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Enhancing Power Quality using a Novel Facts Device without Active Power Injection to Rectify Voltage

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ABSTRACT:Due to uncertainty of loads, now-a-days the power quality problems are evolved affecting the performance of the electrical power distribution networks such as the information technology equipment, power electronics adjustable speed drives (ASD), programmable logic controllers (PLC), energy-efficient lighting, led to a complete change of electric loads nature .This paper proposes a new technical feature of digital controller to reduce grid side and transmission line voltage dips. Voltage harmonics, sag or swell compensation, current unbalances, reactive current effects are avoided on local loads by using fuzzy controller. The voltage sag/swell can be effectively compensated by a dynamic voltage restorer, series active filter, Unified power quality conditioner etc. among the available power quality enhancement devices. UPQC is a universal power quality conditioning device which in-cooperates the advantages of DVR and APF and henceforth reduces the harmonics caused by the voltage source converters. The results are evaluated in MATLABSimulink environment.

KEYWORDS: Unified power quality conditioner, Active filters, Fuzzy logic controller, Voltage harmonics, Voltage dips.

I.INTRODUCTION

The sinusoidal voltage of constant amplitude has become the prime objective of power utility companies. Modern power system consists of hundreds of generating stations and numerous load centers connected through transmission and distribution lines. The industrial and domestic power utilities have been effecting by poor power due to non-linear loads. The power quality decrement is due to non-linear current harmonic injection, reactive power burden, and excessive neutral currents. This will affect systems over-all efficiency. Unified power quality conditioner was a custom power device. It consists of combined series active power filter will compensates voltage harmonics, voltage unbalance, voltage flicker, voltage sag/swell and shunt active filter that compensates current harmonics, current unbalance and reactive current. The controller unit is responsible for disturbance detection, reference signal generation. Power circuit consists of two voltage source converters, stand by and harmonic filters to filter the higher order harmonics. FACTS device s like DVR and APF are used to compensate voltage sag compensation. Active power filter compensate voltage distortion such as harmonics, dips or over voltages. Shunt APF attenuates undesirable load current components. Dynamic voltage restorer deals with power quality using similar control strategy and concepts. To overcome the extra currents produced by DVR and APF the common capacitors are connected to power source with neutral point.

II.OPERATION OF UPQC

A UPQC is one of the most suitable devices to control the voltage sag/swell on the system. The rating of a UPQC was governed by the percentage of maximum amount of voltage sag/swell need to be compensated. It consists of both series and shunt active filters. The current based distortions are cancelled by shunt filters. The voltage based imbalances are

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suppressed by series active filter. It also improves reactive power and power factor of the system. Fig-1 shows the general configuration of UPQC.

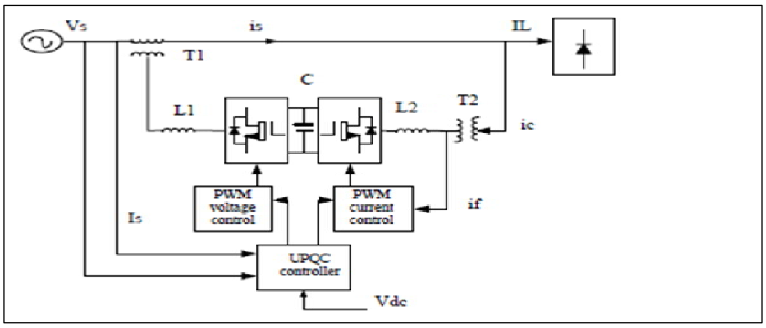

FIG.1-GENERAL CONFIGURATION OF THE UPQC

A. Operation of STATCOM

There are two zones of STATCOM operation [a]. Over Excited and [b]. Under excited power factor in synchronous machine that provides a lead and lag current respectively. The reason of us relating a STATCOM with Synchronous machine is that both of them are more or less similar to each other. The main core of STATCOM is three phase powerful voltage sourced converter. The bus bar voltage is not affected on reactive current output and hence voltage is controlled. It compensates negative sequence allowing split phase adjustment between different phases. To maintain a constant capacitor of DC source for AC system, but for that case the system voltage should be influenced by a VSC, output voltage. So therefore, it can be concluded that STATCOM provides reactive power for reactive power compensation and power factor to be kept in unity

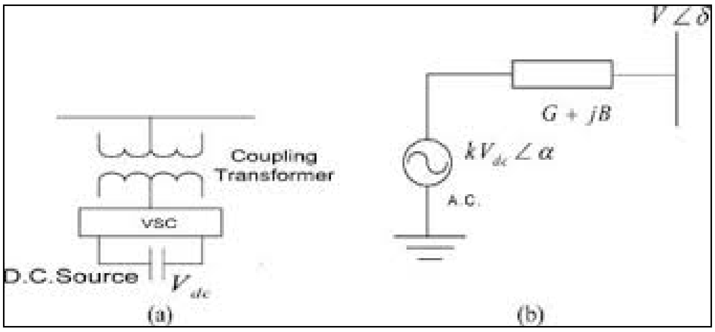

FIG.2-STATCOM

B. Operation of DVR

Dynamic voltage restorer is a static and series compensation device that preventloads from the effect of voltage swells, dips. Its basic principle is to inject voltage of certain frequency and magnitude that balances the lost rms.
The voltage source converter in the dc voltage is converted into ac voltage from energy unit. The sinusoidal pulse width modulation theory is used for inverting switches. The injection transformer in the DVR gives the maximum reliability and effectiveness of the restoration. It is in series with the distribution feeder.Passive Filters was placed at the high voltage side of the DVR to filter the harmonics. These filters are placed at the high voltage side by placing the filters at the inverter side introduces phase angle shift which can disrupt the control algorithm.

The energy storage devices/control system are dc capacitors, batteries, super-capacitors, superconducting magnetic energy Storage and flywheels. The capacity of the energy storage device has a big impact on the compensation capability when large voltage sag occurs. Fig-3 shows the Dynamic Voltage Resistor

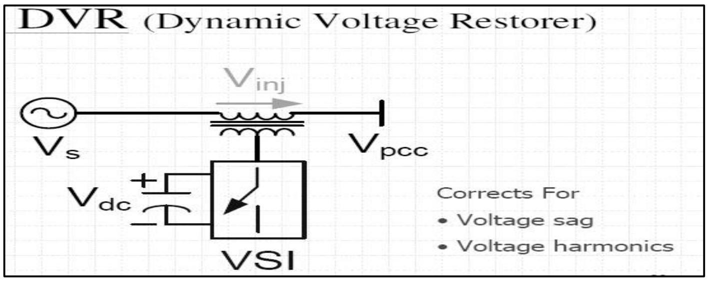

Fig-3 Dynamic voltage Restorer

C. SHUNT CONTROL STRATEGY

The shunt active filters act as current generator that compensates load current. The network current sources are forced to be sinusoidal, shows and in phase with positive sequence system voltages. Fig-4 shows. The PI controller for the shunt conversion and the pulse generation using PWM generator

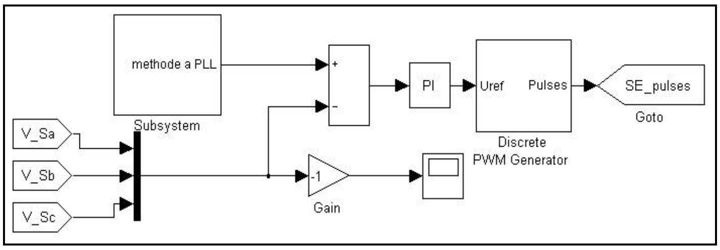

FIG.4-SHUNT CONTROL

D. SERIES CONTROL STRATEGY

The series active filter along with pwm converter inserted in series with network forces the voltage to be sinusoidal and shows. Fig-5 shows. The PI controller for the series conversion and the pulse generation using PWM generator

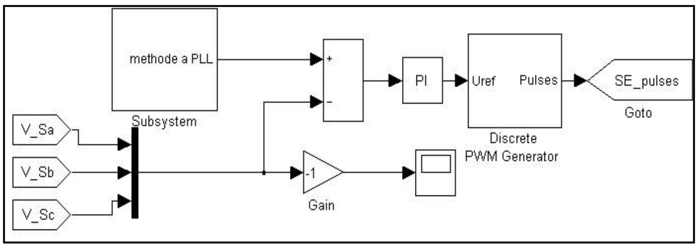

FIG.5-SERIES CONTROL

III.POWER SYSTEM MODEL INCORPORATING FACTS DEVICES

Along with the functional properties of UPQC, the DVR and STATCOM are also incorporated to inject the power in transmission line. Due to nonlinear there is loss in voltage at the receiving end. This avoid sag voltage dips and improves the line and phase voltage. The devices DVR and STATCOM are connected by dc link to maintain the constant voltage. The common point of dc-link is connected to the neutral. The power is injected into the line through neutral when it is connected to the power source. any extra power is also grounded through the neutral. The output is viewed by MATLAB with the help of fuzzy logic. Fig-6 shows when the UPQC neutral is not grounded. Fig-7 shows when the UPQC neutral is grounded.

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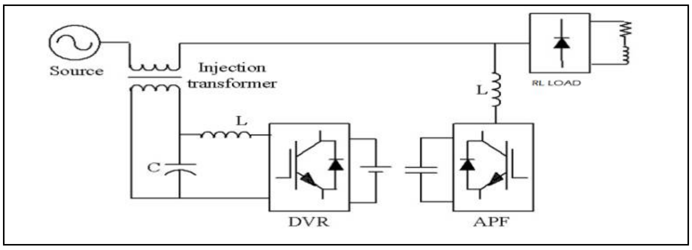


FIG.6-WHEN NEUTRAL IS NOT GROUNDED FOR THE UPQC

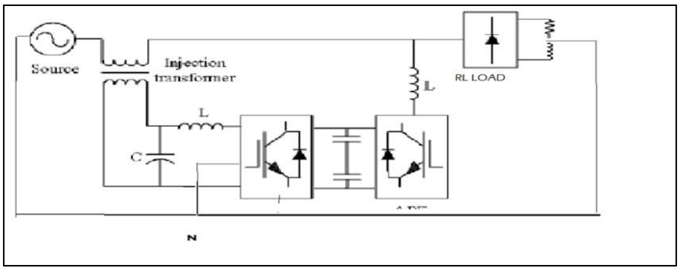
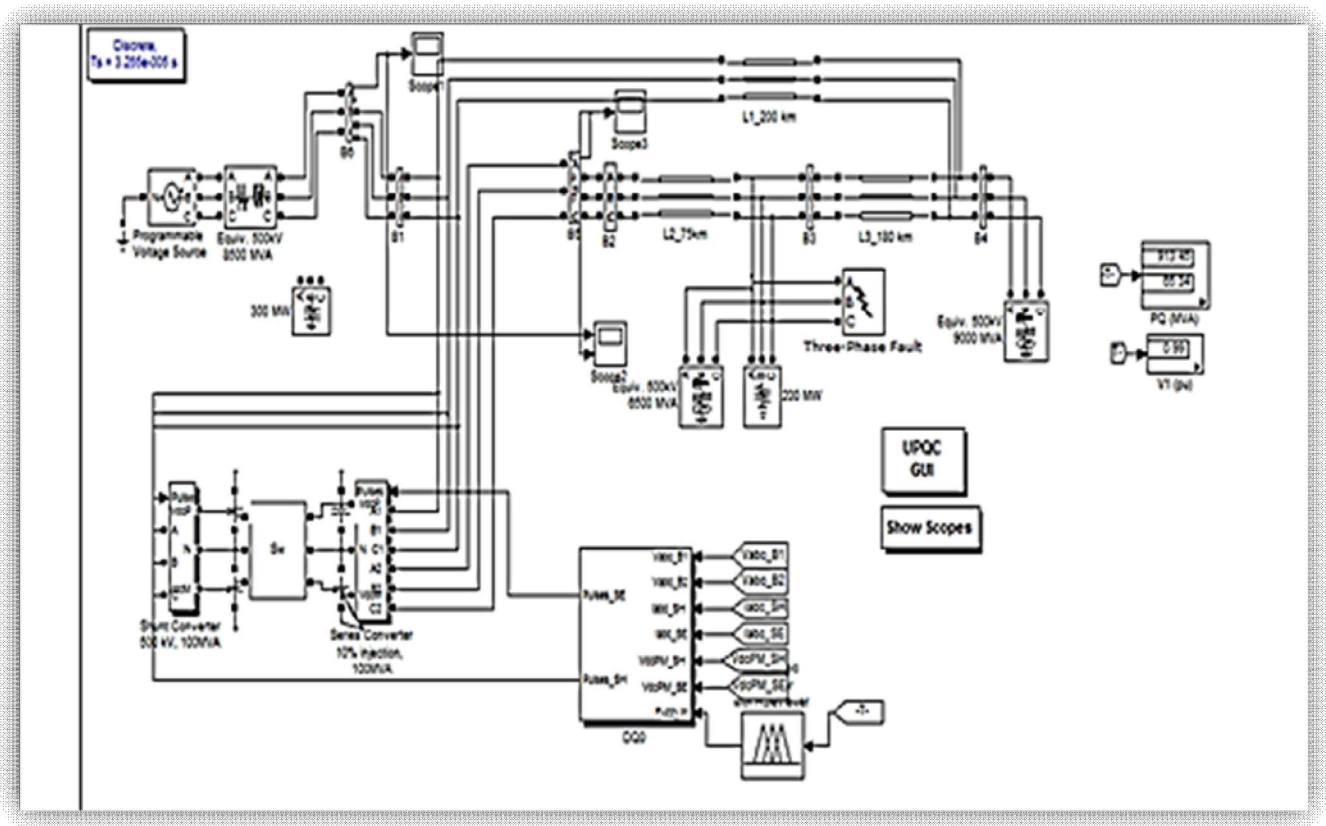


FIG.7-WHEN NEUTRAL IS GROUNDED FOR THE UPQC

IV.SIMULINK MODEL OF THE POWER SYSTEM WITH UPQC



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V. RESULT AND DISCUSSION

A. OUTPUT VOLTAGE

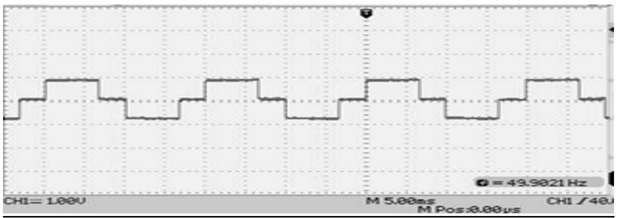

Fig.9 shows the output phase voltage as visualized from the CRO

B. SAG CONDITION

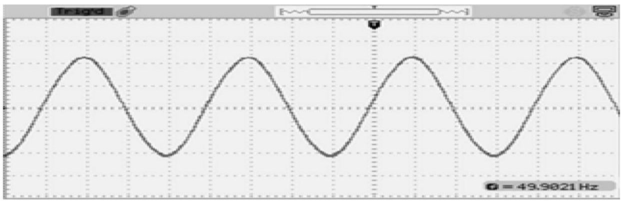

Fig.10 shows the sag condition voltage as visualized from the CRO.

C. AFTER LINE VOLTAGE IS INJECTED

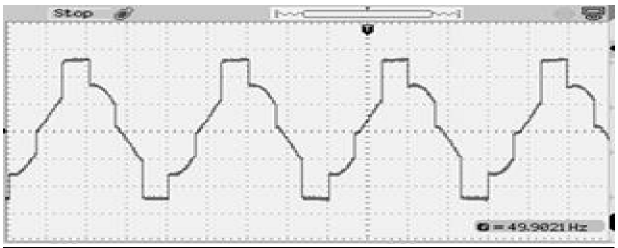

Fig.11 shows the line voltage injected as visualized from the CRO

D. FUZZY VIEWER

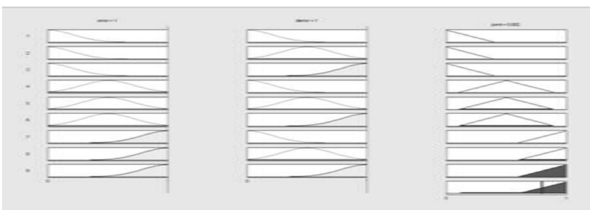

Fig.12 shows the simulation of fuzzy logic as viewed in MATLAB

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E. FFT ANALYSIS

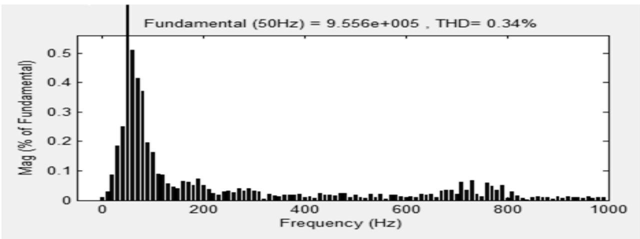

Fig.13 shows the simulation of THD analysis of UPQC in FFT window

TABLE.1-COMPARISION BETWEEN THOERITICAL AND PRACTICAL THD

S.NO	UPQC WITHOUT NEUTRAL CONNECTION	UPQC WITH NEUTRAL CONNECTION
THEORITICAL VALUE OF THD	2.76%	0.40%
PRACTICAL VALUE OF THD	2.45%	0.35%

VI.CONCLUSION

By the analysis and simulation of using UPQC along with neutral connection of dc link and without neutral voltage the factors like voltage sag, voltage dip, harmonic distortions are studied and compared. It is viewed that by using these facts devices in the both transmission and distribution line improves the power factor.

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