The Power Quality Improvement with Harmonic Reduction and Stabilizing main Grid

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Abstract - *Until recently, most of the power system equipment in industrial grids has been operating with deviations from the nominal voltage and frequency supplied by the utility. However, power electronics based equipment is vulnerable to such deviations and might get damaged in case of possible grid faults. This project addresses this issue by proposing a stabilizing device that can be connected between the public grid and the industrial grid which provides not only power quality and security of supply during fault for the industrial grid but also ensuring the power quality for the public grid.*

Most power quality issues are hidden from normal utility bills and plant information systems, but their consequences include plant downtime, reduced capacity, production waste, premature equipment failure, utility penalties, and significant financial impact. In recent years, electric utilities' ability to deliver reliable clean power has become increasingly more difficult. In their rush to meet renewable energy portfolio standards, solar and wind farms have created serious grid stability challenges. This strain on utilities, in combination with the increase in electronic equipment used in industrial facilities means power quality events are only increasing. For many, power quality monitoring is intimidating. The perceived complexity of detecting, analyzing, and solving power quality issues like sags, swells, transients, harmonics, and power factor means it isn't generally isn't part of a normal plant information system. But as the sole party responsible for protecting their own equipment, owners can't afford to sweep power quality under the rug any longer. They must understand the four major power quality issues in order to mitigate costs and improve process reliability.

Key Words: Power quality, harmonic, public grid.

1. INTRODUCTION

The electric utility environment has never been operated with constant voltage and frequency. Until recently, most electrical equipment could operate satisfactorily with some deviations in nominal voltage and frequency supplied by the utility. In the modern industrial facility, there is an increasing shares of power electronics-based equipment such as AC drives, DC drives and switch mode power supplies as well as power electronics-based devices like computers and programmable logic controllers (PLC's) installed by industries. Due to this, the quality of power supply becomes crucial for the safety and stable operation of such equipment due to its vulnerability to the power system disturbance

There are several electrical disturbances that commonly affect industrial processes. The disturbances that have the greatest effect on industrial processes are voltage sags, capacitor switching, surges and harmonics. One disturbance example (i.e. voltage sag) is shown in Fig. Such disturbances, which have been considered to be acceptable for many years now, may cause disruptions to current industrial power systems.

Such disruptions can lead to loss of production for a number of hours and result in huge loss of revenue for the industrial customer.

The work presented in this paper addresses the afore-mentioned issues and proposes a solution for ensuring security of power supply and appropriate power quality for industrial loads during power system faults, while ensuring system stability at the power system side. This solution consists of the grid integration of a device at the point of common coupling (PCC) of the industrial grid to the public grid and has grid stability support functionalities such as voltage control and filtering of harmonics. This paper also gives insights concerning the benefits in installing such a device for both the public grid and the industrial load in case of different operation modes.

2. SYSTEM DESCRIPTION

The system consists of renewable energy sources connected to dc-link of a grid interfacing in this fig.

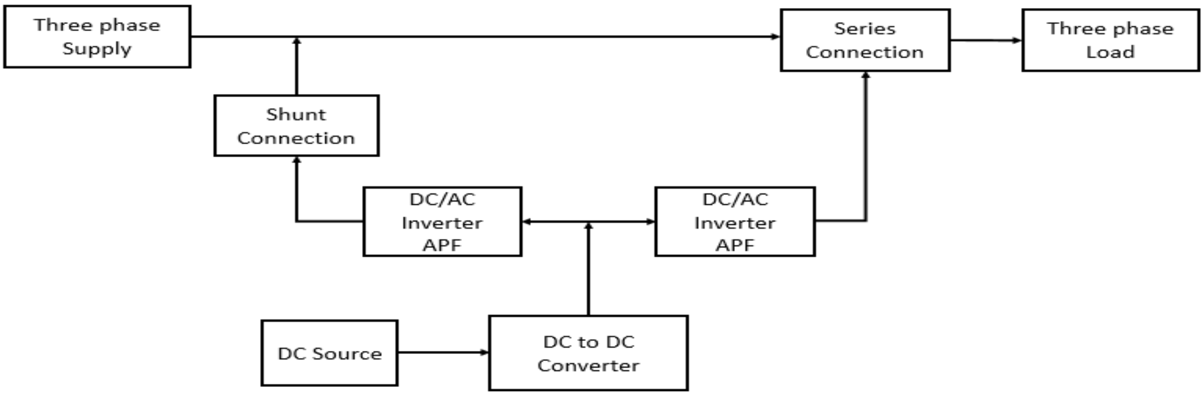

Fig. 1: Power quality improvement with harmonic reduction and stabilizing main grid.

The schematic representation of the integrated grid is shown in fig. The functionalities of the different parts inside the integrated grid are briefly explained below:

The AC/DC converter is used not only to charge the energy storage from the grid side during the normal operation of the grid and but also to provide the harmonic compensation up to 13th order at the grid side through the transformer (20 kV/0.4 kV) in order to maintain the total harmonic distortion (THD) and individual harmonic distortion in terms of voltage at the PCC (point of common coupling) within the grid code required limit during the time when the industrial grid is injecting harmonics into the public grid.

The DC/AC converter provides the voltage support functionality by varying the magnitude and phase angle of the voltage at the low voltage side of the booster transformer. The Booster transformer is used to control the voltage at the high voltage side by modifying the voltage magnitude at the low voltage side.

The DC/DC converter is used to control the charging of the energy storage during the normal operation. However, during a fault at grid side, the DC voltage is controlled to provide voltage support with the help of the capacitor (energy storage) at the load side through the DC/AC converter. The energy storage provides through the DC/DC converter energy for the DC/AC converter to compensate voltage sags. It is charged from the grid during normal operation through the AC/DC converter.

The detailed model of the integrated grid device suitable for RMS (Root Mean Square) and EMT (Electromagnetic Transient) simulations has been developed in order to check its functionalities for different operation modes.

For this purpose, the Power Factory simulation environment has been chosen. The investigations consist of simulating different types of faults occurring in the public grid and testing the unit's functionalities. The purpose of the studies is to support the design and the control development of the real physical device, which is currently being developed by industrial partners.

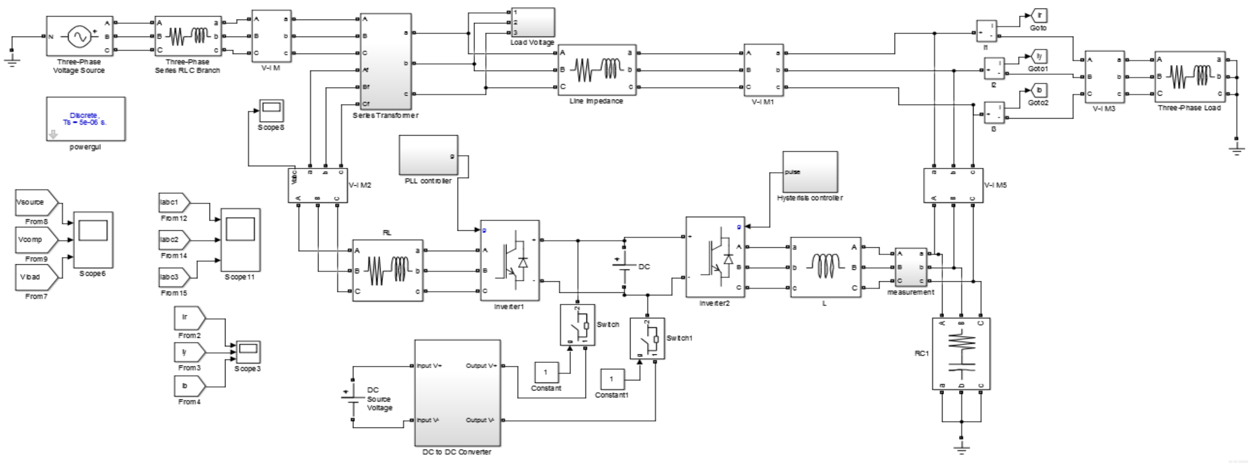

Fig -2: Simulation design of power quality improvement with harmonic reduction and stabilizing main grid.

3. RESULTS

The system was simulated using MATLAB / Simulation model to verify the given proposed method. The power quality improvement with harmonic reduction and stabilizing main grid is presented with PLL method for series connection and hysteresis method for shunt connection are used.

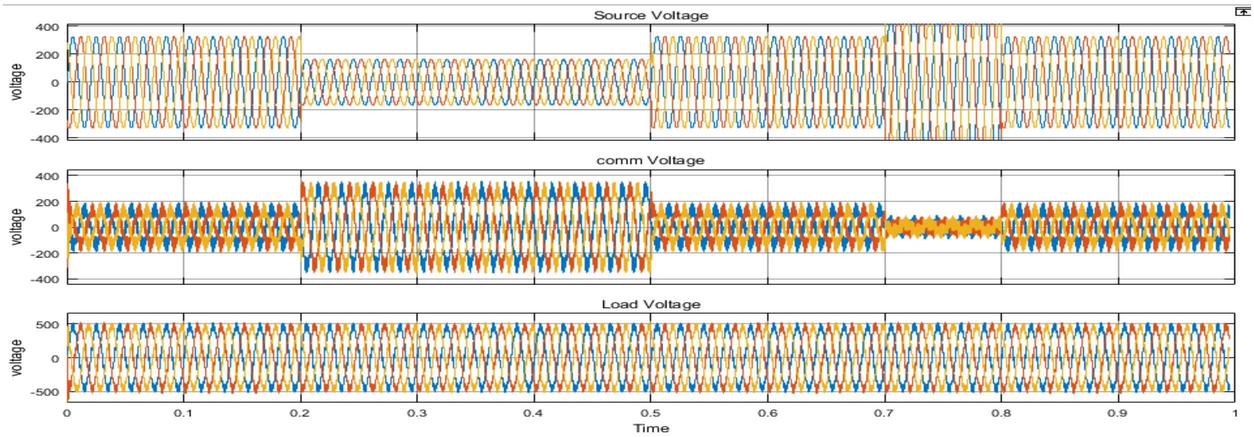

Fig -3: Voltage Compensation

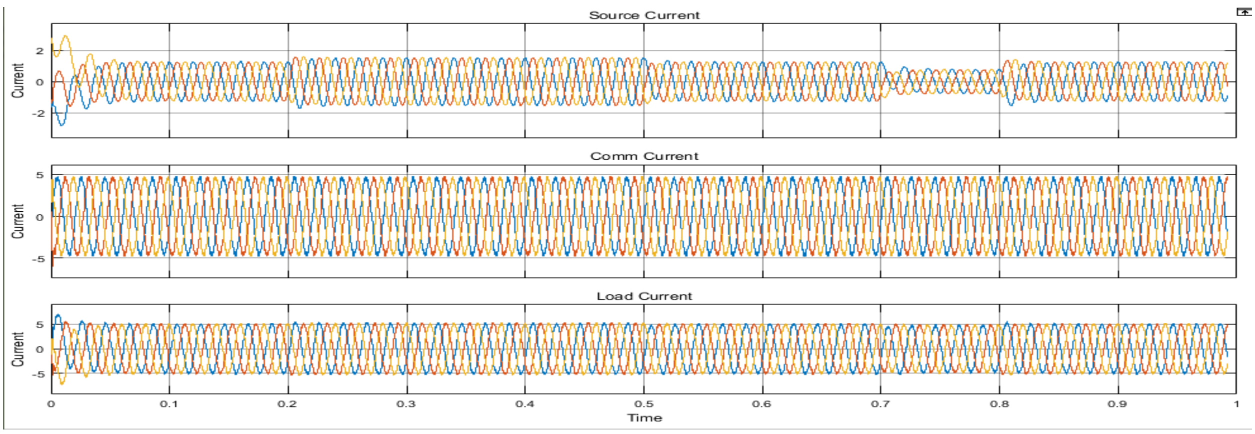

Fig -4: Current Compensation

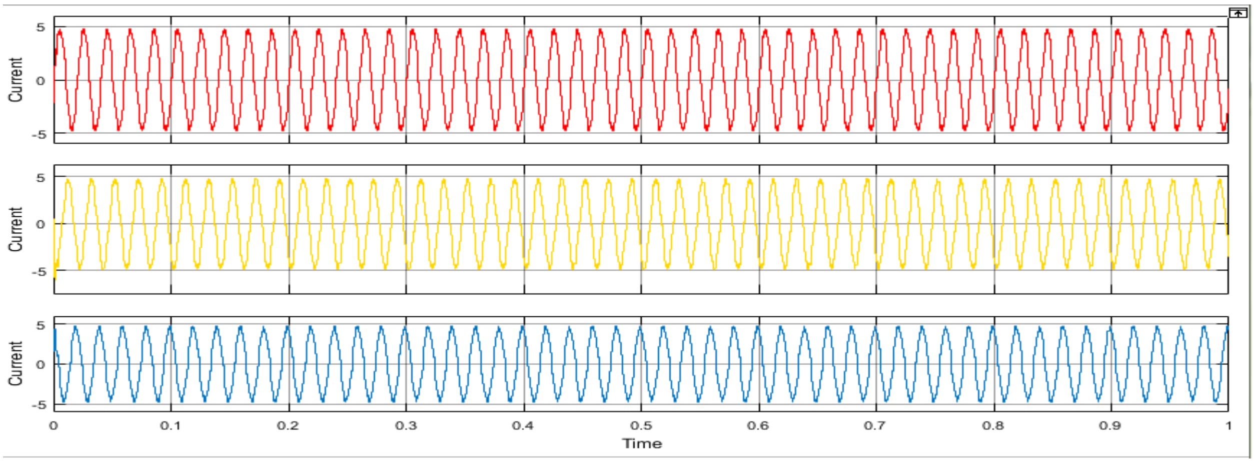

Fig -5: Individual Output Current

4. CONCLUSIONS

The power Electrical system reliability and normal operation of electrical equipment rely heavily upon a clean distortion free power supply. Designers and engineers wishing to reduce the level of harmonic pollution on a power distribution network where nonlinear harmonic generating loads are connected have several harmonic reduction techniques available. Because of the number and variety of available methods, selection of the best-suited technique for a particular application is not always an easy or straightforward process. A power quality improvement in grid connected renewable energy source at distribution by using three phase four wire inverters. The inverter is used to DC to AC at desired voltage level of the grid. Harmonics level of supply currents is 28% without filtering, after implementing filter the harmonic level is reduced to 2.94%. The grid interfacing inverter injected real power from Renewable Energy Sources and effectively utilized at lagging demands. The neutral current is prevented to flow to the grid this is done by 4th leg of inverter to compensated neutral current as nearly equal to Zero. The Total Harmonic Distortion level of the grid current is reduced hence improved the power quality.

It is future demonstration the Power quality under 3 different conditions. PRES=0, PRES<total load power (PL); and PRES >PL. The current unbalance, harmonics at distribution system level, and active power support due to unbalance load connected to the distribution system.

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