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Analysis of Sag Conditioning with DVR in Three Phase Supply

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Abstract **– The dynamic voltage restorer has been gaining acceptance as an effective device for voltage sag compensation. The compensation capability of a dynamic voltage restorer (DVR) depends primarily on the maximum voltage injection ability and the amount of stored energy available within the restorer. Voltage sag is the phenomenon occurring in distribution system. It is the decrease in r m s voltage for a short duration. The D V R is a power electronic device that is used to inject a three phase voltage in series and in synchronism with the distribution feeder voltages in order to compensate for voltage sag. In this paper shows the operation of D V R. The power circuit of a D V R with control techniques used for compensation of sag, swell, harmonics is explained. The D V R control system is explained and verified using simulation. Power quality disturbances is the major concern in the distribution system, that leads to tripping and malfunction of sensitive equipment in distribution system. A D V R can be used to mitigate the power quality issues by injecting/absorbing real and reactive power to the point of connection (PCC). This study presents how the D V R used to compensate the voltage sag, voltage swell, power factor problems and harmonics and thus to improve the distribution system performances. The complete model is subjected to, first without ANN and then with it using A N N. The results obtained in both the cases are analysed and found that proposed device quickly recognize the disturbances and correct all the power quality issues by injecting/absorbing the real/reactive power during power quality events with no/less distortions than conventional system.**

Keywords— Dynamic voltage restorer, artificial neural network, voltage source inverter, ultra capacitor, point of common coupling, insulated gate bipolar transistor.

I. INTRODUCTION

The power quality issues are important topic in power systems. The dynamic voltage restorer can be used to mitigate the problem of voltage sag, voltage swell, harmonics etc. This project describes the problem of voltage sags and swells and its impacts on sensitive loads. The dynamic voltage restorer is a custom power device and it is a cost effective solution for the protection of sensitive loads from voltage sags and swells. The control of the compensation voltages in dynamic voltage is based on artificial neural network method. Simulation results are carried out by math lab for verify the performance of the proposed method. The power quality issues have become an increasing concern in distribution system due to the wide applications of sensitive load and disturbances. Poor power quality results in power disruption for the user and huge economic losses due to the interruption of production processes. The improvement or maintaining the power quality is an important concern. There are many power quality problems in the distribution system like, voltage sag, voltage swell, voltage flicker, harmonics, power factor problems, unbalances etc. Recently, the Power electronics converters/controllers are developed to provide the quality of power for both power suppliers and consumers. Now days a new concept of custom power devices is used for customer's satisfaction. In this work DV R is used to control the power quality issues. The DVR has emerged as a promising device to provide not only for voltage sag mitigation but a host of other power quality solutions such as voltage stabilization, flicker suppression, power factor correction and harmonic control and many control techniques have been developed to mitigate these problems also. Of all the rechargeable energy storage technologies, UCAPs are ideally suited for applications which need active power support in the *milliseconds* to *seconds* timescale. Therefore, UCAP-based integration into the DVR system is ideal, as the normal duration of momentary voltage sags and swells is in the *milliseconds* to *seconds* range. UCAPs have low-energy density and high-power density ideal characteristics for compensating voltage sags and voltage swells, which are both events that require high amount of power for short spans of time. UCAPs also have higher number of charge/discharge cycles when compared to batteries and for the same module size; UCAPs have higher terminal voltage when compared to batteries, which makes the integration easier. With the prevalence of renewable energy sources on the distribution grid and the corresponding increase in power quality problems, the need for DVRs on the distribution grid is increasing. Super capacitor-based energy storage integration into the DVR for the distribution grid is proposed. Various Power Quality mitigation schemes are based on inverter systems and control systems consisting of energy storage and switches. In this work, the DVR is treated. The main focus is on the converter topology for the DVR and its control system. Simulation of the compensator is performed using SIMULINK/MATLAB and performance results are presented. Ultra capacitors (UCAP) have low-energy density and high-power density ideal characteristics for compensation of voltage sags and voltage swells, which are both events that require high power for short spans of time. The novel contribution of this paper lies in the integration of rechargeable UCAP-based energy storage into the DVR topology. With this integration, the UCAP-DVR system will have active power capability and will be able to

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independently compensate temporary voltage sags and swells without relying on the grid to compensate for faults on the grid like in the past. UCAP is integrated into dc-link of the DVR through a bidirectional dc–dc converter, which helps in providing a stiff dc-link voltage, and the integrated UCAP-DVR system helps in compensating temporary voltage sags and voltage swells, which last from 3 s to 1 min.

II. LITERATURE REVIEW

The quality of power delivered to the end user is very important. The power quality is affected by various factors like voltage and frequency variations, presence of harmonics, faults in power network etc. Among them voltage variations (sag) is most important problem. There are many methods to mitigate voltage sag and among them the best way to connect a FACTS device at the point of interest. Yogesh Popat (2015) discuss DVR is used for these purpose. Here discusses how a DVR can be controlled to mitigate voltage sag. The structure and control strategies are presented. It discusses how a DVR can be used. It shows that multi-layer feed forward neural network controller based DVR for voltage sag mitigation. The D V R is a power electronic device that is used to inject a three phase voltage in series and in synchronism with the distribution feeder voltages in order to compensate for voltage sag. In this paper shows the operation of D V R. The power circuit of a D V R with control techniques used for compensation of sag, swell, harmonics is explained. The D V R control system is explained and verified using simulation. Power quality disturbances is the major concern in the distribution system, that leads to tripping and malfunction of sensitive equipment in distribution system. A D V R can be used to mitigate the power quality issues by injecting/absorbing real and reactive power to the point of connection (PCC). This study presents how the D V R used to compensate the voltage sag, voltage swell, power factor problems and harmonics and thus to improve the distribution system performances. The complete model is subjected to, first without ANN and then with it using A N N. The results obtained in both the cases are analysed and found that proposed device quickly recognize the disturbances and correct all the power quality issues by injecting/absorbing the real/reactive power during power quality events with no/less distortions than conventional system.

SYSTEM PARAMETERS USED IN SIMULATION

Sl no	System quantities	standards
1	<u>WIND SYSTEM</u> 1 .WIND TURBINE 2 .P M SYNCHRONOUS MACHINE	BASE ROTATIONAL SPEED = 1.2P.U WIND SPEED = 12M/S
2	THREE PHASE TRANSFORMER	12 TERMINAL THREE PHASE RATED POWER = 6e6 VA FREQUENCY = 60HZ
3	CONTROLLER	CONTROLLER NEURAL NETWORK P W M GENERATOR –CARRIER FREQUENCY – 5000HZ LOWPASS FILTER
4	FILTER	LOW PASS L-C FILTER
5	LOAD	THREE PHASE R L C LOAD
6	ULTRA CAPACITOR 1.SUPER CAPACITOR 2. RATED VOLTAGE	RATED CAPACITANCE= 9 F EQUALENT DC SEIES RESISTANCE =2.1e-3 OHM 400 V

III MODELLING AND ANALYSIS

The power quality problems can arise in many ways in wind turbine system. Here it is used D V R system. A neural network controller is used, it also consists low pass filter, induction generator, source, load. It can be divided into four component blocks. Voltage source PWM inverter, Injection/ coupling transformer, Energy storage device, Filter unit.

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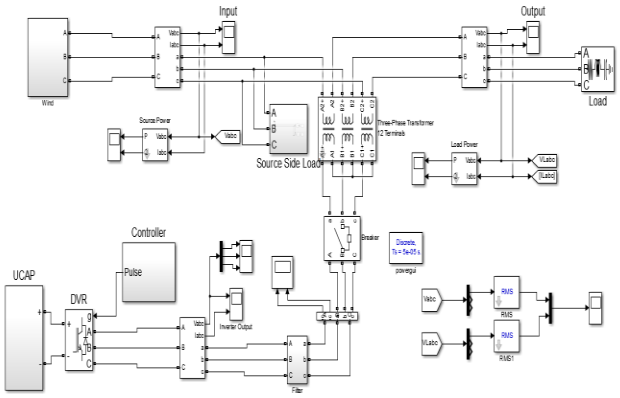

Fig.1 Simulation diagram

Three phase voltage equations used in this system (dq0 –abc transformation) are

$$Va = Vd * sin\omega t + Vq * cos\omega t + V0$$

$$Vb = Vd * \sin\left(\omega t - \frac{2\pi}{3}\right) + Vq * \cos\left(\omega t - \frac{2\pi}{3}\right) + V0$$

$$Vc = Vd * \sin\left(\omega t + \frac{2\pi}{3}\right) + Vq * \cos\left(\omega t + \frac{2\pi}{3}\right) + V0$$

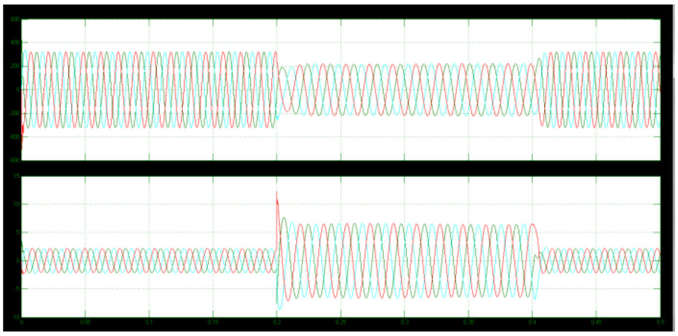
Fig: 2 voltage wave form across source side and injected voltage wave form

The figure 2 shows input voltage wave form of wind system used. The injected voltage wave form is also shown in figure. It is used as a three phase voltage of 300 V used.

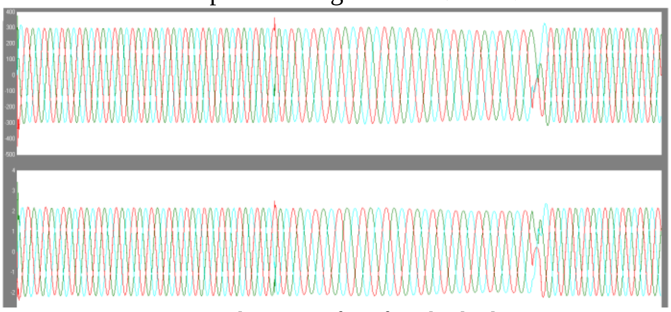
Fig: 3 Voltage wave form from load side

This figure 3 shows a three phase voltage from load side. Here shows that this wave form voltage sag is reduced and load voltage is a constant value. Voltage sag occurs short duration duration of time. The source side load uses a three phase breaker (2 nos.) with a breaker resistance 0.01 ohm and snubber resistance 1e6 ohm. A three phase series RLC load is used with nominal frequency of 60 Hz and active power is 5e3 watt. In three phases transformer uses a three phases rated power is 6e6 VA. With a phase voltage of 250 V and 330V in winding one and two. In three phases breaker uses a breaker resistance of 0.01 ohm and 1e6 ohm snubber resistance. In filter an L C filter is used with inductance of 10e-3 Henry and capacitance of 900e-6 farad used. In super capacitor uses a rated capacitance of 9farad and rated voltage is 400V, leakage current is 5.2e-6A.

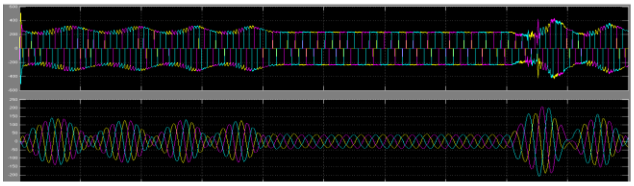
Fig: 4 Inverter output

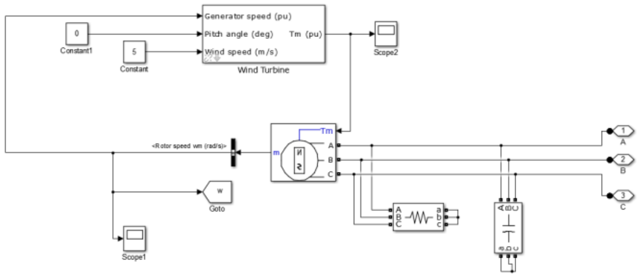

Fig: 5 Simulation diagram for a wind system

In the proposed system model in fig 1 consists a wind energy system is used as an input system is used as input system. In this system used as a wind turbine, permanent magnet synchronous machine. The stator windings are connected in wye to an internal neutral point. The three phase machine can have sinusoidal or trapezoidal back e m f wave form. The rotor can be round or salient pole for sinusoidal machine. It is round when the machine is trapezoidal. Pre-set models are available for the sinusoidal back e m f machine. The five phases has a sinusoidal back emf wave form and round rotor. Pre-set models are not available for this type of machine. Here number of phase is used is three, back e m f wave form is sinusoidal, round rotor type is used. Stator phase resistance used is 2.875 ohm. Armature inductance is 0.000835.

In wind turbine implements a variable pitch wind turbine model. The performance coefficient (Cp) of the turbine is the mechanical output power of the turbine divided by wind power and a function of wind speed, rotational speed, pitch angle (beta). Cp reaches its maximum value at zero beta. Select wind turbine power characteristics display to plot the wind turbine characteristics at specified pitch angle. The first input is generator speed, in per unit of generator base speed. For synchronous or asynchronous generator base speed is synchronous speed. For a permanent magnet generator base speed is speed producing nominal voltage at no load. Second input is the blade pitch angle (beta) in degrees. Third input is wind speed in m/s. The output is the torque applied to generator shaft in per unit of generator ratings. The nominal mechanical power is used as 3e3 watt. Basic wind speed is 12 m/s. Beta is taken as zero.

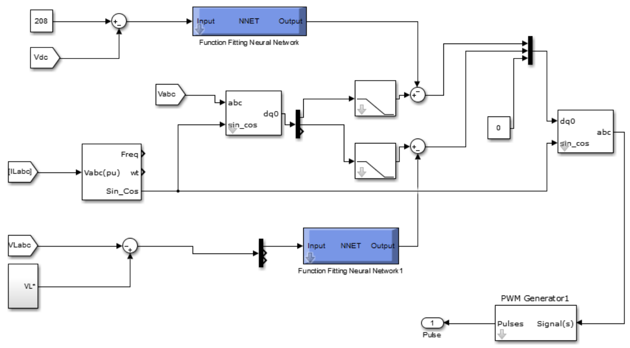

Fig: 6 simulation diagram for controller used

A The Architecture of ANN

In the architecture of artificial neural network (ANN). The ANN controller used in this control system, consists of three neuron layers, the input layer, the hidden layer and the output layer. The input layer offers connection point to transmit the input signal to the hidden layer. The latter begins the learning process and the output layer continues the learning process and provides outputs.

The hidden layer neurons have a tan sigmoid transfer function, and the output layer neurons have a linear transfer function. The ANN has three inputs that are the three phase voltage errors of the IDVR. It also has three outputs that are the three switching functions of the inverter legs .The output of ANN controller is the reference variable for the PWM generator. Therefore, the output of ANN with varying amplitude and phase passes through a comparator and is compared with a carrier signal. When the ANN output's magnitude is more than carrier signal's magnitude, the PWM circuit generates high output and when the ANN output's magnitude is less than carrier signal's magnitude, the PWM circuit produces low output. The carrier signal is a saw tooth waveform at 20 kHz taking values between -1and 1

B Wind power

Today's energy situation requires the introduction of new generation methods. A potential new source is distributed generation of electricity from many relatively small and variable sources, harnessing local renewable forms of energy. Whilst centralized electricity generation systems tend to suggest favourable economics due to their scale, distributed generation systems can demonstrate higher efficiency through direct use of heat, lower transmission Such distributed systems will comprise of plant at many sites utilizing multiple sources of renewable energy. These pose a number of challenges to planners, designers and users alike, in particular if the plant is to operate for significant periods of time without an operational grid connection. In this case, performance will be a function of varying sources, load demands, and the ability to store energy. In addition, it is difficult to determine, in advance, the optimum relative proportions of, for example, photovoltaic generation capacity, wind generation capacity and battery capacity, for a given site (weather pattern) and required power availability. Much literature exists recognizing the importance of the optimization of remote renewable energy sites; generally split into three areas, sizing, control and both. Significant work includes, offering a comprehensive analysis of system components. Airflows can be used to run wind turbines. Modern utility-scale wind turbines range from around 600 kW to 5 MW of rated power, although turbines with rated output of 1.5–3 MW have become the most common for commercial use; the power available from the wind is a function of the cube of the wind speed, so as wind speed increases, power output increases up to the maximum output for the particular turbine. Areas where winds are stronger and more constant, such as offshore and high altitude sites are preferred locations for wind farms. Typical capacity factors are 20-40%, with values at the upper end of the range in particularly favourable sites. Globally, the long-term technical potential of wind energy is believed to be five times total current global energy production, or 40 times current electricity demand, assuming all practical barriers needed were overcome. This would require wind turbines to be installed over large areas, particularly in areas of higher wind resources, such as offshore. As offshore wind speeds average ~90% greater than that of land, so offshore resources can contribute substantially more energy than land stationed turbines.

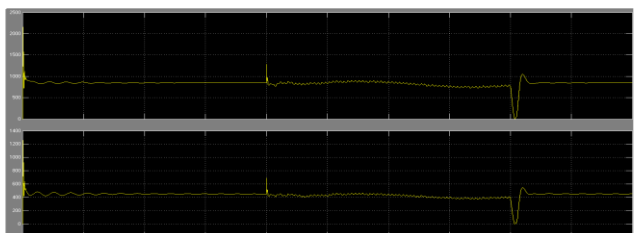

Fig: 7wave form of load power

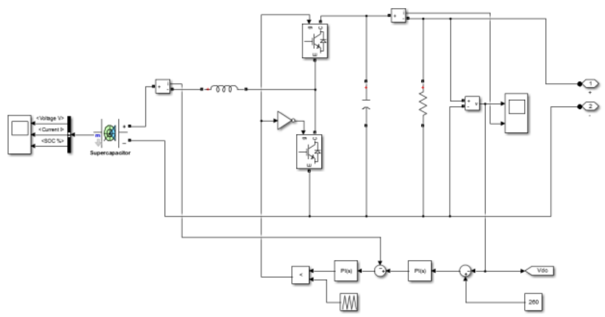

Fig: 8 Simulation diagram for ultra-capacitor (UCAP)

In this paper, UCAP-based energy storage integration to a DVR into the distribution grid is proposed and the following application areas are addressed.

1) Integration of the UCAP with DVR system gives active power capability to the system, which is necessary for independently compensating voltage sags and swells.

2) Experimental validation of the UCAP, dc–dc converter, and inverter their interface and control.

3) Development of inverter and dc–dc converter controls to provide sag and swell compensation to the distribution grid.

4) Hardware integration and performance validation of the integrated DVR-UCAP system.

CONCLUSION

In this paper the concept of integrating UCAP based energy storage to DVR system to improve its voltage restoration capabilities is explored. With this integration DVR will be able to independently compensate voltage sag. Results from simulation and analysis shows that it can be used in the future on the distribution grid to respond to dynamic changes in voltage and prevents sensitive loads from voltage disturbances.

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