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Iupqc Controller to Improve Grid Voltage Regulation

Vishakha chavan
Electrical Engg. Department
GESRHSCOE,Sapat
Nashik, India.

Prof. S. G. Khdilkar
Electrical Engg. Department
GESRHSCOE,Sapat
Nashik, India.

Prof.S.K.Pund
Electrical Engg. Department
SIER, Agaskhind
Nashik, India

Abstract-: ***This topic describe an improved controller for the dual topology of the unified power quality conditioner (iUPQC) extending its applicability in power-quality compensation, as well as in microgrid applications. By using this controller, beyond the conventional UPQC power quality features, including voltage sag/swell compensation, the iUPQC will also provide reactive power support to regulate not only the load-bus voltage but also the voltage at the grid-side bus. other words, the iUPQC will work as a static synchronous compensator (STATCOM) at the grid side, while providing also the conventional UPQC compensations at the load or microgrid side. Experimental results are provided to verify the new functionality of the equipment.***

In the improved iUPQC controller, the currents synthesized by the series converter are determined by the average active power of the load and the active power to provide the dc-link voltage regulation, together with an average reactive power to regulate the grid-bus voltage. In this manner, in addition to all the power-quality compensation features of a conventional UPQC or an iUPQC, this improved controller also mimics a STATCOM to the grid bus. This new feature enhances the applicability of the iUPQC and provides new solutions in future scenarios involving smart grids and microgrids, including distributed generation and energy storage systems to better deal with the inherent variability of renewable resources such as solar and wind power Moreover, the improved iUPQC controller may justify the costs and promotes the iUPQC applicability in power quality issues of critical systems, where it is necessary not only an iUPQC or a STATCOM, but both, simultaneously. Despite the addition of one more power-quality compensation feature ,the grid-voltage regulation reduces the inner-loop circulating power inside the iUPQC, which would allow lower power rating for the series converter.

The experimental results verified the improved iUPQC goals .The grid-voltage regulation was achieved with no load, as well as when supplying a three-phase nonlinear load. These results have demonstrated a suitable performance of voltage regulation at both sides of the iUPQC, even while compensating harmonic current and voltage imbalances.

Keywards: iupqc,statcom

I. INTRODUCTION

Now a day's power-electronics devices have brought about great technological improvements. However, the increasing number of power-electronics-driven loads used generally in the industry has brought about uncommon power quality problems. In contrast, power-electronics-driven loads generally require ideal sinusoidal supply voltage in order to function properly, whereas they are the most responsible ones for abnormal harmonic currents level in the distribution system. In this scenario, devices that can mitigate these drawbacks have been developed over the years. Some of the solutions involve a flexible compensator, known as the unified power quality conditioner (UPQC) [1]–[7] and the static synchronous compensator (STATCOM) . Actually, in a Practical implementation, the performance of the upqc is degenerated by the limited capability of the pwm controls to track accurately their non sinusoidal references. To overcome the above mentioned drawbacks of the conventional upqc, this topic describe a dual approach, called Here as iupqc. The idea consists in having both the series and the shunt converter of the iupqc being controlled as a sinusoidal current source and as a sinusoidal voltage source, respectively.

II.POWER QUALITY TECHNIQUES

- **What is Power Quality?**

The term power quality embraces all the aspects associated with amplitude, phase and frequency of the voltage and current waveforms existing in the power circuit. Poor power quality may occur due to transient conditions in the power circuit or from the installation of non-linear loads.

Following are the core terms and definitions that are used in association with power quality:

Voltage swells – An oversupply of voltage from the power from 0.5 cycle to one minute.
Interruption –Loss of supply voltage in one or more phases for one minute or more than one minute.
Transients – voltage disturbances shorter than sags or swells, which are caused by sudden changes in the power systems.
Voltage unbalance –The voltages of a three-phase voltage source are not identical in magnitude or the phase differences between them are not 120 electrical degrees.

Harmonics – Steady-state deviation in the voltage or current waveform from an ideal sine wave, which are sinusoidal voltages or currents having frequencies that are whole multiples of the frequency at which the supply system is designed to operate (50Hz).Long duration voltage interruption – Complete loss of supply voltage in the RMS supply voltage at fundamental frequency for period exceeding one minute.

- **Power Quality Improvement Techniques And Solution**

Basu et al (2002) have introduced power quality improvement techniques and solutions. The problems can be viewed as the difference between the quality of power supplied and the quality of the power required for reliable operation of the load equipment. Using this view point,the power quality problems can be resolved in to one of the three ways, listed as follows:

- Reducing the power supply disturbances.
- Improving the load equipment immunity to disturbances.
- Inserting corrective equipment between the electrical supply and the sensitive loads

Solution of power quality by using FACT devices

- **FACTS:**

Flexible alternating current transmission system is an integrated or collective system used for the purpose of better control enhance power transfer, better reliability and faster operation of power system network.

IEEE has given the definition of FACTS as “A power electronic based system and other static equipment that provide control of one or more AC transmission system parameters to enhance controllability and increased power transfer capability". Thus fact is a collective name given to application of power electronics for power flow and other quantities control for enhanced operating conditions. hence under facts system not one but controlling schemes will come which are trying to control one or more AC system parameters.

Basic Types Of FACT’S Controllers:

In general, FACTS Controllers can be divided into four categories:

1. Series Controllers.

2. Shunt Controllers.

3. Combined series-series Controllers.

4. Combined series-shunt Controllers.

1. Series Controllers: The series Controller could be a variable impedance, such as capacitor, reactor, etc., or a power electronics based variable source of main frequency, sub synchronous and harmonic frequencies (or a combination) to serve the desired need. In principle, all series Controllers inject voltage in series with the line. Even variable impedance multiplied by the current flow through it, represents an injected series voltage in the line. As long as the voltage is in phase quadrature with the line current, the series Controller only supplies or consumes variable reactive power. Any other phase relationship will involve handling of real power as well.

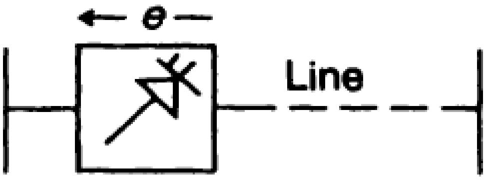

Fig 1:-Series Controller

2. Shunt Controllers: As in the case of series Controllers, the shunt Controllers may be variable impedance, variable source, or a combination of these. In principle, all shunt Controllers inject current into the system at the point of connection. Even a variable shunt impedance connected to the line voltage causes a variable current flow and hence represents injection of current into the line. As long as the injected current is in phase quadrature with the line voltage, the shunt Controller only supplies or consumes variable reactive power. Any other phase relationship will involve handling of real power as well.

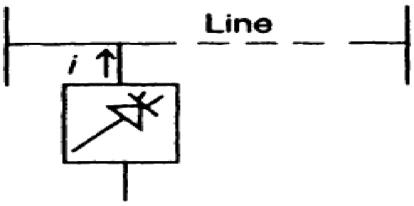

Fig 2:-Shunt Controller

3. Combined series-series Controllers: This could be a combination of separate series controllers, which are controlled in a coordinated manner, in a multiline transmission system. Or it could be a unified Controller,in which series Controllers provide independent series reactive compensation for each line but also transfer real power among the lines via the power link. The real power transfer capability of the unified series-series Controller, referred to as Interline Power Flow Controller, makes it possible to balance both the real and reactive power flow in the lines and thereby maximize the utilization of the transmission system. Note that the term "unified" here means that the de terminals of all Controller converters are all connected together for real power transfer.

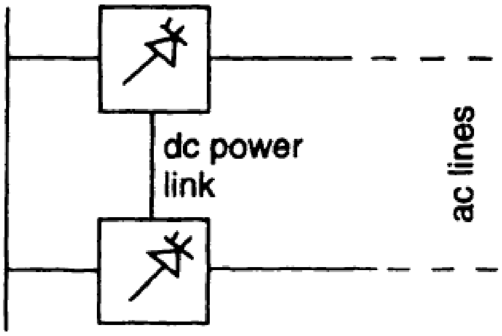

Fig 3:-Combined Series-Series Controllers

4. Combined series-shunt Controllers: This could be a combination of separate shunt and series Controllers, which are controlled in a coordinated manner [Figure 1.4(e)], or a Unified Power Flow Controller with series and shunt elements [Figure 1.4(f)]. In principle, combined shunt and series Controllers inject current into the system with the shunt part of the Controller and voltage in series in the line with the series part of the Controller. However, when the shunt and series Controllers are unified, there can be a real power exchange between the series and shunt Controllers via the power link.

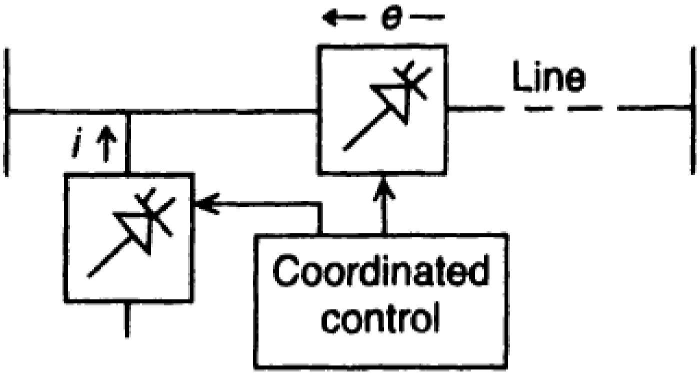

Fig 4:-Combined series-shunt Controllers

III. IUPQC CONFIGURATION

The power circuit of a UPQC consists of a combination Of a shunt active filter and a series active filter connected In a back-to-back configuration. This combination allows the simultaneous compensation of the load current and the supply Voltage, so that the compensated current drawn from the grid And the compensated supply voltage delivered to the load are Kept balanced and sinusoidal. The dual topology of the UPQC, I.e., the iupqc, was presented in [14]–[19], where the shunt Active filter behaves as an ac-voltage source and the series one As an ac-current source, both at the fundamental frequency. This is a key point to better design the control gains, as well As to optimize the *LCL* filter of the power converters, which Allows improving significantly the overall performance of the Compensator [20]. The STATCOM has been used widely in transmission networks .To regulate the voltage by means of dynamic reactive power Compensation.

Nowadays, the STATCOM is largely used For voltage regulation [9], whereas the UPQC and the iupqc Have been selected as solution for more specific applications [21]. Moreover, these last ones are used only in particular Cases, where their relatively high costs are justified by the Power quality improvement it can provide, which would be Unfeasible by using conventional solutions. By joining the extra Functionality like a STATCOM in the iupqc device, a wider Scenario of applications can be reached, particularly in case of Distributed generation in smart grids and as the coupling device In grid-tied microgrids.

In [16], the performance of the iupqc and the UPQC was Compared when working as upqcs. The main difference between These compensators is the sort of source emulated by the Series and shunt power converters.

In the UPQC approach, the Series converter is controlled as a non-sinusoidal voltage source And the shunt one as a non sinusoidal current source. Hence, in Real time, the UPQC controller has to determine and synthesize Accurately the harmonic voltage and current to be compensated. On the other hand, in the iupqc approach, the series converter Behaves as a controlled sinusoidal current source and the shunt Converter as a controlled sinusoidal voltage source. This means That it is not necessary to determine the harmonic voltage and current to be compensated, since the harmonic voltages appear Naturally across the series current source and the harmonic Currents flow naturally into the shunt voltage source.

In actual power converters, as the switching frequency increases, The power rate capability is reduced. Therefore, the Iupqc offers better solutions if compared with the UPQC in Case of high-power applications, since the iupqc compensating References are pure sinusoidal waveforms at the fundamental Frequency. Moreover, the UPQC has higher switching losses Due to its higher switching frequency. This paper proposes an improved controller, which expands The iupqc functionalities. This improved version of iupqc Controller includes all functionalities of those previous ones, Including the voltage regulation at the load-side bus, and now Providing also voltage regulation at the grid-side bus, like a STATCOM to the grid. Experimental results are provided to validate the new controller design.

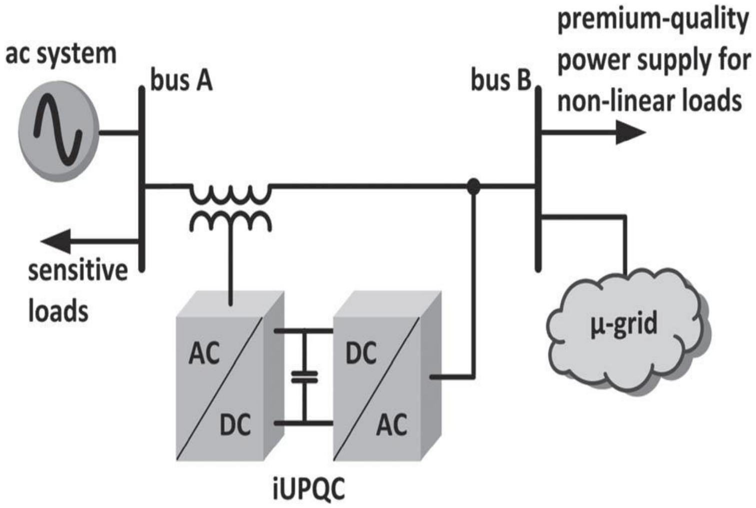

Fig 5:-IUPQC configuration

Advantages of FACTS:

- Increase of transfer of power without adding new transmission line.
- Transmission cost is minimized.
- Smooth steady state and dynamic control.
- Active damping of power oscillation.
- Improvement of system stability and voltage control.
- Provide greater flexibility in sitting new generation.
- Control of power flow in transmission corridors by controlling line impedance, angel and voltage
- Optimum power flow for certain objectives.
- Increase the loading capability of lines to their thermal capabilities including short term and seasonal .

CONCLUSION

In The Improved Iupqc Controller, The Currents Synthesized By The Series Converter Are Determined By The Average Active Power Of The Load And The Active Power To Provide The Dc-Link Voltage Regulation, Together With An Average Reactive Power To Regulate The Grid-Bus Voltage. In This Manner, In Addition To All The Power-Quality Compensation Features Of A Conventional UPQC Or An Iupqc, This Improved Controller Also Mimics A STATCOM To The Grid Bus. This New Feature Enhances The Applicability Of The Iupqc And Provides New Solutions In Future Scenarios Involving Smart Grids And Microgrids, Including Distributed Generation And Energy Storage Systems To Better Deal With The Inherent Variability Of Renewable Resources Such As Solar And Wind Power.

Moreover, The Improved Iupqc Controller May Justify The Costs And Promotes The Iupqc Applicability In Power Quality Issues Of Critical Systems, Where It Is Necessary Not Only An Iupqc Or A STATCOM, But Both, Simultaneously. Despite The Addition Of One More Power-Quality Compensation Feature.

The Grid-Voltage Regulation Reduces The Inner-Loop Circulating Power Inside The Iupqc, Which Would Allow Lower Power Rating For The Series Converter. The Experimental Results Verified The Improved Iupqc Goals. The Grid-Voltage Regulation Was Achieved With No Load, As Well As When Supplying A Three-Phase Nonlinear Load. These Results Have Demonstrated A Suitable Performance Of Voltage Regulation At Both Sides Of The Iupqc, Even While Compensating Harmonic Current And Voltage Imbalances.

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