proc., *IEEE Power Electron. Spec. Conf.*, vol. 1, pp.397-403, 1992.
[12] J. Rodriguez, Jih-Sheng Lai and Fang Zheng Peng,"Multilevel inverter: a survey of topologies, controls, and applications," *IEEE Trans. on Ind. Electronics.*, vol. 49, pp. 724-738, Aug. 2002.
[13] AbdolhosseinEjlali “Sensorless Vector Control of 3-Phase BLDC Motor using a Novel Extended Kalman Filter”, *IEEE Explore,* 978-1-4673-2043-6/12/ $30.00 ©2012.
[14] S.R.Kolla “Effect of Network-Induced Delays in Control Systems: Application to DC Motor Control”, *IEEE Explore*, 978-1-4673-2043-6/12/ $28.00.
[15] Hatem Yassin Diab “Intelligent Maximum Power Tracking and Inverter Hysteresis Current Control of Grid-Connected PV Systems”, *IEEE Explore*, 978-1-4673-2043-6/12/ $24.00.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 12, December 2015

BIOGRAPHY

JibinJoseph: Received his B.Tech. Degree in Electrical & Electronics Engineering fromCUSAT, Kerala, India in 2011& Received M.E in Power Systems Engineering affiliated to Anna University-Chennai,Tamil Nadu, India in 2014. Currentlyhe is working as an Asst. Prof. in EEE dept., College of Engineering kidangoor. He has presented several papers in different national and international conferences and published five papers and one e-book in different reputed articles/journals.His research areas are power system protection, power quality and Renewable energy etc.