MULTI CONVERTER UNIFIED POWER QUALITY CONDITIONER (MC-UPQC)

P. Hari Krishna Prasad[1] and Dr. M. Venu Gopal Rao[2]

[1]*Dept.of Electrical & Electronics Engineering , Adam"s Engineering College , Paloncha, A.P- INDIA*
pharikrishnaprasad78@gmail.com
[2]*Dept.of Electrical Engineering , KL University, Vaddeswaram, A.P- INDIA*
venumannam@gmail.com

ABSTRACT

The paper proposes a new concept in developing outline and asses strategic business and technology aspects of cloud computing. Theoretical background and overview is presented on the basic underlying principles, autonomic and utility computing, Service oriented Architecture. Their relation to cloud computing is explored and a case for scaling out vs. scaling up is made and scaling out of relational databases in traditional application is stressed a bottleneck. The rapid progress in information technology and availability of services at low cost has broadened the use of internet for multiple applications. By evaluating strategic issues and weighting in business adoption pros and cons. Cloud computing is expected to be an economically visible alternative to conventional methodology for implementation of projects without compromising the quality of services. I specifically point out cost efficiency, vendor lock in effects leading to operational risks to be prevailing for the majority of larger business customers that could potentially mandate their IT and computing needs from the cloud. Leading Current cloud architectures are compared in software industry. I explore that the process of cloud business deployment will be gradual, but also that government regulations and legal aspects are also likely to business development process further. Ultimately, I conclude with an outlook and recommendations for companies and cloud providers.

Keywords : Power quality (PQ), unified power-quality conditioner (UPQC), voltage-source converter (VSC).

I. INTRODUCTION

Power quality is the quality of the electrical power supplied to electrical equipment. Poor power quality can result in maloperation of the equipment .The electrical utility may define power quality as reliability and state that the system is 99.5% reliable.

MCUPQC is a new connection for a unified power quality conditioner (UPQC), capable of simultaneous compensation for voltage and current in multibus / multifeeder systems.

A MCUPQC consists of a one shunt voltage-source converter (shunt VSC) and two or more series VSCs, all converters are connected back to back on the dc side and share a common dc-link capacitor. Therefore, power can be transferred one feeder to adjacent feeders to compensate for sag/swell and interruption. The aims of the MCUPQC are:

A. To regulate the load voltage (u_{l1}) against sag/swell, interruption, and disturbances in the system to protect the Non-Linear/sensitive load L1.

B. To regulate the load voltage (u_{l2}) against sag/swell, interruption, and disturbances in the system to protect the sensitive/critical load L2.

C. To compensate for the reactive and harmonic components of nonlinear load current (i_{l1}).

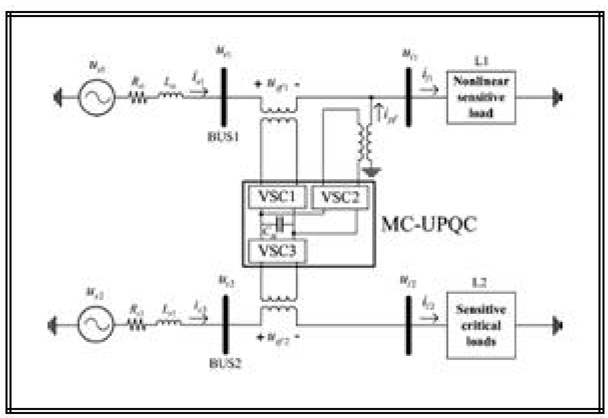

Fig.1: Typical MC-UPQC used in a distribution system.

As shown in this figure 1.1 two feeders connected to two different substations supply the loads L1 and L2. The MC-UPQC is connected to two buses BUS1 and

BUS2 with voltages of u_{t1} and u_{t2}, respectively. The shunt part of the MC-UPQC is also connected to load L1 with a current of i_{l1}. Supply voltages are denoted by u_{s1} and u_{s2} while load voltages are u_{l1} and u_{l2}. Finally, feeder currents are denoted by i_{s1} and i_{s2} and load currents are i_{l1} and i_{l2}.

Bus voltages u_{t1} and u_{t2} are distorted and may be subjected to sag/swell. The load L1 is a nonlinear / sensitive load which needs a pure sinusoidal voltage for proper operation while its current is non-sinusoidal and contains harmonics. The load L2 is a sensitive/critical load which needs a purely sinusoidal voltage and must be fully protected against distortion, sag/swell and interruption. These types of loads primarily include production industries and critical service providers, such as medical centers, airports, or broadcasting centers where voltage interruption can result in severe economical losses or human damages.

A Unified Power Quality Conditioner (UPQC) can perform the functions of both D-STATCOM and DVR. The UPQC consists of two voltage source converters (VSCs) that are connected to a common dc bus. One of the VSCs is connected in series with a distribution feeder, while the other one is connected in shunt with the same feeder. The dc-links of both VSCs are supplied through a common dc capacitor. It is also possible to connect two VSCs to two different feeders in a distribution system is called Interline Unified Power Quality Conditioner (IUPQC). This project presents a new Unified Power Quality Conditioning system called MultiConverter Unified Power Quality Conditioner (MC-UPQC)

II. DISTORTION AND SAG/SWELL ON THE BUS VOLTAGE IN FEEDER-1 AND FEEDEER-2

Let us consider that the power system in Fig. 1 consists of two three-phase three-wire 380(v) (RMS, L-L), 50-Hz utilities. The BUS1 voltage (u_{t1}) contains the seventh-order harmonic with a value of 22%, and the BUS2 voltage (u_{t2}) contains the fifth order harmonic with a value of 35%. The BUS1 voltage contains 25% sag between 0.1s<t<0.2s and 20% swell between 0.2s<t<0.3s. The BUS2 voltage contains 35% sag between 0.15s<t<0.25s and 30% swell between 0.25s<t<0.3s. The nonlinear/sensitive load L1 is a three-phase rectifier load which supplies an RC load of 10Ω and 30µF. The simulink model for distribution system with MC-UPQC is shown in figure 2.

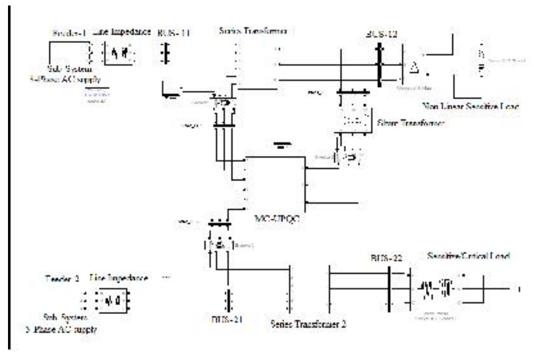

Fig 2: Simulink model of distribution system with MC-UPQC

The critical load L2 contains a balanced RL load of 10Ω and 100mH. The MC–UPQC is switched on at t=0.02s. The BUS1 voltage, the corresponding compensation voltage injected by VSC1, and finally load L1 voltage are shown in Figure 3.

Similarly, the BUS2 voltage, the corresponding compensation voltage injected by VSC3, and finally, the load L2 voltage are shown in figure 4.

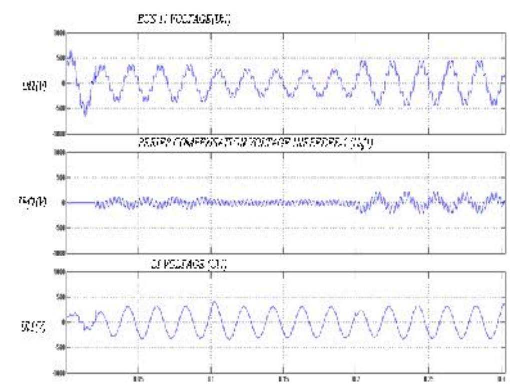

Fig 3:BUS1 voltage, series compensating voltage, and load voltage in Feeder1.

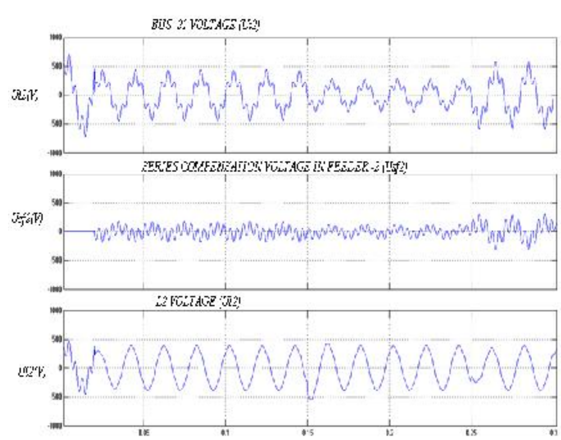

Fig 4:BUS2 voltage, series compensating voltage, and load voltage in Feeder2.

As shown in these figures, distorted voltages of BUS1 and BUS2 are satisfactorily compensated for across the loads L1 and L2 with very good dynamic response.

The nonlinear load current, its corresponding compensation current injected by VSC2, compensated Feeder1 current, and, finally, the dc-link capacitor voltage are shown in Fig. 5. The distorted nonlinear load current is compensated very well, and the total harmonic distortion (THD) of the feeder current is reduced from 28.5% to less than 5%. Also, the dc voltage regulation loop has functioned properly under all disturbances, such as sag/swell in both feeders.

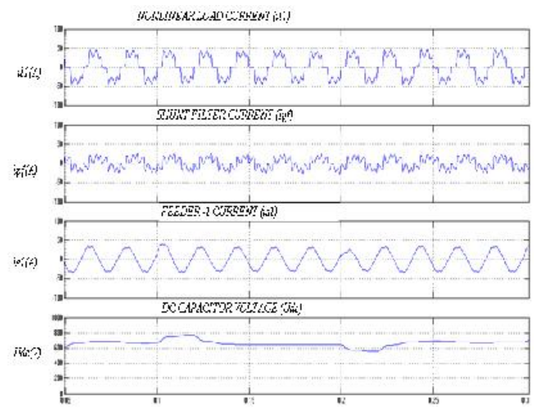

Fig 5: Nonlinear load current, compensating current, Feeder1 current, and capacitor voltage.

III. SYSTEM WITH UNBALANCED SOURCE VOLTAGE IN FEEDER-1

The performance of the MC-UPQC is tested when unbalance source voltage occurs in feeder-1 at nonlinear/sensitive load without and with MC-UPQC. Simulink diagram during unbalance source voltage is as shown in Figure 6.

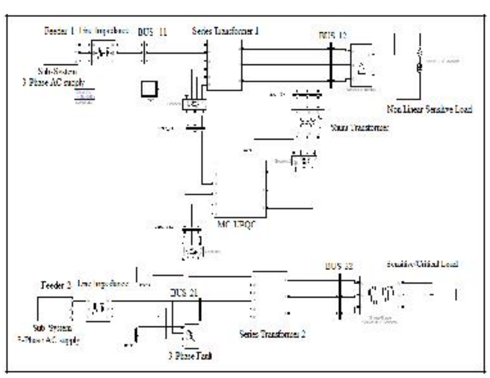

Fig 6: Simulink model of distribution system with MC-UPQC under distortion and unbalanced source on feeder-1.

The control strategies for shunt and series VSCs, which are introduced and they are capable of compensating for the unbalanced source voltage and unbalanced load current. To evaluate the control system capability for unbalanced voltage compensation, a new simulation is performed. In this new simulation, the BUS2 voltage and the harmonic components of BUS1 voltage are similar.

However, the fundamental component of the BUS1 voltage ($U_{t1\,fundamental}$) is an unbalanced three-phase voltage with an unbalance factor (U_- / U_+) of 40%.The unbalance source voltage of system response without MC-UPQC is shown in Fig 7.

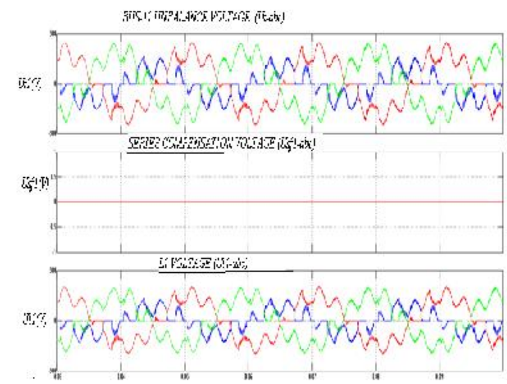

Fig 7: BUS1 voltage, series compensating voltage, and load voltage in Feeder1 under unbalanced source voltage without MC-UPQC.

The simulation results with MC-UPQC for the three-phase BUS1 voltage, series compensation voltage, and load voltage in feeder 1 are shown in Fig 8. The simulation results show that the harmonic components and unbalance of BUS1 voltage are compensated by injecting the proper series voltage. In this figure, the load voltage is a three-phase sinusoidal balance voltage with regulated amplitude.

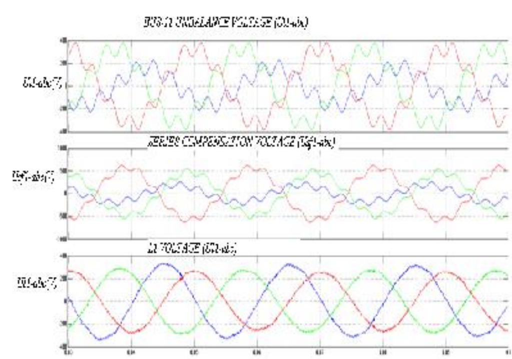

Fig 8: BUS1 voltage, series compensating voltage, and load voltage in Feeder1 under unbalanced source voltage with MC-UPQC.

IV. SYSTEM WITH DURING SUDDEN LOAD CHANGE IN FEEDER-1.

The performance of the MC-UPQC is tested when sudden load change occurs in feeder-1 at nonlinear/

sensitive load without and with MC-UPQC. Simulink diagram during sudden load change is as shown in Fig 9.

To evaluate the system behavior during a load change, the nonlinear load L1 is doubled by reducing its resistance to half at 0.5 s. The other load, however, is kept unchanged. In this case load current and source currents are suddenly increased to double and produce distorted load voltages (U_{l1} and U_{l2}) as shown in Fig 10.

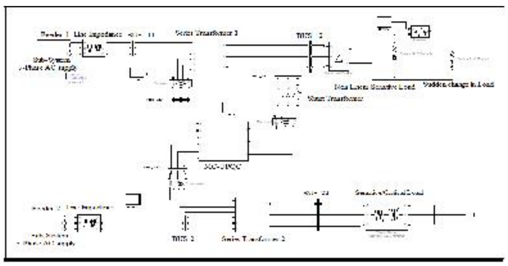

Fig 9: Simulink model of distribution system with MC-UPQC under distortion and sudden change in load on feeder-1

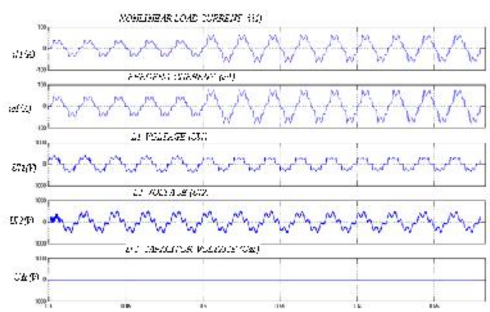

Fig 10: Simulation results for load change: nonlinear load current, Feeder1 current, load L1 voltage, load L2 voltage, and dc-link capacitor voltage without MC-UPQC.

The system response with MC-UPQC is shown in Fig 11. It can be seen that as load L1 changes, the load voltages and remain undisturbed, the dc bus voltage is regulated, and the nonlinear load current is compensated.

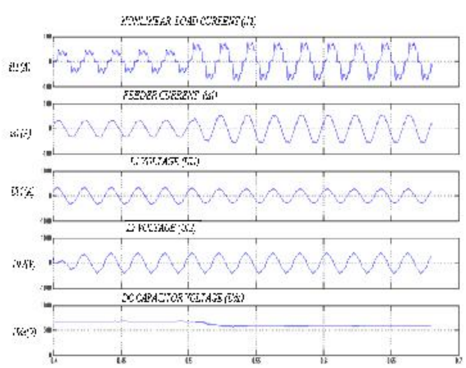

Fig 11: Simulation results for load change: nonlinear load current, Feeder1 current, load L1 voltage, load L2 voltage, and dc-link capacitor voltage with MC-UPQC

V. CONCLUSION

The present topology illustrates the operation and control of Multi Converter Unified Power Quality Conditioner (MC-UPQC). The system is extended by adding a series VSC in an adjacent feeder. The device is connected between two or more feeders coming from different substations. A non-linear/sensitive load L-1 is supplied by Feeder-1 while a sensitive/critical load L-2 is supplied through Feeder-2. The performance of the MC-UPQC has been evaluated under various disturbance conditions such as voltage sag/swell in either feeder, fault and load change in one of the feeders. In case of voltage sag, the phase angle of the bus voltage in which the shunt VSC (VSC2) is connected plays an important role as it gives the measure of the real power required by the load. The MC-UPQC can mitigate voltage sag in Feeder-1 and in Feeder-2 for long duration.

REFERENCES

[1] Hamid Reza Mohammadi, Ali Yazdian Varjani, and Hossein Mokhtari,

"Multiconverter Unified Power-Quality Conditioning System: MC- UPQC" IEEE TRANSACTIONS ON POWER DELIVERY, VOL. 24,

NO. 3, JULY 2009.

[2] R.Rezaeipour and A.Kazemi, "Review of Novel control strategies for UPQC" Internal Journal of Electric and power Engineering 2(4) 241-247, 2008.

[3] S. Ravi Kumar and S.Siva Nagaraju"Simulation of D-

STATCOM and DVR in power systems" Vol. 2, No. 3, June 2007 ISSN 1819-6608 ARPN Journal of Engineering and Applied Sciences.

[4] M.V.Kasuni Perera" Control of a Dynamic Voltage Restorer to compensate single phase voltage sags" Master of Science Thesis, Stockholm, Sweden 2007.

[5] M. Basu, S. P. Das, and G. K. Dubey, "Comparative evaluation of two models of UPQC for suitable interface to enhance power quality," *Elect.Power Syst. Res.*, pp. 821–830, 2007.

[6] A. K. Jindal, A. Ghosh, and A. Joshi, "Interline unified power quality conditioner," *IEEE Trans. Power Del.*, vol. 22, no. 1, pp. 364–372, Jan. 2007.