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Power Quality Improvement Using UPQC

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ABSTRACT
This paper presents the power quality improvement using UPQC. UPQC consists of series inverter, shunt inverter and capacitance. Every inverter connected with pulse generator for switching on. UPQC is especially obtained to resolve different kind of power quality drawback like reactive power compensation, voltage interruption and harmonics. DVR is connected in series to deliver the active and reactive power to distribution network. DC-link capacitors stay high as a result of the DVR needs a minimum amount of DC-link voltage to compensate sag. So, DC –link voltage is connected with PV module to reduce the cost. Design of UPQC device with multi-bus system obtained using MATLAB/SIMULINK and simulation results are mentioned to support the developed conception.
Keywords—(Dynamic Voltage Restorer) DVR, Harmonics, Reactive power compensation, Unified Power Quality Conditioner (UPQC)

I. INTRODUCTION

Electrical power generated and distributed to the long distance. Some non-linear loads are connected on the distribution side for effective flow of power to the consumers. It cause voltage flicker, distortion, transient [1], [2]. Hence by using facts devices we'll be able to reduce the power quality issues. Distribution resources (DR) causes voltage increase or decrease on the feeder depending on DR kind, control technique, its delivered power at feeder parameters and loading [3]. Interruption is critical when compared with voltage sag in latter it may become a number one power quality problem. DVR is connected between supply and critical load feeder. It provides complete security for distribution network.

DVR is connected after the D.C energy supply to reduce the distortions at the load [4]. Once voltage sag happens DVR switches into active mode to react as fast as possible to inject the specified AC voltage between the grid and load [5]. In traditional level DVR is control in null state to keep the losses to a minimum [6]. Most of the sag are non-symmetrical [7]. DVR price is less compared to the other facts devices, smaller in size, quick response, less maintance, high energy capability.

Now a days renewable energy supply has taken a necessary role in energy generation for customer. A little distributed generation (DG) has been interconnected with DC link VSI so as to keep up the voltage and frequency [8]. Though DG desires a lot of controls to reduce the issues like grid power quality and reliability [9]. PV distributed generation supply as increased greatest share of this sort of energy within the future it may become a main source for energy generation.

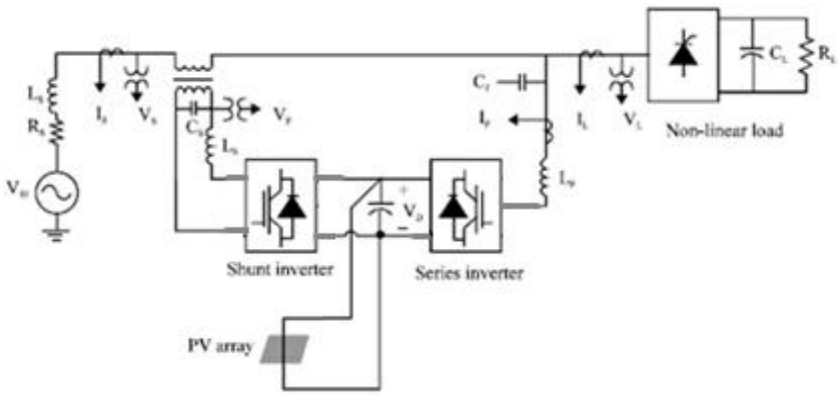


Fig.1.Block Diagram of Unified power quality conditioner with PV array

II. UNIFIED POWER QUALITY CONDITIONER (UPQC)

Block diagram of UPQC device with PV array shown in fig1. It consists of series inverter, shunt inverter and capacitance.

The equation of Active Power and Reactive Power of the line

$$P = \frac{V_S V_R}{X} \sin \delta \quad (1)$$

$$Q = \frac{V_S V_R \cos\delta - V_R^2}{X} \quad (2)$$

Where,

V_S =Sending End Voltage

V_R =Receiving End Voltage

X =System Reactance

Series Inverter:

DVR is connected at the series side to deliver maximum amount of power to distribution network. Once any distraction appears then it restorers the power from energy storage device and provides to the load.

Capacitance:

Capacitance is connected if any distraction occurs then it switched on. PV module is connected with the capacitance for reducing the cost.

Shunt Inverter:

Shunt inverter is connected for supplying to non –linear loads. It removes harmonics and injects the current into system.

III. MATLAB MODELING AND SIMULATION

The testing of system connected with 11KV and frequency 50Hz is modeled with Matlab/Simulink. To compensate reactive power, voltage interruption and harmonics.

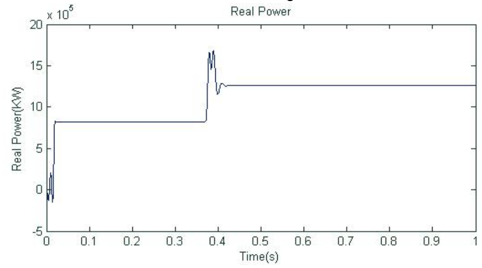
The loads at the receiving end with resistance 20Ω and inductance of 10mH. The extra loads are 10Ω and 5mH. DC in UPQC is connected with photovoltaic cell.

The output of electrical converter is filtered by using LC filter. Multi- bus system is modelled using the elements of matlab simulink and parameters data is produced in table I. Therefore the simulation results are given

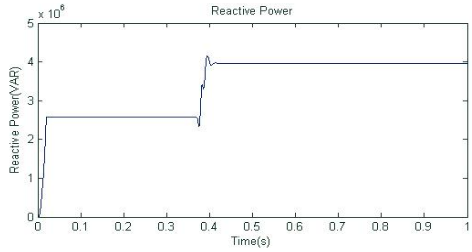
TABLE I
SYSTEM AND CONTROL PARAMETERS

PARAMETERS	SCALED VALUE USED IN SIMULATION MODEL
Distribution supply voltage	11KV
Transformer Ratio	1:1
Frequency	50 Hz
Load Resistor	20Ω,10Ω
Load Inductor	10 mH,5mH
Inverter	IGBT Based,6 arms,6 pulse, Capicator=25μs

Simulation result without UPQC Device:



(a)



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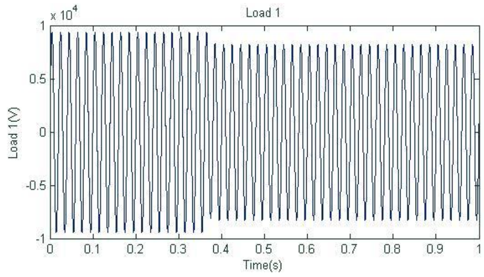
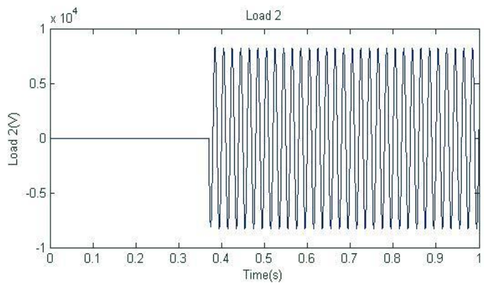
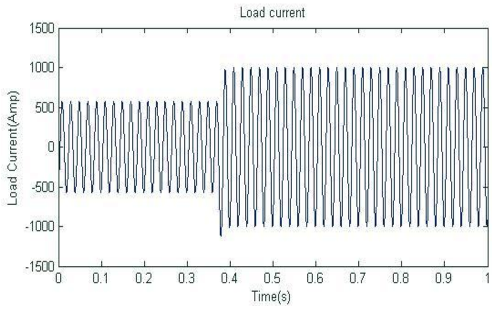


(c)



(d)



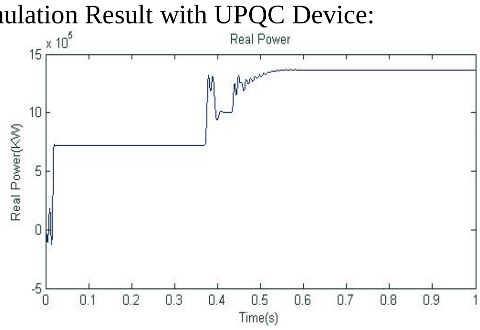
(e)

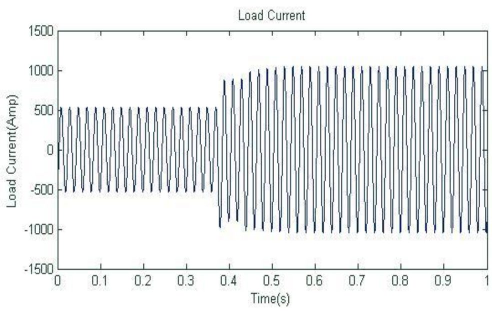
Fig.3.(a) real power, (b) reactive power, (c)load1, (d) load2, (e)Load Current.

In Fig.3.(a) & (b) real and reactive power for load with reference to time at receiving end. Fig 3(b) At t=3.9 to t=4.2 changes occurs in reactive power this is due to transient response. Once load1 is switched on after a while another load is switched on then sag happens in loads.

By using UPQC device we'll be able to overcome this kind of distraction occurring as a result of modification in load voltage and current. It increases the power flow at distribution side. In the following waveforms we will be able to know the differences.

Simulation Result with UPQC Device:

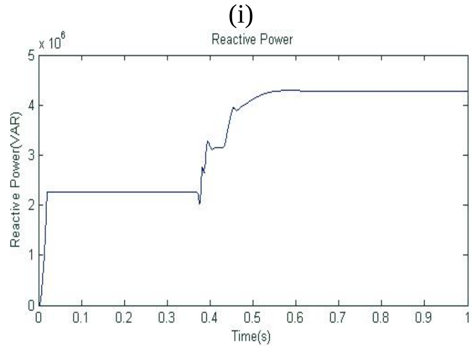




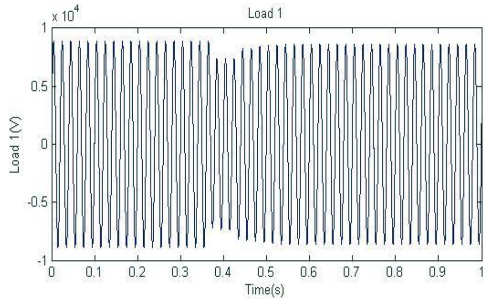
(v)

Fig.3.Simulation result with using UPQC device of (i) real power, (ii) reactive power, (iii) Load 1, (iv) Load 2,(v) Load Current .

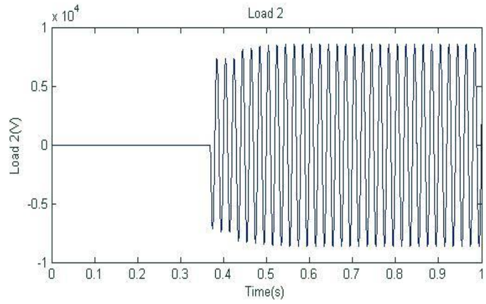
(i)



(ii)



(iii)



(iv)

In fig 3(ii) when t=0.4s to 0.5s transits happens as a result of switch on another load in reactive power flow with reference to time. Most quantity of active power is transferred by using UPQC device.

In fig 3(iii) t=3.7 to 4.2 sag occurs due to switching on another load. Fig 3(iv) t=3.7 load 2 is switched on then sag occurs for while and then maximum amount of power is transferred. By using UPQC device we'll be able to reduce the load voltage and load current distraction.

TABLE II
COMPARISON BETWEEN WITHOUT AND WITH UPQC DEVICE:

BUS .NO	ACTIVE POWER WITHOUT UPQC DEVICE	ACTIVE POWER USING UPQC DEVICE	REACTIVE POWER WITHOUT UPQC DEVICE	REACTIVE POWER WITH UPQC DEVICE
1	1.425	1.492	1.441	1.509
2	3.205	3.357	3.701	3.928
3	1.017	1.065	6.389	6.691
4	1.313	1.375	2.645	2.771
5	1.429	1.496	7.675	8.037
6	1.338	1.401	1.359	1.423
7	1.641	1.719	1.652	1.730
8	1.041	1.190	1.189	1.254
9	1.342	1.405	5.434	5.691
10	5.434	5.691	5.881	6.165
11	3.205	3.350	3.457	3.621
12	1.012	1.030	6.023	6.271
13	1.234	1.304	1.468	1.623
14	1.425	1.492	3.205	3.357

IV. CONCLUSION

In this paper multi bus system was connected and result obtained using matlab / simulink. DC link is connected with the solar module for supply to the non –linear load, to reduce the price. UPQC device keeps the load voltage in constant. It supplies the power to load even any unbalanced distribution happens in system.

DVR transfer the maximum amount of active power to the distribution network. Using DE technique, the optimum location and size of UPQC is obtained so as to extend the active power flow. Furthermore range of bus system can be increased.

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