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Simulink Modelling of Integrated Dynamic Voltage Restorer-Supercapacitor, for Power Quality Enhancement Using Neural Network Control System

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ABSTRACT: Now a days, the energy storage technologies operational and maintenance charge is decreasing rapidly. The integration of this technology into the distribution power generation, power quality is being enhanced since these devices gives quick response and high reliability. Dynamic voltage restoration is a process and instrument necessity to maintain, or restore and also compensate functional electric load during voltage sag and swell, harmonics in voltage supply. DVR is the most reliable custom power device that can protect sensitive load and it can be thoroughly solved the power quality problem in distribution power generation. Super capacitor is a specially designate capacitor which have low-energy density and high- power density, quick charge/discharge rates that area unit all ideal characteristic for meeting high voltage low energy events like grid intermittencies sag/swells. It combined the properties of capacitors and batteries into one device. SCAPs are electronic devices which are able of holding huge amount of electrical intrust quantity. It is also called as Ultra Capacitor (UCAP). This paper describe the integration of SCAP-DVR system is used to compensate the momentary voltage sags and swells, which last form 3s to 1min. the design and control methods of both inverter and converter have been maintain and substantiate MATLAB simulation model. Also in this model, neural network control system and PWM pulse generation is used.

KEYWORDS: DC-DC converter, neural control, dynamic voltage restorer (DVR), Supercapacitor, sag/swell.

I.INTRODUCTION

The purpose of power system is to give electrical energy or power to consumer. Non linear loads, utility switching and fault clearing produce disturbance that result the quality of this delivered power. In the present scenario, electric power is viewed as an integral product with stated characteristics, which can be measured, forecast, certified and improved. The word power quality means different things to different people. Power quality means the quality of the normal voltage supplied to your facility. It is based on the extent of diversity of the voltage and current waveform from the ideal clean sinusoidal waveforms of fundamental frequency. To improve the power quality, it is necessary to know what kind of disturbances occurred and quality initially assign to the quality of the service delivered as 'measured' by the consumers ability to use the energy delivered in the desire manner. A power quality monitoring system that is capable to automatically perceive, characterize and classify disturbance on electrical lines is thus required

Power Quality delivery within the current distribution system area unit addressed within the literature, due to the hyperbolic utility of sensible and necessary items such as conference network, process industries and formal manufacturing process. In, the creator propose the usage of the DVR with reversible energy storage at the dc-terminal to meet the active power needs of the grid during power injection into the grid, creator also specify voltage disturbances. So as to avoid and minimize the active power injection into the grid, author also explained an alternate solution that is to compensate for the voltage sag by inserting a lagging voltage.

Renewable energy generation is growing quick and ideas similar smart grid are severe to change the role of consumer from being a passive consumer to an active contributor who can supply stored excess power in several DERs

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such as wind, solar, hybrid electric vehicles (HEVs) and plug- in hybrid vehicle (PHEVs) back to the distribution grid or the micro grid. Of all the energy storage technologies, SCAPs have low energy density, high power density and quick charge/discharge characteristics. They even have additional charge/discharge cycles and higher terminal voltage per module when put next to batteries, of these characteristic make SCAPs ideal option for providing support to events on the distribution grid that need full power for short spans of your period. SCAPs have historically been restrain to regenerative disruption and alternative energy smoothing applications.

The major contribution of this composition is in integration SCAP for a broader frequent of application similar active/reactive power support, renewable intermittence smoothing, voltage sag/swell compensation and power quality conditioning to the distribution grid. Renewable intermittence smoothing is associate degree application which needs to bidirectional transfer of power from the grid to the SCAPs and vice-versa by charging and discharging the SCAP. This application needs high active power support within the 10s-3min constancy which may be obtained by integrating SCAPs through a shunt active power support in the 3s-1min period scale which can be provided integrating SCAP into the grid through series dynamic voltage restorer (DVR). All the on top of functionalities can also be provided by integrating the SCAP into restraint conditioner analysis situs. Energy storage integration to a DVR into the distribution grid is design and the sequential application areas are addressed.

- Integration of the SCAP with DVR system proposes power capacity to the system, that is necessary for independently compensating voltage sag and swell.
- Experimental validation of SCAP, dc-dc converter and inverter their interface and control.
- Development of inverter and dc-dc converter controls to give sag and swell compensation to the distribution grid.
- Hardware integration and completion validation of the integrated DVR-SCAPs system

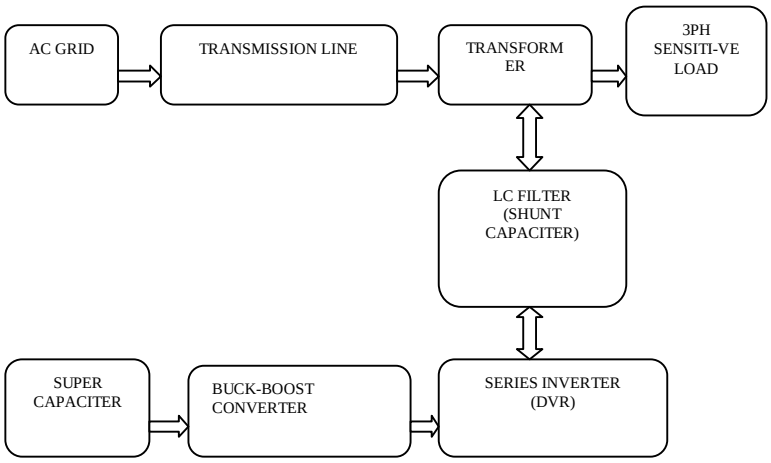

Fig.1. One-line diagram of DVR with SCAP energy storage.

II.MODEL DESCRIPTION

A. Bidirectional dc-dc converter

A SCAP cannot be instantly connected to the dc-link of the inverter similar a battery, as the voltage profile of the SCAP varies since its discharge energy. Therefore there's a required to integrate the SCAP voltage decreases whereas discharging and will increases whereas charging. The design of the bidirectional dc-dc converter and its controller area unit show-n in fig.1, whenever the input consist of 3 SCAPs connected in series and the output consist of a nominal load of 213.5 Ω to prevent operation of no-load, and therefore output is connected to dc-link of the electrical converter. The number of active power support required by the grid throughout the voltage sag event depend on the depth and length of the voltage sag, and dc-ac converter should to be capable to consist up this power throughout the discharge

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mode. The series voltage controller is connected series with the protected load, typically the association is formed via transformer, but configuration with direct connection via power electronics exist. The resulting voltage at the load bus equals the complete sum of the grid voltage and the insert voltage which is come from the DVR. The converter produce the reactive power need whereas the reactive power taken from the energy storage. The energy storage is entirely other appearance on the requirements of compensating. DVR will compensate voltage at each transmission and distribution sides, typically a DVR is put in on a critical load feeder. During the normal operating state DVR works during a low loss standby form throughout this provision the DVR is claimed to be steady state. Once a disturbance occur and supply voltage depart from par value, DVR supplies voltage for compensating of sag and swell is claimed to be transient state.

B. Dynamic Voltage Restorer (DVR)

DVR is the most powerful and efficient custom power device. The reason behind this is its lower expense, smaller size and its fast response towards the disturbances. The main function of DVR is to inject the desired voltage measure in series with the help of an injection transformer whenever voltage sag is detected. DVR is a device which is used to sustain, restore an operational electric load when sag, swell and other disturbance is occurs in voltage supply. This process uses critical device such as an automatic transfer switch and IGBT module in order to work.

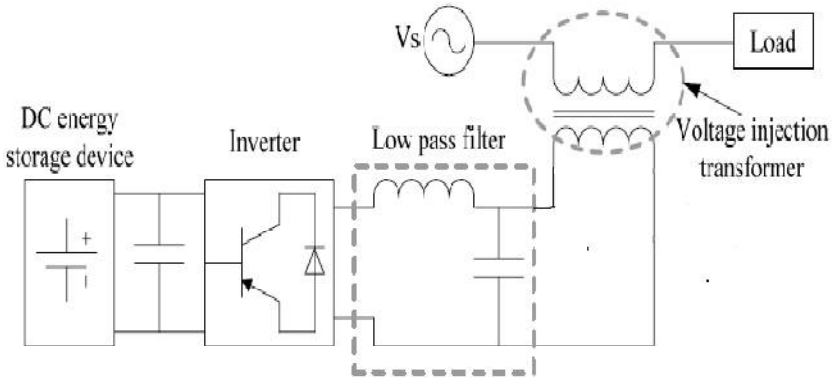

Fig.2 Basic Circuit Diagram Of DVR

C. Buck Boost Converter

Switched mode supplies can be used for several functions together with dc-dc converters. Often, though a dc supply, such as a battery is also obtainable, its obtainable voltage is not consistent for the system being supplied. For instance the motor used in driving electric vehicles require much higher voltages, with region of 500V, than might be supplied by a battery alone. Although banks of batteries were used, the additional weight and area obsessed would be too great to be sensible. The release to the current downside is to use fewer batteries, large or small, is that their output voltage varies because the obtainable charge is used up. By using boost converter if this low output level booted-up to helpful level again, the battery life is to be increase. It is different to buck converter. That means output voltage is same or greater than input voltage. However it is important to remember that, as power (P) =voltage (V) × current (I), if the output voltage is raised the accessible output current must decrease.

D. Super capacitor

Supercapacitor, also called as ultracapacitor is an electrical element able of holding many times additional electrical charge amount than a standard capacitor. This characteristic makes ultracapacitor useful in devices that necessity relatively current and low-voltage electrochemical battery. These devices, different their electromechanical counterparts, store information about home and business electrical power and energy consumption, and contain no moving parts. Within the event of a power failure, an ultracapacitor permits the meter to send a final stat-us communication to the utility company, anticipate data loss and the confusion that might result. The ultracapacitor

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intrust up with the help of a small direct-current (dc) generator that the user can manually operate for a couple of minutes by turn a small crank. Once the ultracapacitor has acquired a full charge, the device can function for quite awhile before it needs a recharge.

E. Neural Network (NN)

A neural network is a system with input and output and is composed of many simple and similar processing elements. Neural networks are recommended for intelligent control as a part of well known structure with adaptive critic. Recently, much research has been done on application of NN for control of nonlinear dynamic process. At present, most of the works on system control using NNs are based on multilayer feedforword NNs with more efficient variation of this algorithm. The neural network based controller offers very fast implementation of proposed PWM. In this project a multilayer neural network is used The proposed project employs a feedforward neural network, which receives the command voltage and generate PWM waves for single phase bidirectional dc/dc converter with the help of logic circuits. So the data to be used in NNs with back propagation learning or more efficient variation of that algorithm.

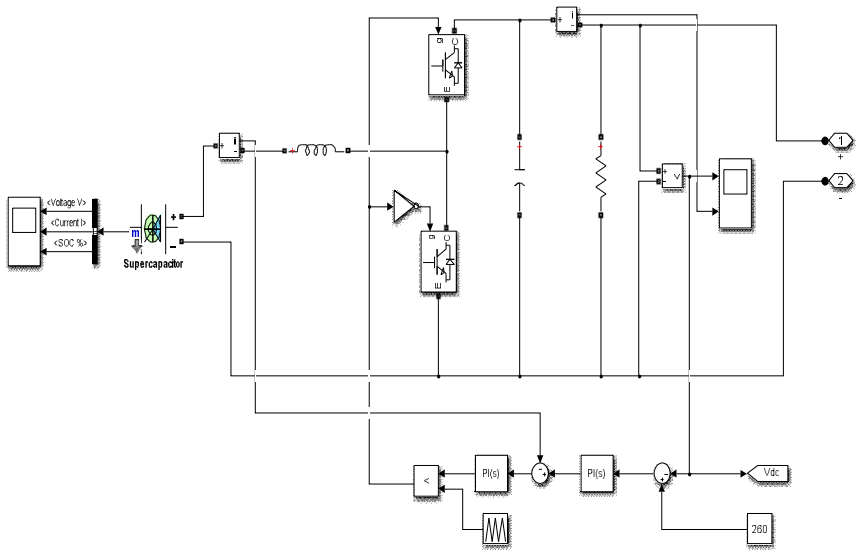

Fig.3 Model of Integrated DVR-SCAPs with its controller

III. PROBLEM STATEMENT

Power quality is the ability to use the energy delivered in the desire manner and to give sufficiently high grade electrical services to the customer. Synchronization of the voltage frequency section permits electrical system to perform their intended manner while not important loss of performance or life. The word is used to explain electric power that drives an electrical load and the load's ability to perform properly. Without the proper power, an electrical device may malfunction. Fail untimely or not operate, which effects the distribution system. There are the some power quality problem defines-

A. Voltage Sag

A decrease of the normal voltage level with ranging from 10-90% at any instant of period and for duration of 0.5 cycle to 1 min. Longer duration of low voltage called a 'sustained sag'.

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B. Voltage Swell

Voltage swell is defined as temporary increase of the voltage, at the power frequency, external normal tolerances. Or it happens when a heavy load turns off in a power system, with duration of more then one cycle and typically less than a few seconds.

C. Harmonics

A harmonic frequency is a multiple of the fundamental frequency and this frequency of the ac electric power distribution system is 50 Hz. A harmonic frequency is any sinusoidal frequency, Harmonic frequencies can be even or odd multiples of the sinusoidal fundamental frequency.

IV. MODELING AND SIMULATION RESULTS

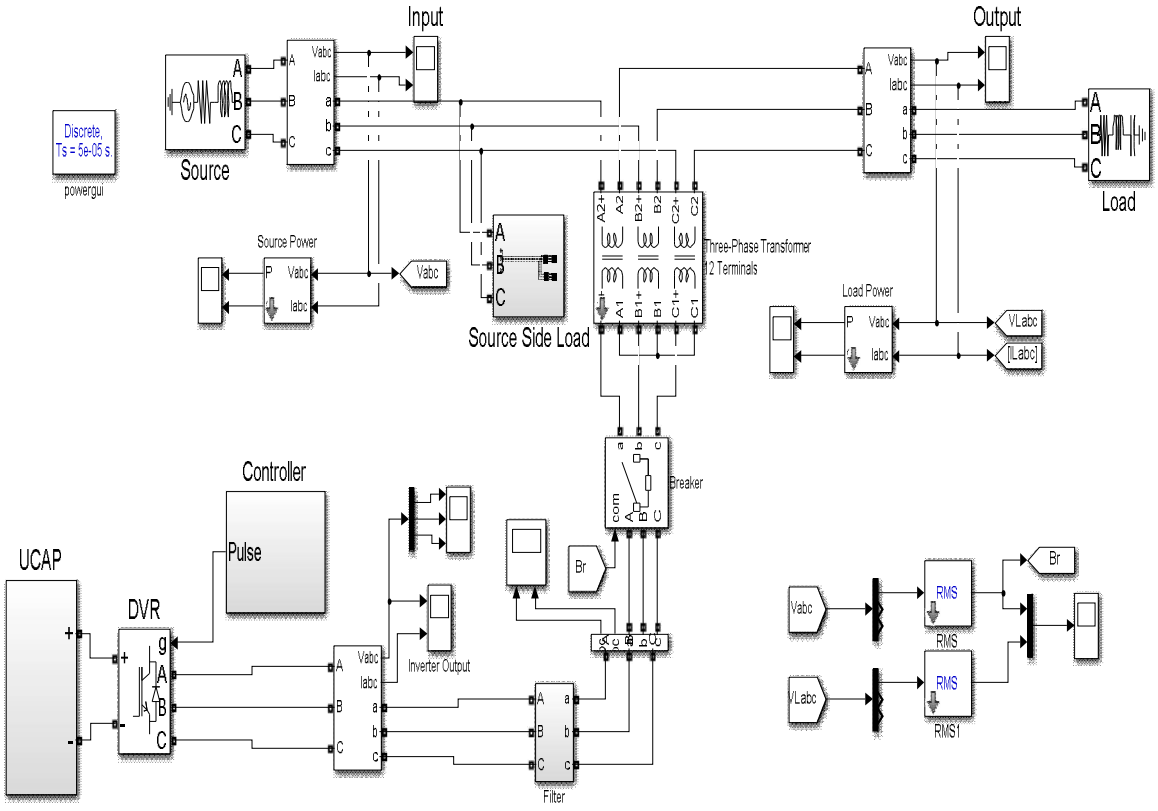

Fig.4 Simulation model of SCAPs supported DVR system

The active power lack of the grid is met by the DVR power Pdvr, which is almost equaled to the input power to the inverter Pdc in available from the SCAP. Therefore, it can be determine from the plots that the active power lack between the grid and load during the voltage sag event is Conditioner being met by the SCAP-based energy storage system through bidirectional dc–dc converter and the inverter. It can also be noticed that the grid reactive power Qgrid reduces during the voltage sag while Qdvr increases to compensate for the reactive power loss in the system. Similar analysis can also be carried out for voltage sags that appear in one of the phases (A, B, or C) or in two of the phases (AB, BC, or CA); however, three-phase voltage sag case requires the maximum active power support and is presented here.

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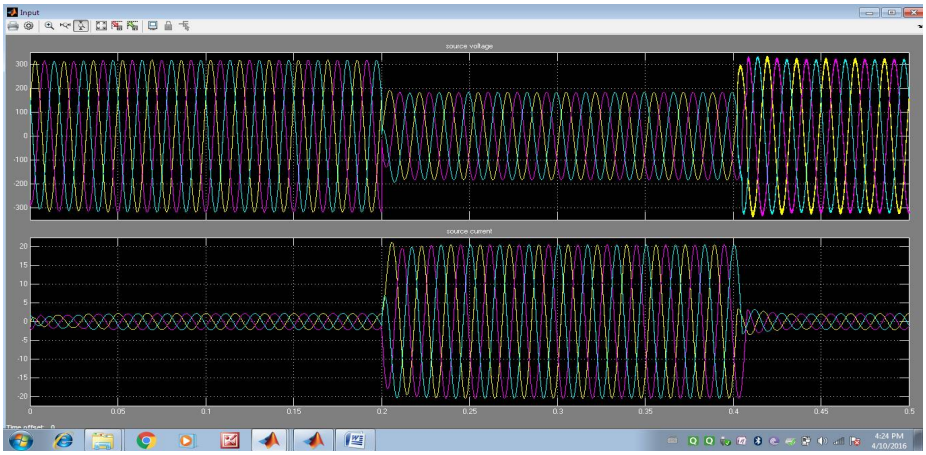

Fig.5

In figure-5 shows source voltage and source current three phase voltage sag/swell simulation. In this consideration 50% 3 phase voltage sag/swell occurring at the utility grid, which is initiated 0.2s and it is kept until 0.4s with total voltage sag/swell duration of 0.2s.

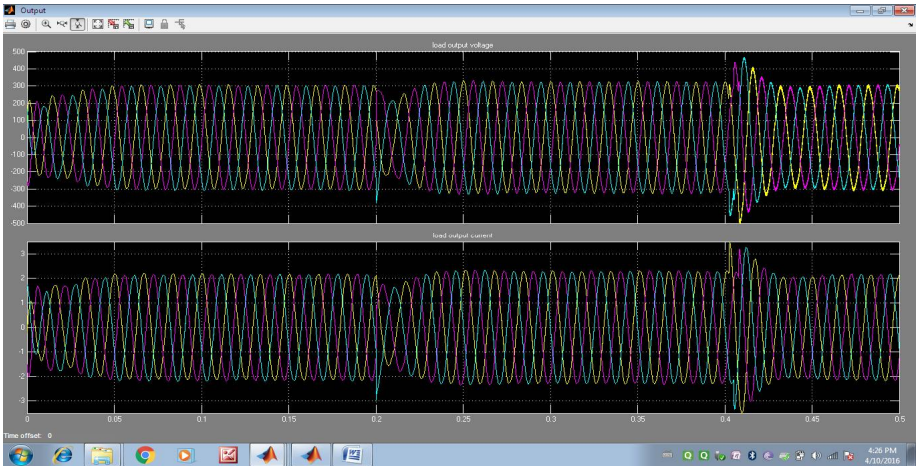

Fig.6

In figure-6 shows the load output voltage and load output current which is line-neutral injected voltages of series inverter.

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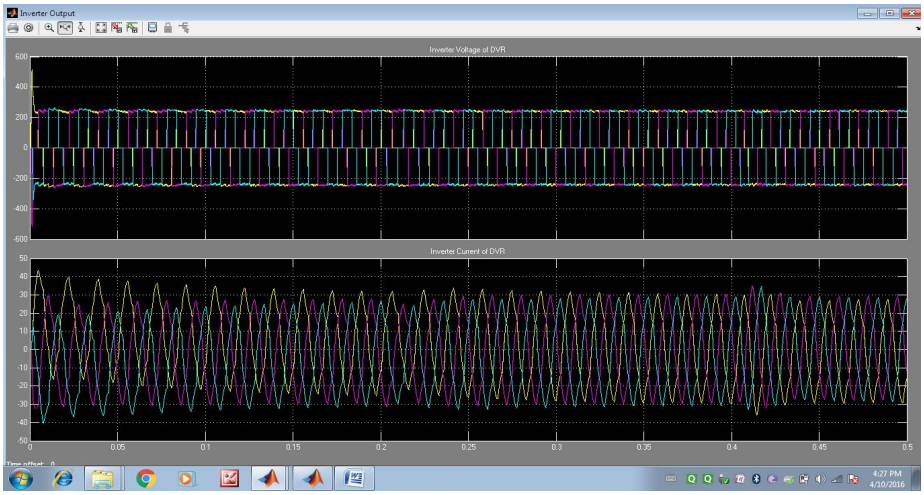

Fig.7

In figure-7 shows the inverted output voltage and current from the DVR with sag/swell and harmonics compensation.

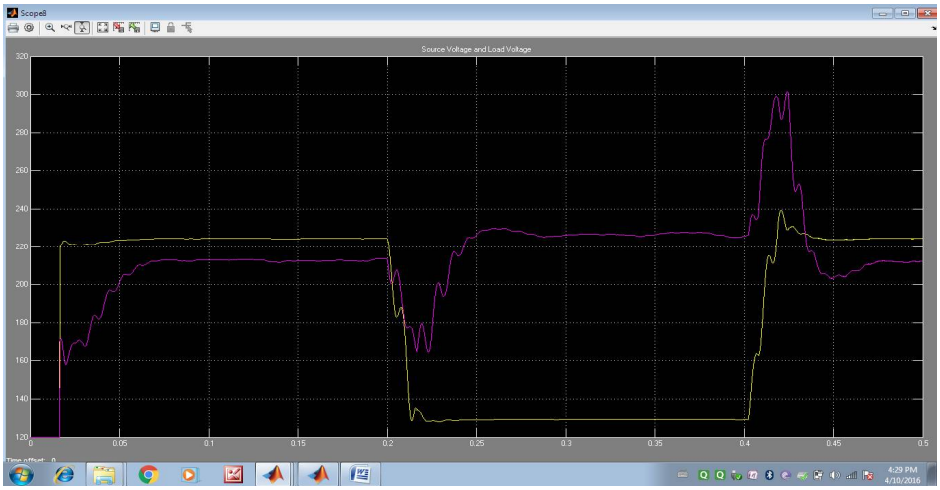

Fig.8

In figure-8 shows the simulation graph of source voltage and load voltage. In this graph results also shows the exact output waves of the converter. The simulation results confirm to verify the feasibility of the proposed converter.

V.CONCLUSION

This paper presents a integrated SCAP-DVR analysis for improving power quality, by using neural network control system. A higher level integrated neural network control system is proposed which takes decisions based on the system parameter, gives input to the inverter and dc-dc converter controllers to carry out their control actions. The control strategy of the SCAP-DVR is based on adc-dqo method for improving voltage profile. The proposed system by using NN controller is provide greater power quality response as compare to existing model (PI). The modelling and simulation of the integrated SCAP-DVR system, power quality in distribution grid will be improve and that particular system successfully compensate voltage sags/swells and harmonics.

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