An improved Algorithm for Power Quality Analysis using UPQC System

Pandeeswari C[#1], Ashok kumar V[*2], Keerthiga P.C[#3], Shuveatha C.R[*4]

EEE Department,

K. Ramakrishnan College of Engineering,

[1]pandeeshca@gmail.com

[2] ashokkumarped13@gmail.com

[3]pckeerthiga@gmail.com

[4] crshuve@gmail.com

***Abstract*— Unified power quality conditioner (UPQC) is one in all the foremost comprehensive FACTS devices which may controls 3 system parameters severally. During this system a completely unique configuration of UPQC that consists of a twelve switch convertor parallel with a series. Capacitor has been planned to inject desired series voltage. It means that operation of twelve-switch convertor during this configuration be an equivalent as combination of 2 converters in typical UPQC. However, planned configuration requirements less power natural philosophy switches logic gate drive circuits and management theme becomes less complicated than typical UPQC configuration, exploitation series condenser parallel by twelve switch convertor scale back the injection voltage's THD, eliminate output filter, also decrease the converters power rating as compared with typical UPQC composed of series and shunt converters. The planned UPQC is exploitation MATLAB/SIMULINK software system and simulation results square measure bestowed to point smart operation of the new UPQC.**

Keywords- - **UPQC, THD (Total Harmonic Distortion), FACTS (Flexible AC Transmission Systems), VSI (Voltage supply Inverter), PWM.**

I. INTRODUCTION

Today with the progress of power electronic, versatile AC transmission systems (FACTS) area unit one among the foremost vital technologies that is increasing quite alternative electrical power management strategies[1].FACTS devices will management the ability flow in conductor, regulate voltage at the purpose association to network and compensate reactive power. Additionally FACTS devices will utilize in facility damping improvement as a result of they need acceptable time response to damp oscillations. As mentioned blessings the uses of FACTS area unit increasing of voltage regulation, power transferring capability, and damping of power oscillations [2]. Most comprehensive device within the FACTS idea is that the Unified power quality conditioner (UPQC). It will regulate the 3 management parameters of system at the same time and severally [3]. The conductor electrical phenomenon, bus voltage, and point in time between 2 buses area unit parameters will be management victimization UPQC. The standard UPQC consists of 2 voltage supply converters, one among them is connected asynchronous with facility network with other in shunt and each area unit connected back to back throughout a DC link. Due to the standard UPQC is predicated on victimization to 2-level-3-phase voltage supply converters, it cause downside that the injected series voltage isn't a curving wave shape with low Doctor of Theology and output filters area unit essential. UPQC based mostly "zigzag electrical device links" through "multilevel converters" be 2 choices to clarify this downside that reported [4].

Zigzag arrangement solves doctorate downside however increase the price, volume, power loses and conjointly management of this structure is tough. On the opposite hand, construction converters need complicated circuit and management strategy to satisfy doctorate standards. to beat mentioned issues, recently proposes a unique topology of UPQC that is consists of 2 3- section consecutive shunt converters and a series capacitance. During this topology the price, volume and rated power of UPQC is minimized. Conjointly each of converters square measure connected in parallel with line therefore the management theme becomes easier than standard UPQC, and a lot of necessary than said benefits of this configuration is reduction of injected voltage doctorate. During this topology 2-level 3-phase consecutive convertor has been used, thus it needs twelve power electronic switches. Recently the novel twelve-switch convertor has been introduced as a decent various to existing 3-phase consecutive converters as shown in Figure one as compared with consecutive converters, the projected twelve-switch convertor uses fewer range of power electronic switches that reduces the price [5].

This system gift a unique UPQC supported 2 parallel connections and a series capacitance. In projected UPQC the novel twelve-switch convertor has been used rather than consecutive convertor therefore the range of power electronic switches from twelve to 12 as compared with according topology. During this system initial a replacement twelve-switch convertor is introduced and therefore the carrier primarily based PWM switch rule for this convertor has been thought-about. Novel UPQC supported twelve-switch convertor is explained in next section. Simulation results on projected UPQC square measure provided to substantiate operation of projected structure.

II. SERIES AND SHUNT CONVERTER

This system proposes a replacement shift management UPQC system topology that includes of twelve switches in total. the most purpose is to decrease the general switch count of the back-to back UPQC system whereas holding its operational options with none performance group action. To retain the linear modulation vary and uniform shift frequency for all the switches among the projected topology, a carrier based mostly binary zero sequence injection theme is additionally developed. AN applicable management formula is developed to accomplish the seamless method of the projected UPQC topology below completely different operational conditions. AN experimental study is voted for bent on certify the performance of the projected topology [6].

Voltage	Switching State
$V_{sh} = V_{sr} = V_{dc}$	$S_{C1}, S_{C'1}$= ON and $S_{C2}, S_{C'2}$= OFF
$V_{sh} = V_{sr} = 0$	$S_{C2}, S_{C'2}$= ON and $S_{C1}, S_{C'1}$= OFF
$V_{sh} = V_{dc}$ and $V_{sr} = 0$	$S_{C1}, S_{C'2}$= ON and $S_{C2}, S_{C'1}$= OFF
$V_{sh} = 0$ and $V_{sr} = V_{dc}$	$S_{C2}, S_{C'1}$= ON and $S_{C2}, S_{C'1}$= OFF

TABLE 1: Switching States for Phase "C" Of Shunt and Series VSI In Existing System

Twelve-switch configuration was earlier to replace twelve-switch consecutive convertor for twin induction machine drive system. Even if the configuration permits freelance management of each machine with a good vary of variation in load torsion and motion speeds, it imposes a downside on the dc link voltage. If Um1and Um2 area unit the utmost values of part-to- phase voltages at the terminal of the induction machine M1 and M2, severally,

VDC>= max(Um1+Um2)for twelve –switching system

VDC>= max(Um1,Um2)for twelve –switching system

Where Vdc is that the voltage across the dc link condenser. Within the special case of um1=um2= U the subsequent constraints is established.

VDC>= 2U for twelve – switch system

VDC>= U for twelve – switch system

Equation implies that the dc link voltage should be doubled to attain the utmost motion speed for each machine at constant time. Doubling of dc link voltage increase all the element stresses by 2 folds, thus compensative the saving of 2 switches. For the equivalent dc link voltage, the twelve-switch structure results in reduction within the terminal voltage and succeeding speed vary of each instrumentation. Makes an attempt to boost the dc-bus utilization for the twelve-switch design are rumored. The advance rumored, is obtained at the expense of identical operative (speeding and loading) conditions for each machines. The controller divides the dc link voltage through allocate predefined shift vectors close to every machine. The restriction that the regulator should have previous information of the voltage profile for every machine makes the system impractical for variable industrial loads [7]. The twelve-switch configuration is used to drive the 2 induction motors within the center driven winders. It overcomes the limitation of dc link over size given by thanks to "inverse load outline" of the 2 instrumentation. Once one motor begin at most speed, the opposite motor operates at minimum speed and contrariwise. As a result of each motors increase/decrease speed in Associate in nursing exchange fashion, their voltage demand is totally completely different (opposite). This enables the twelve-switch theme to continue operational for middle driven winders utilizing constant dc link voltage needed for end-to-end convertor. However, the middle driven winder may be a special case and generally twelve switch configurations haven't shown a lot of value for twin motor drive systems [8].

III. EXISTING SYSTEM

Different types of custom power devices are used to improve the power quality in the consumer premises [9–11]. Dynamic Voltage Restorer (DVR), one of the aforesaid devices, is used to protect the critical load (digital communication networks, advanced medical instruments, financial transactions system, elevator etc.) from voltage related power quality issues [12]. The DVR is connected in series with the grid terminal before the critical loads and injects the required amount of compensating voltage to maintain the load voltage within the specified value. A DVR generally consists of DC energy storage device, voltage source inverter (VSI), passive filter components and injection transformer. A single line diagram of a DVR circuit is shown in Fig. 1.

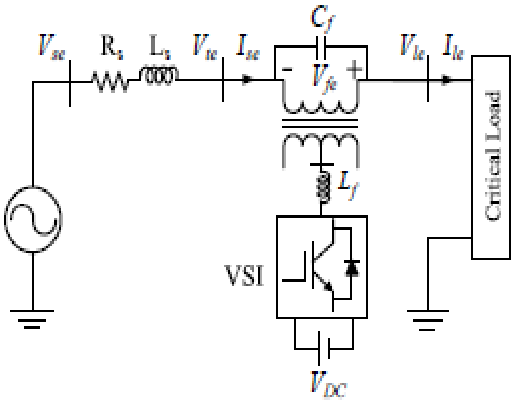

Fig.1.Single line diagram of general Dynamic Voltage Restorer (DVR) circuit.

In Fig. 1, V_{te}; I_{le}; V_{le} and V_{fe} are the effective line to neutral grid terminal voltage, line current, load voltage and DVR injection voltage, respectively. Whereas, V_{le}^* are the desired RMS line to neutral load voltage. The DC bus voltage is maintained constant by using energy storage devices. In order to ensure the optimum use of energy storage devices, the proposed algorithm should compensate the load voltage with optimum utilization of active power. The overview of the control algorithm is shown in Fig. 2.

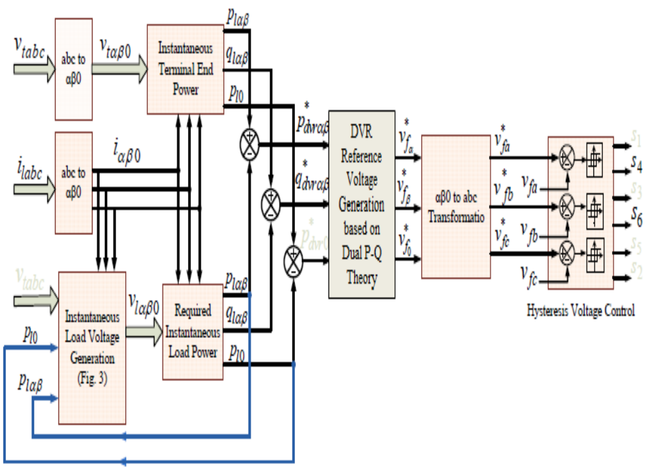

Fig. 2. Complete block diagram representation of the DVR control scheme.

IV. PROPOSED SYSTEM

In this system, a completely unique topology of UPQC, supported twelve switches is projected for power quality improvement applications. The projected topology is accomplished by combining the section C switches of shunt and series VSI in Figure. 3, severally, into a standard leg with a shared set of 2 switches. Till now the twelve-switch structure has been used in drives applications with sure limitations.

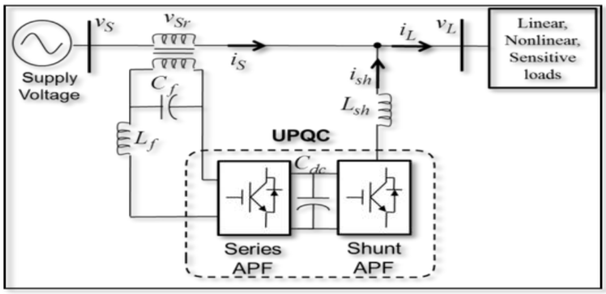

Fig 3. Conventional UPQC consist of shunt and series converters

In this paper, a non-linear slippery mode management (NLSMC) and new shift dynamics management strategy are projected for a unified power quality conditioner (UPQC) to boost the facility quality drawback in grid distribution network. The projected non-linear slippery surface reflects the dominant action of the DC-link condenser voltage with a variation of the system's damping magnitude relation and permits the DC-link voltage to get a coffee overshoot and little subsidence time. This NLSMC technique combines with a completely unique synchronous-reference frame (SRF) management technique for generation of a fast and stable reference signal for each shunt and series converters [13]. A brand new shift dynamics management strategy has been styled for the voltage supply converters of UPQC and this design helps within the reduction of band violation of the physical phenomenon band moreover as improvement within the following behavior of UPQC throughout grid perturbations. Consequently, NLSMC-SRF technique in conjunction with new shift strategy in UPQC provides an efficient compensator for voltage/current harmonics, sag/swell, voltage unbalance and interruptions. The projected management strategy of UPQC is valid through MATLAB/SIMULINK, followed by the experimental system victimization time period hardware-in-the-loop. Adequate results area unit rumored when a comparative assessment with the traditional proportional–integral and physical phenomenon controller [5].

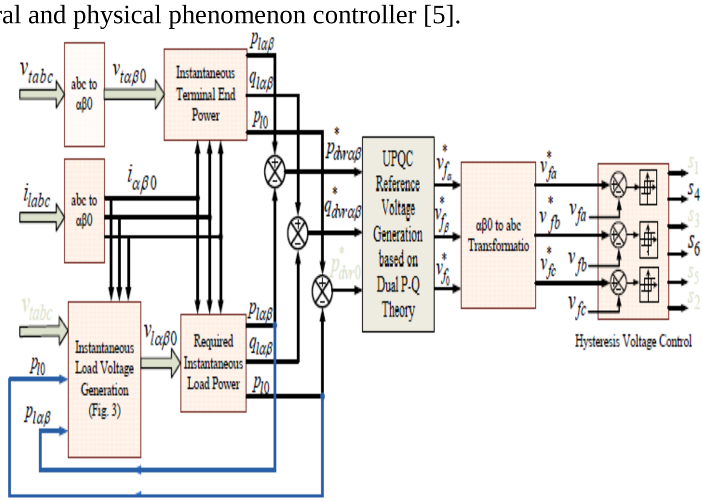

Fig. 4. Complete block diagram representation of the UPQC control scheme

V. CONTROL OPERATION

The unified power quality conditioner (UPQC) has the performance of voltage-current compensation devices to boost its comprehensive compensation impact, this paper combines the normal inflammatory disease regulator and theory and styles a inflammatory disease managementler to use in UPQC DC-link capacitance voltage management links and following control link of the compensation. The strategy synthesizes the robust benefits of the high accuracy of ancient inflammatory disease management steady-state and lustiness of the management. The simulation leads to Matlab/Simulink surroundings show that the management rules will effectively improve the performance of compensation. A traditional UPQC to regulate active and reactive power flow transmission at the same time consists of series and shunt converters that are connected succeeding with common dc-link capacitance as shown in Figure. The voltage of the UPQC bus or its reactive power is controlled by the shunt device and it conjointly regulates the dc link voltage. The series device is controlled by the line active and reactive power flow by injecting a desired series voltage, that is manageable equally in magnitude and section angle. The series device injects voltage to line, by dynamic injected series voltage active and reactive power exchange between the series device and also the power grid. Active power needed by the series device and the losses of the UPQC devices has been provided by the shunt converter.

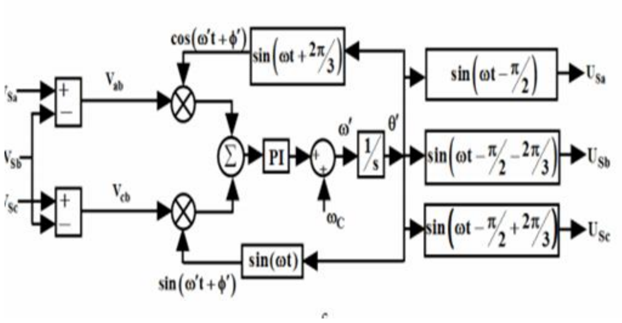

Fig 5. Control circuit implementation

Fig 5. shown the projected configuration of UPQC that consists of a twelve-switch technique. A series condenser has been utilized in parallel between 2 shunt converters that desired injection voltage to regulate active and reactive power has been injected by this condenser, mistreatment this configuration cut back doctorate, eliminate output passive filter, and additionally cut back converters power rating compared with the traditional UPQC accommodates series and shunt converters[13]. In projected UPQC during this paper, a twelve-switch ac-ac device has been used instead 2 dc-ac converters in novel UPQC supported 2 shunt converters and a series condenser. Like mentioned during this device, the input and output voltages is severally controlled then it is noted that the operation of twelve-switch ac/ac device during this configuration is that the same as combination of 2 dc/ac converters in standard configurations [14-16].

Twelve-switch configuration was earlier reported to replace twelve-switch back-to-back converter for dual induction machine drive system. Although the configuration allows independent control of both machines with a wide range of variation in load torque and rotational speeds, it imposes a limitation on the dc link voltage. If and are the maximum values of phase-to- phase voltages at the terminals of the induction machine and, respectively

V is the voltage across the dc link capacitor. In the special case of the following constraints can be established

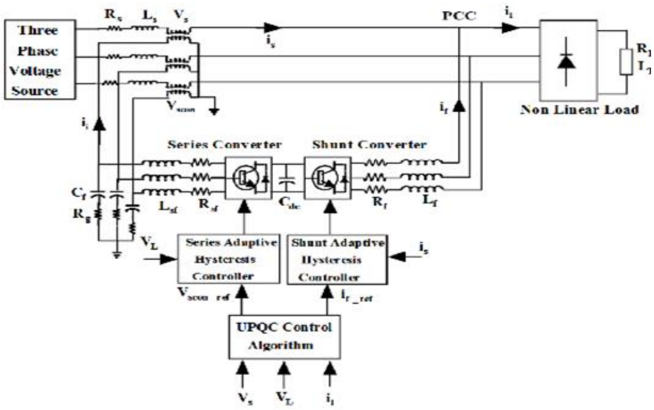

Fig 6. Proposed twelve-switch UPQC

V. RESULTS

To approve the execution of the projected twelve-switch UPQC [17-18], Associate in nursing searching model is formed. The results and experimental study is given roar. The arrangement half adequately mitigates the sounds within the framework voltage. The improved load voltage profile is taken whereby the doctorate is lessened to three.

OVER ALL IMPLEMENTATION CIRCUIT DIAGRAM

The UPQC configuration is shown in figure. The UPQC consist of two voltage supply inverters connected through a common dc link capacitance. The voltage connected downside like voltage sag, voltage swell, voltage unsteady and voltage harmonics square measure salaried by series electrical converter connected to the line serial. The current connected issues like current harmonics are solved by shunt electrical converter hook up with the line. The DC link capacitance connects the shunt APF and series APF together and facilitates for sharing active power among inverter.

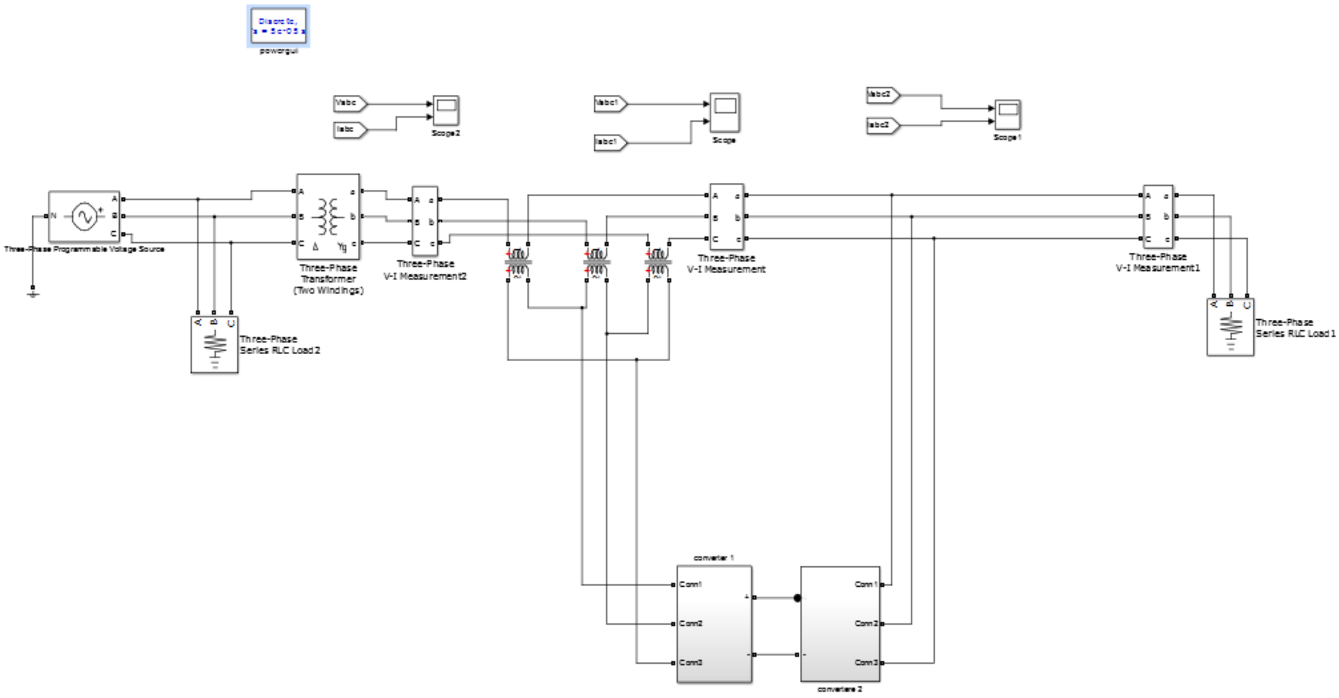

Fig 7. UPQC implementation

SIMULATION RESULTS

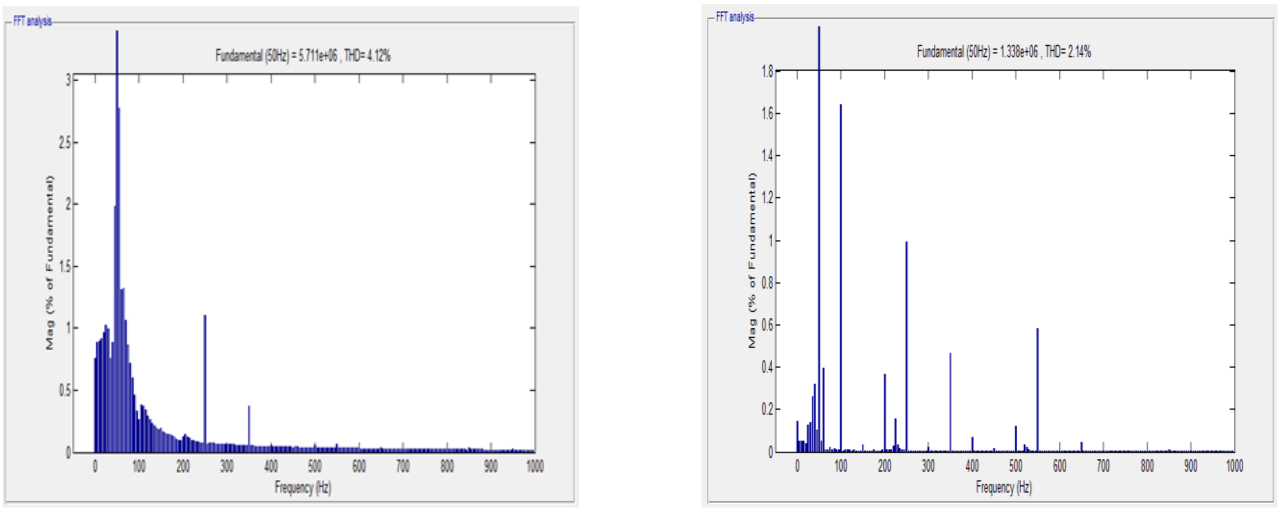

Fig 5.5 Comparison of FFT for DVR and UPQC

Current accomplishing curving lattice streams with the THD of two.1%. Therefore, the higher than check cerebrate confirms the utility of the planned twelve-switch UPQC topology for helpful applications to boost the facility

VI . CONCLUSION

This system planned a unique UPQC using novel twelve-switch device. The prompt configuration wants fewer switches AND circuit drives circuits. Therefore, the planned topology ends up in reduction of installation space and price.

Also, PWM based mostly shift algorithmic rule has been given for novel device. Besides, management strategy of UPQC supported a prompt device be represented. The simulation results show that the planned UPQC will operate per management ways against within the active and reactive power references unexpected variations.

REFERENCES

[1] J. M. Ramirez, J. L. Murillo-Pérez, "Steady-State Voltage Stability with StatCom", IEEE TRANS. ON Power Systems, Vol. 21, NO. 3, AUGUST 2006.

[2] B. Han, H. J. Kim, S. T. Baek, "Performance analysis of SSSC based on three-level multi-bridge PWM inverter", Electric Power Systems Research, Vol.61, pp. 195-202, 2002.

[3] R. Tapia, J. M. Ramirez, "Power Systems Neural Voltage Control by a STATCOM", International Joint Conference on Neural Networks Sheraton Vancouver Wall Centre Hotel, Vancouver, BC, Canada July 16-21, 2006.

[4] A. T. Al-Awami, Y.L. Abdel-Magid, M.A. Abido, "A particle-swarm-based approach of power system stability enhancement with unified power flow controller", Electrical Power and Energy Systems, Vol.29, pp. 251-259, 2007.

[5] S. T. Kalyani, G. T. Das, "simulation of real and reactive power flow control with UPQC connected to a transmission line", Journal of Theoretical and Applied Information Technology, pp. 16-22, 2008.

[6] A. Shukla, A. Ghosh, A. Joshi, "Static shunt and series compensation of an SMIB System using flying capacitor multilevel inverter", IEEE Trans. Power Deliv. 20 (2005) 2613–2622.

[7] D. Soto, T.C. Green, "A comparison of high-power converter topologies for the implementation of FACTS controllers", IEEE Trans. Indus. Electron. 49 (2002) 1072–1080.

[8] A. K. Sadigh, M. TarafdarHagh, M. Sabahi, "Unified power quality conditioner based on two shunt converters and a series capacitor", Electric Power Sy level stems Research, 80 (2010) 1511–1519.

[9] M. Farhoodnea, A. Mohamed, and H. Shareef, "A comparative study on the performance of custom power devices for power quality improvement," in 2014 IEEE Innovative Smart Grid Technologies - Asia (ISGTASIA), May 2014, pp. 153–157.

[10] C. Kumar and Mahesh K. Mishra, "Operation and control of an improved performance interactive DSTATCOM," EEE Trans. Ind. Electron., vol. 62, no. 10, pp. 6024–6034, Oct 2015.

[11] S. B. Karanki, N. Geddada, Mahesh K. Mishra, and B. K. Kumar, "A modified three-phase four-wire upqc topology with reduced dc-link voltage rating," IEEE Trans. Ind. Electron., vol. 60, no. 9, pp. 3555–3566, Sept 2013.

[12] S. B. Karanki, N. Geddada, Mahesh K. Mishra, and B. K. Kumar, "A modified three-phase four-wire UPQC topology with reduced dc-link voltage rating," IEEE Trans. Ind. Electron., vol. 60, no. 9, pp. 3555–3566, Sept 2013.

[13] C. Liu, B. Wu, N. Zargari, D. Xu, "A Novel Nine Switch PWM Rectifier-Inverter Topology for Three-Phase UPS Applications," European Conference on Power Electronics Applications, Sep. 2007.

[14] T. Kominami, Y. Fujimoto, "A Novel Nine-Switch Inverter for Independent Control of two Three Phase Loads", Industry Applications Conference, pp. 2346-2350, 2007.

[15] S. M.D. Dehnavi, M. Mohamadian, A.Yazdani, F. Ashrafzadeh, "Space Vector Modulation for Nine Switch Converters", IEEE Trans. on Power Electronics, Vol. 25, No. 6, pp. 1488-1496, June 2010.

[16] M. R. Banaei, A. R. Dehghanzadeh, "Doubly Fed Induction Generator Based a Novel Nine Switch AC/AC Converter", International Review on Modelling and Simulations, vol. 4, No. 2, pp. 562- 567, April 2011.

[17] R.Manivasagam, Dharmalingam, Velayutham "Power Quality Problem Mitigation by Unified Power Quality Conditioner: An Adaptive Hysteresis Control Technique", International Journal of Power Electronics(IJPE), Volume 6, No.4, 2014, P.No- 403-425.'.Inderscience Enterprises Ltd