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A Specialized UPQC for Combined Simultaneous Voltage Sag/ Swell Problems in Distribution System

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Abstract: ***Here, in this paper a brand new concept of highest utilization of a unified power quality conditioner (UPQC). The series inverter of UPQC is maintained to operate simultaneous 1) voltage sag/swell and in the case of only sag and swell recompense and 2) load reactive power distribute with the shunt inverter. The active power control process is utilized to compensated voltage sag/swell and individual sag and swell and interconnected with theory of power angle control (PAC) of UPQC to correlate the load reactive power between the two inverters. Now the series inverter simultaneously produces active and reactive powers; this method is called as UPQC-S (S for complex power notation). An correct mathematical calculation to increase the PAC concept for UPQC-S is discussed in this paper. This software worm as MATLAB/SIMULINK based simulation results is analyzed to support the developed method. Moreover, this method is accept with a digital signal processor based innovative study.***

Key Words: Active power filter (APF), power angle control (PAC), power quality, reactive power compensation, unified power quality conditioner (UPQC), voltage sag and swell compensation.

INTRODUCTION

Generally in Modern power distribution system is becoming highly unsafe to the various power quality issues. The large use of nonlinear loads is furthermore contributing to improved current and voltage harmonics conditions. So the penetration stages of small/large scale renewable energy systems based on fuel cells, solar energy and wind energy, etc., committed at distribution network as well as transmission system is improving significantly. This interconnection system of renewable energy sources in a power system is furthermore imposing brand new challenges to the electrical power industry to having this newly exiting distributed energy system. At the stage of distribution UPQC is a most interesting method to compensate various major power quality real issues. The functional block diagram illustration of a UPQC model based system is representing in this paper. It is generally having of two voltage source inverters are connected back to back utilizing by a common dc link capacitor. Here in this paper a new approach of optimal usage of a UPQC.

The problems of sag and swell on the power system are one of the main important power quality issues. The voltage sag/swell and only sag and only swell could be exactly compensated using by a dynamic voltage restorer, active filter attached in series manner, UPQC etc. Among the existing power quality considerable devices, the UPQC has superior sag/swell compensation capabilities. Three main important regulated stages for UPQC can be develop to eliminate the sag on the system: 1) active power control producer in while an in-phase voltage is provided through sequence inverter, More widely noted as UPQC-P 2) reactive power compensation producer in while a quadrature voltage is introduce is noted as UPQC-Q and 3) a minimum VA loading producer in which a series voltage is applied at a certain angle,

Here in this paper known as UPQC-$VAmin$ .Among the precedent three parameters, the quadrature voltage introduce desired a maximum series introduce voltage, when the in-phase voltage booster desires the minimum voltage apply magnitude.

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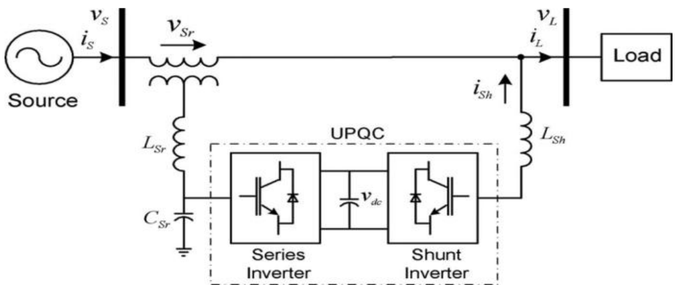

Fig.1 Unified power quality conditioner (UPQC) system configuration.

In a minimal VA loading concept, the sequence inverter voltage is introduced at a maximum angle with respect to the supply current. Excluding the sequence inverter inoculation, the current taken by the shunt inverter, to prolong the dc link voltage and the universal power balance in the system, plays an overriding role in ascertain the generally UPQC VA loading. Here In this paper on UPQC-V A decrease is intense on the maximum VA load of the sequence inverter of UPQC mostly throughout voltage sag problem. Because an out of phase element is demand to be introduce for voltage swell recompense.

Here, in this paper on UPQC-$VAmin$ is attentive on the optimal VA load of the in series inverter of UPQC mostly, during voltage sag in condition. Hence an out of phase component is desired to be applied for voltage swell element, the suggest VA loading in UPQC-$VAmin$ resolution on the beginning of voltage sag, may not be at outstanding value. A comprehensive exploration on VA loading in UPQC-$VAmin$ investigation both voltage sag and voltage swell methods are more important. Here, in this paper the approve a method of power angle control (PAC) of UPQC. The PAC approach of recommend that with proper control of in series inverter voltage with the in series inverter profitably supports segment of the load reactive power necessity and hence minimize the wanted VA rating of the parallel inverter. Moreover, fundamentally this regularize reactive power allotment feature is experienced during common steady state problem without influence the response load voltage magnitude. The magnificent angle of series voltage inoculation in $UPQC - Vmin$ is measuring using by lookup table or another method is particle swarm optimization scheme. On the other way the PAC of UPQC concept regulate the series inoculation angle by calculating the power angle is measured in flexible by calculate the immediate load active/reactive power and thus, protect fast and correct estimation.

More to PAC of UPQC, the reactive power pass regulate used to shunt and series inverters are additionally done in a unified power flow controller (UPFC). A UPFC is utilize in a power transmission network considering a UPQC is engage in a power distribution network to operate the shunt and series recompense at the same time. The power transmission networks are normally operated under balanced and distortion-free background, opposite to power distribution networks that may having dc element, deformation, and unbalance. The primary factual of a UPFC is to regulate the passing of power at considerable frequency. Then, when working this power flow regulate in UPFC the transmission system voltage may not be prolonged at the constant value.

Moreover, in PAC of UPQC the load surface voltage is surely operated at rated value when working load reactive power divided by shunts and sequence inverters.

Here, in this paper the approach of UPQC is furthermore expanded for voltage sag and swell problems. This change approach is used to compensate voltage sag or swell while allotted the load reactive power between two inverters. In view of the sequel inverter of UPQC in this instance delivers both active and reactive power, it is specific the name UPQC-S (S for complex power notation). The key inclusion of this paper is defined as follows.

1) The series inverter of UPQC-S is capture advantages for simultaneous voltage sag or swells compensation problems and load reactive power compensation in correlative with shunt inverter.

2) In UPQC –S the exiting VA loading is production used to its maximum potential during all the operating possibilities opposite to $UPQC - VAmin$ where mainly center is to reduce the VA loading of UPQC through voltage sag problem.

3) The approaches of UPQC-S smother voltage sag as well as swell problems.

Here, in this paper a correct mathematical formation of PAC for UPQC-s is conveying out. The interconnection and more effectiveness of the suggest UPQC-S approaches are validated by simulation as well as empirical responses.

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FUNDAMENTALS OF PAC CONCEPT

A UPQC is one of the main appropriate devices to controlling the voltage sag or swell problems on the system. The rating of a UPQC is manage by the percentage of maximum quality of voltage sag are swell used to be compensated. Even although the voltage variations (sag or swell problems) is a short period of power quality condition.

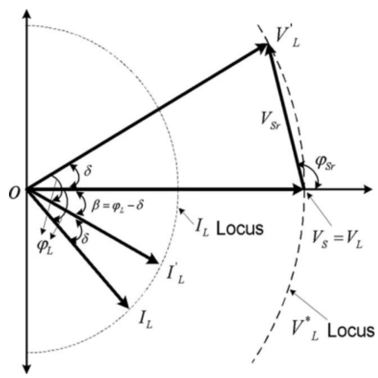

Fig.2. Concept of PAC of UPQC.

Hence, under balanced operating conditions the series inverter of UPQC approves that with actual control of the power angle linking the source and load voltages, while load reactive power requirement can be allotted by both shunt and series inverters without disarrange the overall UPQC ratings. The phase presentation of the PAC approach under a rated steady state infection as depicted in fig 2. Following to this thesis a vector V_{Sr} and a phase angle φ_{Sr} while applied through series inverter produce a power angle δ increase between the sources V_S and resulted load voltage $V_L^{'}$ administer the alike voltage levels. Then power angle changed source relative phase improvements between the supply voltage and resulted load current$I_L^{'}$. In other words with PAC approach the series inverter maintain the load reactive power essential and hence decreasing the reactive power demand allotment by using the shunt inverter.

For the steady-state disorder is

$$|V_S| = |V_L| = |V_L^*| = |V_L'| = k. \qquad (1)$$

Then, Phasor VSr can be obtained as

$$\delta = \sin^{-1}\left(\frac{Q_{Sr}}{P_L}\right) \qquad (2)$$

VOLTAGE SAG OR SWELL COMPENSATION UTILIZING UPQC-P AND UPQC-Q

The voltage sag problem on a system could be reduced through active power controlling and reactive power control approaches. The UPQC-Q method is limited range to compensate the sag problem on the system. Even although the UPQC-P control scheme can more effectively compensate both voltages sag and swell problems on the system. Furthermore to compensate an equally ratio of sag, the UPQC passion more magnitude of series applying voltage than the UPQC-P method.

Unusual, UPQC-Q also commit a power angle shifted between resulted load and source voltage levels but the shift is a purpose of an effect of sag problem on the system. When the phase shifted in UPQC-Q could not be perpetuate to change the load reactive power sustain. In additional the phase shifted in UPQC-Q is valid only throughout the voltage sag condition. Hence, here in this paper PAC approach is interconnected with active power controlling approach to manage simultaneous voltage sag or swell problems and the load reactive power maintain by using the sequence inverter of UPQC control multi functionality is called as UPQC-S. The More benefits of UPQC-S above the other command techniques are taken as follows.

1. The inverter which interconnected in sequence of UPQC-S could maintain both active power (for voltage sag or swell problems) and reactive power (for load reactive power problems) simultaneously and more over the name UPQC-S (S for complex power notation).
2. The realizable VA loading of UPQC is worm to its peak capabilities and thus comparing to general UPQC operations for same amount of sag mitigation the required rating of shunt inverter in UPQC-S will be lower.

PAC APPROACH UNDER VOLTAGE SAG CONDITION

Considering then the UPQC system is already operating under the PAC approach, i.e., both the inverters are reductions of the load reactive power and the introduce sequence voltage produce a power angle δ between resultant load and the definite supply voltages. If a sag/swell problem occurs on the system while both the inverters should retain applying the load reactive power, as they were ahead the sag condition. Additionally, the sequence inverter should also reduce the voltage sag/swell problems by introduce the appropriate voltage element. In other words, whatever of the changes in the supply voltage the sequence inverter should prolong same power angle δ between pair of the voltages.

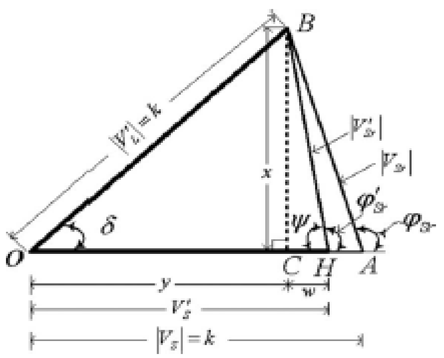

Fig. 3. Detailed phasor diagram to estimate the series inverter parameters for the proposed UPQC-S approach under voltage sag condition.

For the load reactive power recompense using PAC approach

$$\vec{V}_{Sr1} = \vec{V}'_L - \vec{V}_S \quad (3)$$

$$V_{Sr1}\angle\varphi_{Sr} = V'_L\angle\delta - V_S\angle 0^\circ. \quad (4)$$

For the voltage sag recompense using active power control concept

$$\vec{V}_{Sr2} = \vec{V}^*_L - \vec{V}'_S \quad (5)$$

$$V_{Sr2}\angle 0^\circ = V^*_L\angle 0 - V'_S\angle 0^\circ. \quad (6)$$

For the load reactive power and sag recompense

$$\vec{V}'_{Sr} = \vec{V}_{Sr1} + \vec{V}_{Sr2} \quad (7)$$

$$V'_{Sr}\angle\varphi'_{Sr} = V_{Sr1}\angle\varphi_{Sr} + V_{Sr2}\angle 0. \quad (8)$$

A.Series Inverter Parameter Estimation under Voltage Sag

In this method, the desired order of inverter parameters to obtained simultaneous load reactive power and voltage sag recompense are computed.

The voltage changing factor kf which is derived as the Ratio of the dissimilarity of instantaneous source voltage and rated load voltage magnitude levels to the rated load voltage magnitude values.

$$k_f = \frac{V_S - V^*_L}{V^*_L}. \quad (9)$$

For the sag problem under PAC

$$k_f = \frac{V'_S - V'_L}{V'_L} = \frac{V'_S - k}{k}. \quad (10)$$

To calculate the magnitude of VSr, in ΔCHB

$$|V'_{Sr}| = k.\sqrt{1 + n_O^2 - 2 \cdot n_O \cdot \cos\delta}. \quad (11)$$

To calculate the phase of VSr

$$\angle CHB = \angle\psi = \tan^{-1}\left(\frac{x}{w}\right) = \tan^{-1}\left(\frac{\sin\delta}{n_O - \cos\delta}\right) \quad (12)$$

So,

$$\angle\varphi'_{Sr} = 180^\circ - \angle\psi. \quad (13)$$

B.Shunt Inverter Parameter Estimation under Voltage Sag

The involve current introduce by the shunt inverter in order to process the UPQC-S below voltage sag compensation method is computed. The current ISh presents the demand current if the shunt inverter is worm alone to reduce the total load reactive power demand. To attain the voltage sag compensation problem although active power controls approach the source should supply increased current.

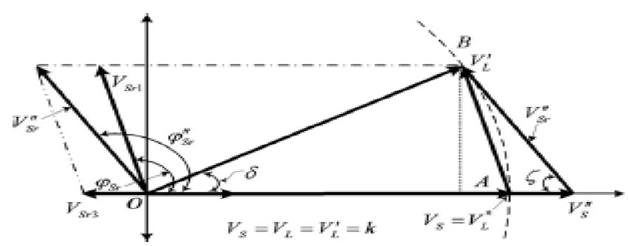

Fig. 4. Phasor representations of the proposed UPQC-S approach under voltage swell condition

To maintain the active power involve although voltage sag problem, the source provide the more source current.

Then voltage sag condition

$$I'_S = \frac{I_L}{1 + k_f} \cdot \cos\varphi_L. \quad (14)$$

So,

$$I'_S = k_O \cdot I_L \cdot \cos\varphi_L. \quad (15)$$

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As per ΔGFJ

$$I''_{\mathrm{Sh}} = \sqrt{(I'_L \cdot \sin\beta)^2 + [I'_L \cdot (\cos\beta - k_O \cdot \cos\varphi_L)]^2} \quad (16)$$

$$\rho = \tan^{-1}\left(\frac{\cos\beta - k_O \cdot \cos\varphi_L}{\sin\beta}\right)$$
(17)

So,

$$\angle\varphi''_{Sh\_S} = \angle\rho + 90^\circ$$
$$\angle\varphi''_{\mathrm{Sh}\_L} = (\angle\rho + 90^\circ) - \delta.$$
(18)

Consequently, to maintain the sequence inverter to introduce the desired amount of voltage for load reactive power and sag recompense condition the parallel inverter allow now provide the current Ish. This obtained shunt recompense current would maintain the dc tie voltage at the fixed level. So, it changes the desired active power supplied linking the supply and shunt inverter, shunted inverter and series inverters (though dc tie) and finally, from sequence inverter to the load demand.

UPQC-S CONTROLLER

An in detailed controller for UPQC found on PAC control scheme is described. Here, in this paper the generation of referral signals for series inverter is considering. The series inverter operated the load voltage at the desired level; the reactive power required by the load remains constant irrespective of variations in the source voltage magnitude levels.

More even the power angle δ is prolonged at constant value below various working conditions. So, the reactive power allotted by the series inverter and consequently by the shunt inverter changes. The reactive power allotted by the series and shunt inverters could be remains at constant values by following the power angle to various under sag or swell and unique sag and swell conditions.

CONCLUSION

Here, in this paper a novel approaches of controlling complex power (simultaneous active and reactive power notations) although series inverter of UPQC is presented and called as UPQC-S. The considered approach of the UPQC-S method is mathematically developed and analyzed for voltage sag and swell and unique voltage sag and voltage swell conditions. The developed immense equations for UPQC –S can be utilized to estimate the required series supplied voltage and shunt compensating current outlines (the magnitude and phase angle) and then level magnitude of VA loading below voltage sag and swell problems in both the conditions.

The simulation and innovative results demonstrate the more effectiveness of the required approach of simultaneous voltage sag or swell and only sag and swell and load reactive power allotted features of series part of UPQC-S. The importance benefits of UPQC-S applications are: 1) the multifunction potential of series inverter to compensate voltage variation (sag, swell, etc.) while maintaining load reactive power 2) good utilization of series inverter rating of UPQC and 3) decreases in the shunt inverter rating due to the reactive power allotted by using the inverters.

REFERENCES

[1] R. C. Dugan, M. F. McGranaghan, and H. W. Beaty, lectrical Power Systems Quality.. New York: McGraw-Hill, 1996, p. 265.

[2] C. Sankaran, Power Quality. Boca Raton, FL: CRC Press, 2002, p. 202.

[3] R. A. Walling, R. Saint, R. C. Dugan, J. Burke, and L. A. Kojovic, “Summary of distributed resources impact on power delivery systems,” IEEE Trans. Power Del., vol. 23, no. 3, pp. 1636–1644, Jul. 2008.

[4] L. Gyugyi, “Unified power-flow control concept for flexible AC transmission systems,” IEE – C Gene. Trans. Distr., vol. 139, no. 4, pp. 323–331, Jul. 1992.

[5] N. G. Hingorani and L. Gyugyi, Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems. New York: IEEE Press, 2000, p. 432.

[6] V. K. Sood, HVDC and FACTS Controllers – Applications of Static Converters in Power Systems. Boston, MA: Kluwer, 2004, p. 295.

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