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A Grid Coordination Rule Using Hybrid Active Power Filter

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Abstract: This paper deal with the A grid coordination rule using hybrid active power filter. A remarkable appearance is made by renewable energy in today technology. The main purpose of renewable energy is to reduce the dependency on petrol based generations. The combination of wind energy, hydro energy, solar power, etc. created certain problems like stability problem, power quality issues in the grid. These problems were reduced by using passive filters, but in today's technology it is replaced by active filter like Static Synchronous Compensator (STATCOM) and Dynamic Voltage Restorer (DVR). STATCOM regulates the voltage level while DVR solves the voltage power quality issues. In the existing system DC source, non linear load and PI controller is used. In the propose system the DC source will be replace by solar panel to provide fixed voltage to the system with a Neural network replace PI controller the Neural network overcome the problems of overshoot and remove delay time and inverse response. In the propose system non linear load will be replace by variable non linear load.

Keywords: STATCOM; DVR; Wind Turbine; Grid; Active power filter

1. INTRODUCTION

Now a day's power electronic based equipment are used in industrial and domestic purpose. These equipments have significant impact on the quality of supplied voltage and have increased the harmonic current pollution of distribution systems. They have many negative effects on power system equipment and customer such as additional losses in overhead and underground cables, transformers and rotating electric machines, problem in the operation of the protection systems, over voltage and shunt capacitor, error of measuring instruments, and malfunction of low efficiency of customer sensitive loads. Passive filter have been used traditionally for mitigating the distortion due to harmonic current in industrial power systems. But they have many drawbacks such as resonance problem dependency of their performance on the system impedance, absorption of harmonic current of nonlinear load, which could lead to further harmonic propagation through the power system. To overcome of such problem active power filters is introduced. It has no such drawbacks like passive filter. They inject harmonic voltage or current with appropriate magnitudes and phase angle into the system and cancel harmonics of nonlinear load.

Active power filters (APF) generate either harmonic currents or voltages in a manner such that the grid current or voltage waves conserve the sinusoidal form. The APFs can be connected to the grid in series (Series APF), shunt (SAPF) to compensate voltage harmonics or current harmonics respectively. Or can be associated with passive filters to construct the hybrid filters (HAPF).

1.1 Shunt Active Power Filter: The voltage sourced inverter based Shunt APF is similar to STATCOM. It is connected in shunt at the PCC. It injects the current which is equal and opposite to the harmonic current. It acts as a current source injecting harmonics and is suitable for any type of load. It also helps in improving the load power factor. The circuit diagram of the power system with shunt connected APF is shown in Fig. 2.4. The cost of these filters is relatively higher and so not preferred for large scale system.

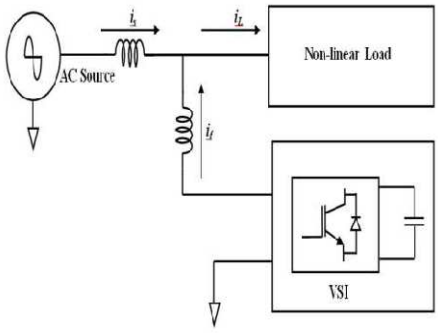

Figure1: Shunt Active Power Filter

1.2 Series Active Power Filter: As the name indicates, these filters are connected in series with the line through a matching transformer. This filter injects the compensating voltage in series with the supply voltage. Thus, it acts as a voltage source which can be controlled to compensate the voltage sag/swell. These filters have their application mainly where the load contains voltage sensitive devices. The circuit diagram of the power system with series connected APF is shown in Fig. These filters are not used practically since they are required to handle high current rating which increase the size of the filter as well as the losses occurring the filter.

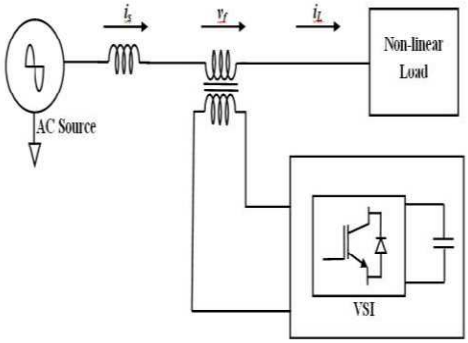

Figure2: Series Active Power Filter

1.3 Static Synchronous Compensator (STATCOM): The STATCOM has been reported to improve the power quality in power systems with DG integration of wind. STATCOM can be implemented to regulate the voltage as a shunt compensator for the WTIG. It is a Battery Energy Storage System (BESS) connected to a DC link capacitor which itself connected to a Voltage Source Converter (VSC).

The STATCOM is shunt connected and uses in this paper a Hysteresis current control method to inject a current in the system to counter the harmonics created by the non-linear load and the WTIG. The basic STATCOM model is shown in Fig.1. It is a solid-state switching converter, capable of generating or absorbing independently controllable real and reactive power at its output terminals when it is fed from an energy source.

STATCOM is considered as voltage-source converter that, from a given input of dc voltage, produces a set of 3-phase ac-output voltages, each in phase with and coupled to the corresponding ac system voltage through a relatively small reactance.

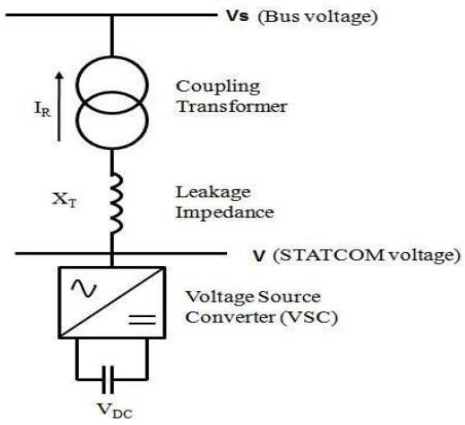

Figure3: Basic STATCOM Model

1.4 DVR Model: The DVR is used to protect critical or sensitive loads by mitigating the effects of voltage sags or swells on the distribution feeder due to faults in the system by maintaining constant voltage magnitude. It is basically a BESS connected to an inverter which itself is connected to an injected transformer that is mounted in series with the 3 phase sensitive load.

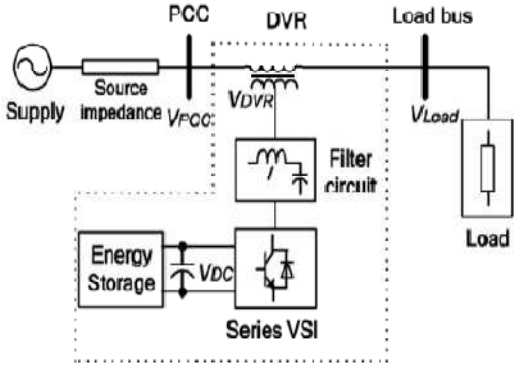

Figure4: DVR Basic Model

The DVR can compensate voltage sags by injecting reactive power or real and reactive power. This depends on the depth and width of the sag or swell. As for the control of the DVR many techniques exist to control the voltage injection, the chosen one is the Space Vector Pulse Width Modulation (SVPWM) which is proven very effective and gives a better result than conventional PWM in terms of THD and power quality. The reference phase consists of: phase, frequency and magnitude components. All will vary to some point during normal network operation [15].

The block diagram of the control system used is shown in Fig. 4. The control system of a DVR plays an important role, with the requirements of fast response in the face of voltage sags and variations in the connected load. This paper uses an open loop control for the DVR system using PLL. The PLL is to synchronize the DVR with the power system by generating a reference voltage to be compared with the actual one.

1.5 Wind Turbine Induction Generator: The wind turbine needs a relatively large amount of reactive power to operate. This power must be fed externally whether from a capacitor bank, or a controlled inverter, or from the electrical synchronous grid. The reactive power absorbed by the WTIG causes the

voltage on the bus where the generator is connected to drop, and the system build up will raise the voltage again to the nominal voltage of the grid.

2. GRID COORDINATION RULE

The American Wind Energy Association (AWEA) led the effort in the united state for adoption of the grid code for the interconnection of the wind plants to the utility system. The first grid code was focused on the distribution level, after the blackout in the United State in August 2003. The United State wind energy industry took a stand in developing its own grid code for contributing to a stable grid operation. The grid quality characteristics and limits are given for references that the customer and the utility grid may expect.

According to Energy-Economic Law, the operator of transmission grid is responsible for the organization and operation of interconnected system. The grid quality characteristics and limits are given for references that the customer and the utility grid may expect. According to energy economic law, the operator of transmission grid is responsible for the organization and operation of interconnection system

2.1 BESS-STATCOM: The battery energy storage system (BESS) is used as an energy storage element for the purpose of voltage regulation. The BESS will naturally maintain dc capacitor voltage constant and is best suited in STATCOM since it rapidly injects or absorbed reactive power to stabilize the grid system. It also control the distribution and transmission system in a very fast rate. When power fluctuation occurs in the system, the BESS can be used to level the power fluctuation by charging and discharging operation. The battery is connected in parallel to the dc capacitor of the STATCOM. The STATCOM is a three phase voltage source inverter having the capacitance on its dc link and connected at the point of common coupling.

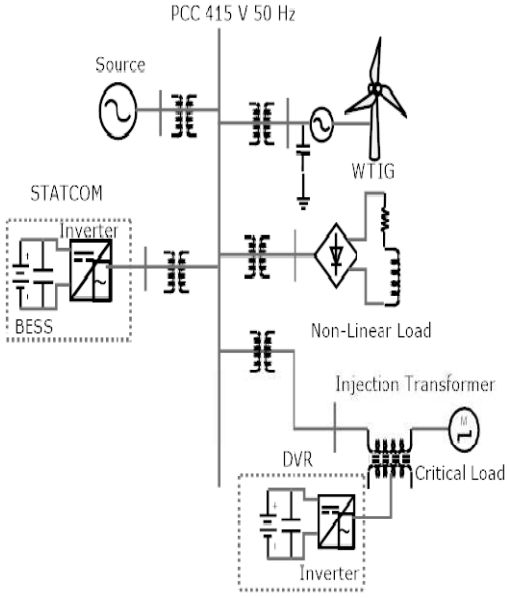

Figure5: Proposed system in study

3. PROPOSED SYSTEM

We have to study our system at the PCC, which is the interest of this kind of research. Studying at the PCC will give an idea of the system behavior at any other Bus. Fig. 5 shows the grid or the infinite bus connected to the PCC, it shows the WTIG, a non-linear load for harmonics generation. The DVR and STATCOM are used for Active filtering. They cancel the effect of voltage sags and swells by injecting a voltage into the system, and remove the harmonic by injecting a current into the system. In a proposed system STATCOM and DVR are used to main power quality and improvement voltage stability. In the

propose system the DC source will be replace by solar panel to provide fixed voltage to the system with a fuzzy logic controller replace PI controller the neural network overcome the problems of overshoot and remove delay time and inverse response, instability in rise time and settling time. In the propose system non linear load will be replace by variable non linear load.

of selected power electronics devices. Series RC circuits are connected in parallel with each switch device. One three phase linear transformer are used this block implement three single phase two winding transformer all winding terminals.

When the proposed model shows to explain the model first fall connected the three phase voltage source in series RL branch with three phase source. The three phase source block implements a balanced three-phase voltage source with the internal R-L impedance. The three voltage sources are connected in y with a neutral connection that can be internally grounded or made accessible. You can specify the source internal resistance and inductance either directly by entering R and L values or indirectly by specifying the source inductive short circuit level transformer ratio. They are connected three phase voltage and current measurement. The three phase VI measurement block is used to measure instantaneous three phase voltage and current in a circuit. When connected in series with three phase elements, it select the three phase to ground or phase to phase peak voltages and current. Select no if you do not want to measure three phase voltage. Select phase to ground if you want to measure the phase to ground voltages. Select phase to phase if you want to measure the phase to phase voltages. Select yes if you want to measure the three phase current that flow through the block. They are five voltage source measurement are used. One three phase transformer used. This block implements a three phase transformer by using three single phase transformer. And three phase breaker are used three phase breaker connect this block in series with the dialog box or apply an external logical signal. If you check the "external control" box, the external control input will appear. And one universal bridge are used this block implement a bridge

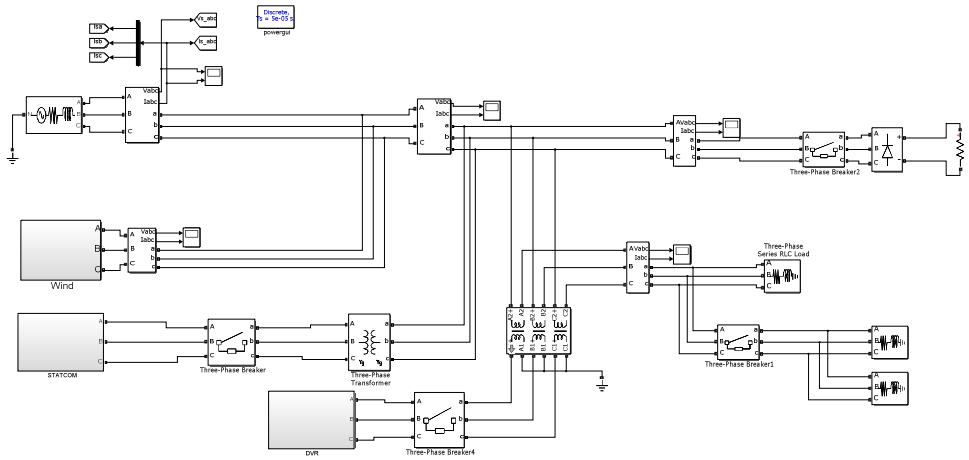

Figure6: Proposed Model

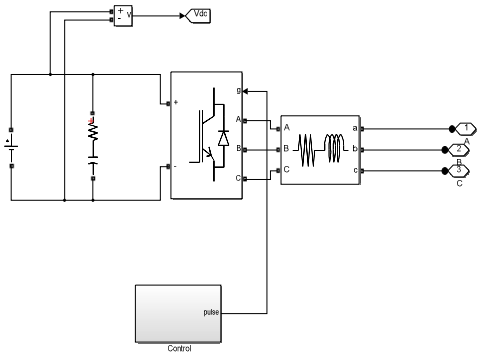

Figure7: STATCOM Model

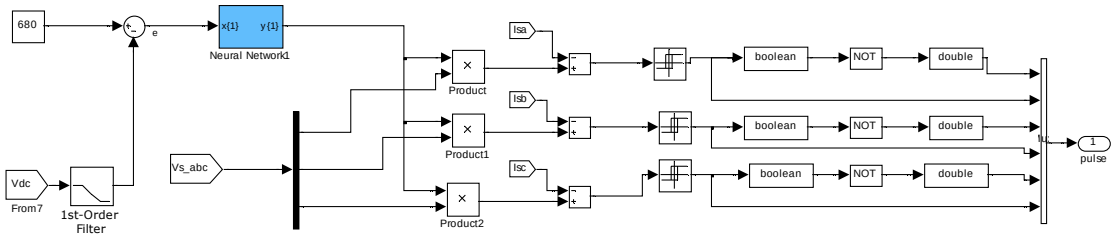

Figure8: Neural Network Connection

4. SIMULATION RESULT

This section deals with the simulation results of the proposed STATCOM result to minimize the problem of undershoot and overshoot. And DVR result to overcome the problems of voltage sage and swell.

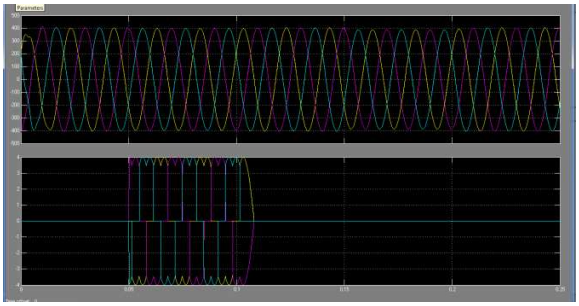

Figure 9: STATCOM output waveform

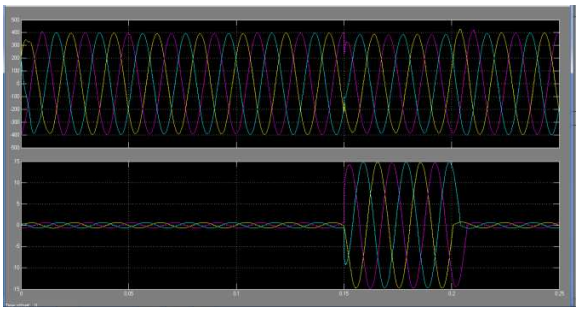

Figure 10: DVR output waveform

The proposed system uses a active power filter and STATCOM and DVR to calculate the FFT analysis and find the problem of total harmonic distortion (THD). And overcome the problem of overshoot undershoot and sage and swell.

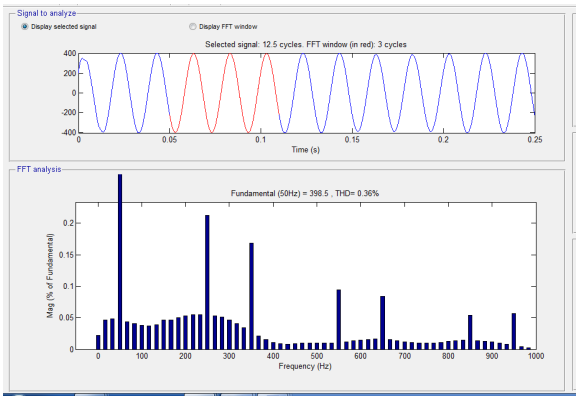

Figure 11.STATCOM Harmonic Spectrum (THD=0.34%)

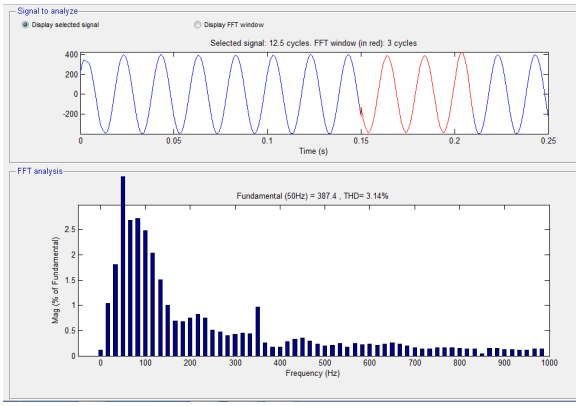

Figure 12: DVR Harmonic Spectrum (THD=3.14%)

5. CONCLUSION

I have concluded with the basic explanations and block diagram. I have concluded the problem of overshoot and find the THD. This paper examined the STATCOM hysteresis control technique for harmonic cancelation with load tracking in a system where a wind turbine is present and it examined the work of the DVR when connected to a critical load from the same system. It used a separate control for the STATCOM and the DVR interchanging their roles. This paper used as variable non-linear loads. And neural network are used to minimize the overshoot and voltage sage and swell and find total harmonic distortion.

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