Power quality improvement In single phase grid using photovoltic in UPQC

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Abstract - In this method a single-phase single-stage solar photovoltaic integrated unified power quality conditioner (PV-UPQC). The PV-UPQC consists of a shunt and series-connected voltage compensators connected back to back with common DC-link. The shunt compensator performs the dual function of extracting power from the PV array apart from compensating for load current harmonics. An improved synchronous reference frame control based on moving average filter is used for the extraction of load active current component for improved performance of the PV UPQC. The series compensator compensates for the grid side power quality problems such as grid voltage sags/swells. The compensator injects voltage in-phase/out of phase with point of common coupling (PCC) voltage during sag and swells conditions respectively. The proposed system combines both the benefits of clean energy generation along with improving power quality. The steady-state and dynamic performance of the system is evaluated by simulating in Matlab-Simulink under a nonlinear load. The system performance is then verified using a scaled- down laboratory prototype under several disturbances such as load unbalancing, PCC voltage sags/swells and irradiation variation

I. INTRODUCTION

UPQC

A Unified Power Quality Conditioner (UPQC) is an up-to-date PQ conditioning device of the custom power device family. The concept being relatively new is still being researched. It is speculated that this will be a universal solution to all power quality issues because of its voltage and current compensating capability. This research work focuses on the development of a laboratory prototype of a UPQC for application to problems of power quality in electrical networks. The UPQC is a power electronics based compensator which works on the principle of active filtering. It is a combination of Shunt (SHUC) and Series (SERC) Compensators, cascaded via a DC link capacitor. Based on the position of the SHUC and the SERC two configurations of a UPQC are possible. Each compensator of the UPQC consists of an IGBT based full bridge inverter, which may be operated in a 22 voltage or a current controlled mode depending on the control scheme. Inverter I (Series Compensator, SERC) is connected in series with the supply voltage through a low pass LC filter and a transformer.

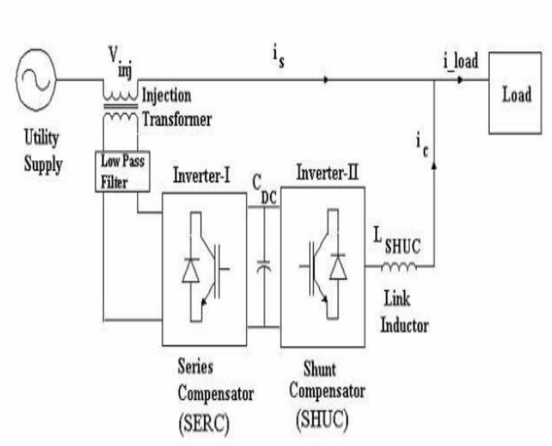


Figure. 1. 1 UPQC configuration

SERIES TRANSFORMER

The required voltage is generated in series by the APF so the voltage on the load side can be fully balanced and controlled. With the help of these transformers, a sine wave is injected into the transmission line. It is necessary to make sure that the turn rate of the series transformer is equal to the compensating voltage of the inverter. A low-pass filter is used to create a series of inverters to eliminate high-frequency voltage components and turn the voltage source. A high-pass filter is used in the output of the parallel inverter, so that the ripple is absorbed by the current switched to the current. Voltage disturbances are considered one of the most serious risks of power system stability and most electronic devices, such as personal computers, programmable logic controllers and variable speed drivers

FILTER TECHNIQUE

Filters are an integral part of many systems, especially in communications and tool systems. Filters cross one band and reject the other. It is generally implemented in one of three technologies passive RLC filters, active RC filters, and switch capacitor filters. Crystals and SAW filters are often used at very high frequencies. Passive filters work well at high frequencies, but at low frequencies, the required triggers are large, bulky, and not ideal. In addition, the inductors are difficult to produce in a single form and are incompatible with many modern assembly systems. Active RC filters use functional amplifiers, resistors and capacitors, and are manufactured using unique thick film and thin film technology. The effectiveness of these filters is limited by the performance of the operating amplifier (e.g., frequency response, bandwidth, noise, offset, etc.). Switch-capacitor filters are monolithic filters that usually provide better performance in terms of cost. Made using capacitors, switches and function amplifiers. Compared to passive LC or active RC filters, poorly performing filters generally adjust the frequency spectrum of the input signal according to the level of the transmission function. The signal phase properties are modulated as they go through the filter

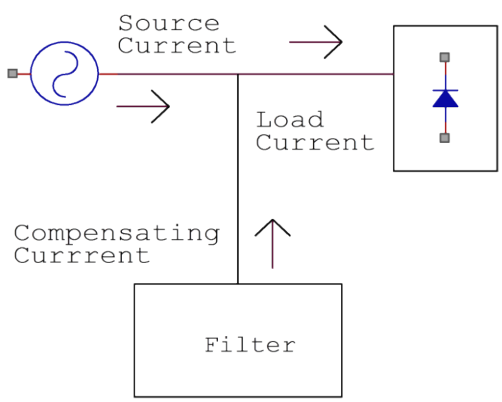


Figure 1.3 Basic operation of Filter

Power Quality

A variety of equipment can be used to improve power quality, from inexpensive (providing low security or compensation), expensive equipment (high level of protection or compensation) to the requirements of improving power quality. For example, intermediate voltage suppressors are used to detect surgeries and reduce them to safer conditions, while voltage regulators maintain voltage output within a certain range, despite fluctuations in input. Isolation transformers can be useful in compensating the high or low voltage required to change the voltage. The quality of the force depends on the network topology of the force, the amount of energy injected into the network of conform non-linear loads, and the intensity of the transition transients. Many modern power electronics face loads.

2. SOFTWARE DESCRIPTION

PROJECT DESCRIPTION

The proposed system that is going to be described in this phase is done using the Mat Lab Simulink model. In order to get the desired output, the simulation circuit has been methoded in Mat Lab software by using the respective components that is present in the Mat Lab Simulink. This simulation circuit will be described in detail below.

FEATURES

The MATLAB System

The MATLAB system consists of these main parts

SIMULINK DESCRIPTION

SIMULINK

A block diagram environment for multi domain simulation and Model-Based Method. It supports system-level method, simulation, automatic code generation, and continuous test and verification of embedded systems. Simulink provides a graphical editor, customizable block libraries, and solvers for modelling and simulating dynamic systems. It is integrated with MATLAB, enabling you to incorporate MATLAB algorithms into models and export simulation results to MATLAB for further analysis. To model a system and then simulate the dynamic behavior of that system. The basic techniques you use to create the simple model in this tutorial are the same techniques that you use for more complex models. To create this simple model, you need four Simulink blocks. Blocks are the model elements that define the mathematics of a system and provide input signals.

PERFORMANCE

A high-performance Simulink model compiles and simulates quickly. Simulink provides techniques that you can use to speed up model simulation. As a first step to improving simulation performance, use Performance Advisor. Performance Advisor checks for conditions that might be slowing down your simulations. The tool can automatically make changes to your model to address these conditions or you can review and apply suggested changes manually. Performance Advisor can check your model for conditions and settings that can slow down simulation speed.
It can recommend modeling Controllers, implement them automatically, and run simulations in accelerator mode for you. Use Accelerator and Rapid Accelerator modes to achieve faster simulation without changing the model itself. Achieve faster simulation with your models by manually employing some of these Controller techniques.

3. CONVENTIONAL METHOD EXISTING METHOD

The development of smart grid, the power quality problems are getting more and more serious, such as voltage sag/swell, voltage and current harmonic distortion and so on. The unified power quality conditioner (UPQC) has been used to improve multiple power quality problems which is an important developmental trend of current power system. In this method, a harmonic comprehensive detection algorithm based on improve p-q theory is proposed to be applied to the UPQC. The development of smart grid, the power quality problems are getting more and more serious, such as voltage sag/swell, voltage and current harmonic distortion and so on. A static synchronous compensator (STATCOM) has been used to improve multiple power quality problems which is an important developmental trend of current power system. In this method, a harmonic comprehensive detection algorithm based on improve p-q theory is proposed to be applied to the STATCOM. It can quickly and accurately detect a variety of power quality problems such as harmonic currents, voltage sag/swell, and unbalanced single-phase voltage. The enhanced low-pass filter an improved harmonic detection algorithm based on p-q theory under distorted and unbalanced source and load condition is presented in this method

DISADVANTAGES

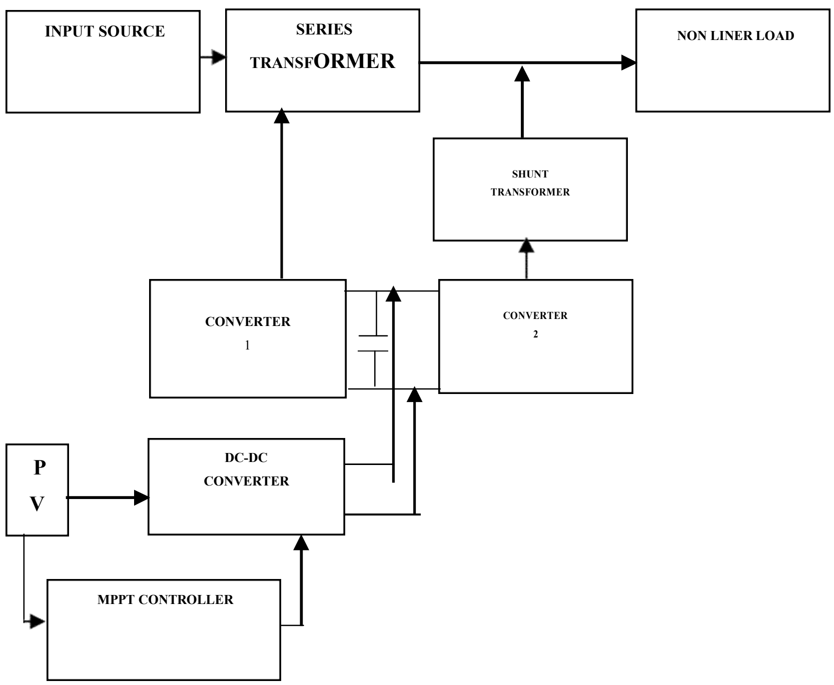
- Voltage unbalances could occurs between the different levels
- Requires accesses number of diode flying capacity inverter
- Central control is required and it is complicated
- Conduction loss is high
- Capacity expansion is difficult

PROPOSED METHOD

PV-UPQC is method for single-stage systems. PV UPQC has a parallel series compensator and a series compensator. Shunt compensation is attached to the load side. The solar photovoltaic array is integrated directly into the UPQC's

DC bus with a reverse barrier diode. The series operates in compensatory voltage control mode and compensates for the sagging/swelling of the grid voltage. Shunt and series compensators are integrated into the grid via interface triggers. A series compensator transformer is used to phase the voltage generated by the series compensator. Ripple filter is used to filter the harmonics generated by the switching action of the converter. The load used is a non-linear load with a bridge rectifier and a voltage feed load. PV Peak power of the output. PV Since the array is directly integrated into the DC connector of the UPQC, the PV array size must be equal to the MPPT voltage equal to the required DC connection voltage. This rating is based on PV. It allows the active power to be supplied to the load in the array and to supply the power in the lower phase under the estimated conditions. Detailed specifications for PV arrays are given in Appendix A. Other components method include interface inductors for serial and parallel compensators and serial injector transformers for serial compensators.

BLOCK DIAGRAM:



BLOCK DIAGRAM EXPLANATION:

- The main subsystems of PV-UPQC are the shunt compensator and the series compensator. The shunt compensator compensates for the load power quality problems such as load current harmonics and load reactive power.
- In case of PVUPQC, the shunt compensator performs the additional function of supplying power from the solar PV array. The shunt compensator extracts power from the PV-array by using a maximum power point tracking (MPPT) algorithm.
- The series compensator protects the load from the grid side power quality problems such as voltage sags/swells by injecting appropriate voltage in phase with the grid voltage.
- The shunt compensator extracts the maximum power from the solar PV-array by operating it at its maximum power point.
- The maximum power point tracking (MPPT) algorithm generates the reference voltage for the DC-link of PV-UPQC.

POWER FACTOR

Power factor is a power quality issue in that low power can sometimes cause equipment to fail. In many instances, the cost of low power factor can be high; utilities penalize facilities that have low power factor. Because they find it difficult to meet the resulting demands for electrical energy. Operating in a high power factor environment ensures that the power system is functioning efficiently. It also makes economic sense. Apparent power in an electrical system can be defined as being equal to voltage times current. Power factor may be viewed as the percentage of the total apparent power that is converted to real or useful power. Apparent power and power factor are not physical quantities by themselves, but they characterize physical phenomena, however in a way that may depend on the situation considered.

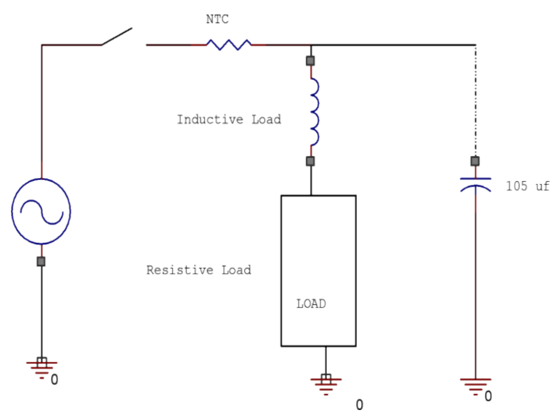


Figure 3.2 Schematic diagram of power factor

The caution is that in some special situations the same quantity may characterize more than a single phenomenon, but this is not necessarily the case in other or more general situations. However in non-sinusoidal situations and/or nonlinear load different power factors are proposed to express these situations. New definitions of electrical quantities in non-standard situations are needed because of the changes in the situation in power systems. Definitions of the power factor related to various quality aspects may be useful to compare and optimize the effectiveness of techniques for compensation of the loads with respect to the various quality aspects.

SERIES AND SHUNT INVERTERS

It is a voltage-source inverter connected equivalent circuit of UPQC was shown in the Fig. in series with AC line through a series transformer and acts as a voltage source to mitigate voltage distortions. It eliminates supply voltage flickers and imbalances from the load terminal voltage. Control of the series inverter output is performed by using pulse width modulation (PWM). Among the various PWM technique, the hysteresis band PWM is frequently used because of its ease of implementation. Also, besides fast response, the method does not need any knowledge of system parameters.

In this work hysteresis band PWM is used for the control. Equivalent circuit of a UPQC inverters. The details of the hysteresis control technique are analyzed in the subsequent sections. It is a voltage source inverter connected in shunt with same AC line which acts to cancel current, compensate reactive current of the load and Il = load current improve the power factor of the system. It also performs by series APF the DC link voltage regulation, resulting in a significant reduction of the DC capacitor rating. The output current of the control strategy used in both series and shunt converter is adjusted using a dynamic hysteresis converters are based on Synchronous Reference Frame band by controlling the shunt of the semiconductor. The conventional SRF method can be used to switches such that output current follows the reference extract the harmonics contained in the supply voltages or signal and remains in a predetermined hysteresis band.

Voltage Sag

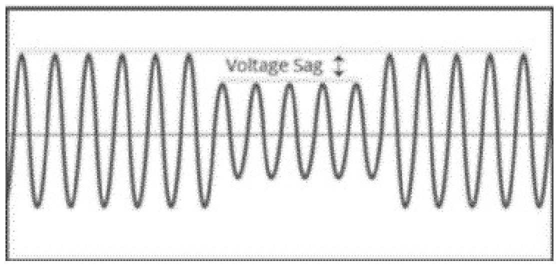


Figure: Voltage Sag Found In Supply Voltage

Voltage Sag is the decrease in RMS voltage of power frequency for a time span of half cycles to 1 minute. Voltage sag is a severe and drastic PQ issue especially with sensitive loads which are voltage sensitive like equipment for control processing, adjustable speed drives (ASD) and computers. It can also be manipulated as a short duration reduction in voltage as a consequence of a sudden abrupt increase in current value. Few of the common industrial situations where voltage sags could be visible are energizing of transformer, starting process of motor, and typical faults. Voltage sags have become increasingly important when considering the various power quality issues that cause inconvenience to customers. For some customers voltage sags cause especially high costs. Thus, power distribution companies should understand the voltage sags experienced in their networks and their options in terms of decreasing the influence of voltage sags. In this thesis, voltage sag mitigation includes the use of conventional means and regular power system components.

The method uses only input data that is typically available and the basic fault calculations already in use in power distribution companies. The thesis also presents calculated and measured voltage sag distributions from Finnish power distribution networks. In addition, the thesis shows how various, specific power system characteristics affect the sag distribution. Sag-sensitive customers should be supplied by their own main transformers and the local distribution network kept as limited as possible. For overhead line networks, power distribution transformers should be protected against over voltages using surge arresters instead of spark gaps. Underground cables are superior to overhead line networks, but mixed networks having both underground cables and overhead lines in the same distribution network should be avoided. Surprisingly, the increased level of distribution automation often gives rise to the most severe voltage sags. Since basic decisions in the development of power distribution networks may have a positive as well as negative influence on voltage sag characteristics, more awareness of these effects is needed, the main focus has been voltage sags. However, voltage sags represent only one power quality issue to be taken into account in the planning and operation of power distribution networks. Thus, voltage sag analysis should not be a separate part of power distribution planning but should be included as one, important element in a comprehensive power system analysis. The economic calculations presented in this thesis showing the especially high costs caused by voltage sags strengthen this claim.

Voltage Sag is the most severe problem in the power quality. Voltage sag is the decrease in voltage between 10% and 90% of nominal voltage for half cycle to one minute. Sags account for the vast majority of power problems experienced by end users they can be generated both internally and externally from an end users facility. External causes of sags primarily come from the utility transmission and distribution network. Sags coming from the utility have a variety of cause including lightning, animal and human activity, and normal and abnormal utility equipment operation.

Voltage Swell

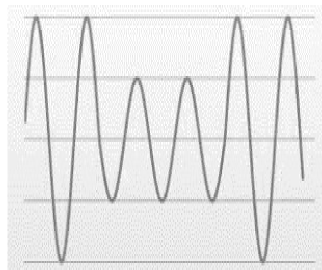


Figure 3.3Voltage swell found in supply voltage

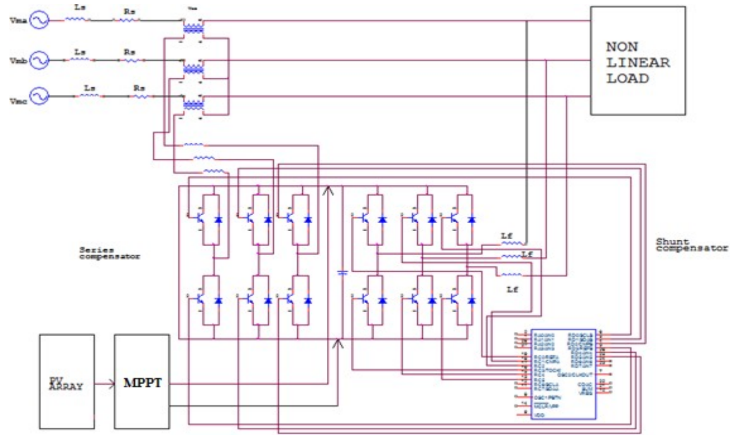
Voltage swell is a sudden increase in the RMS supply voltage varying in a range from 1.1p.u. to 1.7 p.u., with an approximate time range of from half a cycle to 1 min. These appear due to large loads sudden shutdown, capacitor banks getting energized, or due to few faults produced inside the power system. Its occurrence probability appear when compared to voltage sags is very much less, but these are more harmful to sensitive equipment/non-linear loads. A swell is the opposite of a sag - an increase in voltage above 110% of nominal for half cycle to one minute. Although swells occur infrequently when compared to sags, they can cause equipment malfunction and premature wear. Swells can be caused by shutting off loads or switching capacitor banks on

ADVANTAGES:

- The minimum ratings of the shunt converter and series converter of the UPQC in order to obtain the maximum utilization rates of the power converters in the UPQC
- The performance of the method UPQC has verified the feasibility of the proposed algorithms.
- The minimum VA rating of UPQC is selected by using the variable PAC method. It will increase the utilization rate of the converters and reduce the manufacturing cost of the system.
- Can provide smooth changeover of the displacement angle during the transient state.
- The proposed algorithms can be applied in the advanced UPQC topologies, e.g., transformer less UPQC, to increase the utilization rate of the converters in the system

4. RESULT AND DISCUSSION

CIRCUIT DIAGRAM



5. CONCLUSION

The dynamic performance of Single phase PV-UPQC have been analyzed under conditions of variable irradiation and grid voltage sags/swells. The performance of the system has been validated through experimentation on scaled down laboratory prototype. It is observed that PV UPQC mitigates the harmonics caused by nonlinear load and the system is found to be stable under variation of irradiation, voltage sags/swell and load unbalance. The performance of d-q control particularly in load unbalanced condition has been improved through the use of moving average filter. It can be seen that PV-UPQC is a good solution for modern distribution system by integrating distributed generation with power quality improvement.

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