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Dynamic Voltage Restorer (DVR) Based On Artificial Neural Network (ANN) and Photovoltaic Design for Power Quality Improvement

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Abstract - In the present electric power grids, power quality issues are recognized as a crucial concerns and a frequently occurring problem possessing significant costly consequence such as sensitive load tripping and production loss. Consequently, demand for high power quality and voltage stability becomes a pressing issue. Dynamic voltage restorer (DVR) is one of the most effective solutions for "restoring" a custom power device, the quality of voltage at its load-side terminals its source-side terminals is disturbed when the quality of voltage and new DVR topology based medium-voltage application has been proposed on double flying capacitor multi-cell (DFCM) converter. The advantage of the proposed DVR is that it does not need any line-frequency step-up isolation transformer, which is bulky and costly, to be connected to medium-voltage power grid. The proposed DVR topology obtains the required active power from the energy storage feeding the dc link of the DFCM converter. The pre-sag compensation method, which is explained in detail, is used to restore amplitude and angle of the sensitive load voltage. Moreover, an approach based on d-q synchronous reference frame to determine DVR reference voltages is utilized. The proposed DVR topology is simulated and results to illustrate its performance under various conditions of voltage sag compensation are provided.

***Keywords*:** Double Flying Capacitor Multi-cell Converter; Dynamic Voltage Restorer; Multilevel Power Converters; Power Quality, Voltage Sag.

I. INTRODUCTION

The concept of using inverter-based dynamic voltage restorers (DVRs) for preventing customers from momentary voltage disturbances on the utility side was demonstrated for the first time by Woodley *et al.*. The concept of using the DVR as a power quality product has gained significant popularity since its first use. The propose the usage of the DVR to meet the active power requirements of the grid during voltage disturbances with rechargeable energy storage at the dc-terminal. In order to avoid and minimize the active power injection into the grid, the authors also mention an alternative solution which is to compensate for the voltage sag by inserting a lagging voltage in quadrature with the line current. Due to the high cost of rechargeable energy storage, various other types of control strategies have also been developed in the literature to minimize the active power injection from the DVR. The high cost of the rechargeable energy storage prevents the penetration of the DVR as a power quality product. However, the cost of rechargeable energy storage has been decreasing drastically in the recent past due to various technological developments and due to higher penetration in the market in the form of auxiliary energy storage for distributed energy resources (DERs) such as wind, solar, hybrid electric vehicles (HEVs), and plug-in hybrid electric vehicle (PHEVs).

DVR for preventing customers from momentary voltage disturbance on the utility side and In order to avoid minimize the active power injection into the grid. Voltage sag are result of transient phenomenon in power grid such as short circuit in the upstream power in tx line ,inrush current involved with the starting of large machine, sudden change of load, etc Traditional methods of tap changing transformer and UPS are bulky, costly and not fast enough eliminate the voltage sag load side. Custom power devices DVR as power electronics based solution to minimize costly outcomes of voltage sag.

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II. LITERATURE SURVEY

A literature survey is an evaluative report of information found in the previous researches and it related to selected area of study. It should give a theoretical base for the research papers and helps to determine the quality of research work. The back ground work for the proposed method and the supporting papers will be discussed here.

1) "**Medium Voltage Dynamic Voltage Restorer (DVR) Based on DFCM Converter for Power Quality Improvement**" Dynamic voltage restorer (DVR), as a custom power device, is one of the most effective solutions for "restoring" the quality of voltage at its load-side terminals when the quality of voltage at its source-side terminals is disturbed.

2) "**An Integrated Dynamic Voltage Restorer (DVR)-Ultra capacitor Design for Improving Power Quality of the Distribution Grid**" Dynamic voltage restorer (DVR) is one product that can provide improved voltage sag and swell compensation with energy storage integration. 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.

III. SYSTEM DESIGN

a) Proposed Block Diagram

The concept of using multilevel inverter-based dynamic voltage restorers (DVRs) for preventing customers from momentary voltage disturbances on the utility side was demonstrated for the first time by Woodley *et al.* The concept of using the DVR as a power quality product has gained significant popularity since its first use. In, the proposed system the usage of the DVR to meet the active power requirements of the grid during voltage disturbances with rechargeable energy storage at the dc-terminal.

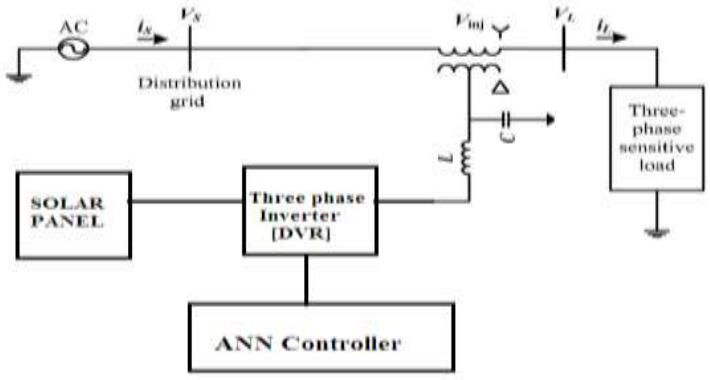

Figure-1: Proposed Block Diagram

b) Block Diagram Description

In order to avoid and minimize the active power injection into the grid, the authors also mention an alternative solution which is to compensate for the voltage sag by inserting a lagging voltage in quadrature with the line current. Due to the high cost of rechargeable energy storage, various other types of control strategies have also been developed in the literature to minimize the active power injection from the DVR. The high cost of the rechargeable energy storage prevents the penetration of the DVR as a power quality product. However, the cost of rechargeable energy storage has been decreasing drastically in the recent past due to various technological developments and due to higher penetration in the market in the form of auxiliary energy storage for distributed energy resources (DERs) such as wind, solar, hybrid electric vehicles (HEVs), and plug-in hybrid electric vehicle (PHEVs).

IV. SIMULATION OUTPUT

a) Simulation diagram

The simulation of the circuit is done using MATLAB Simulink and result waveforms are obtained as shown in figure-3 to figure-6. The simulation of the photovoltaic system, which consists of the solar, dc–dc converter, and the grid-tied inverter, is carried out using PSCAD. Hardware experimental setup of the integrated system is presented and the ability to provide temporary voltage sag and swell compensation in all three phases to the distribution grid dynamically is tested. Results for

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transient response during voltage sags/swells in two phases will be included in the full-version of this paper.

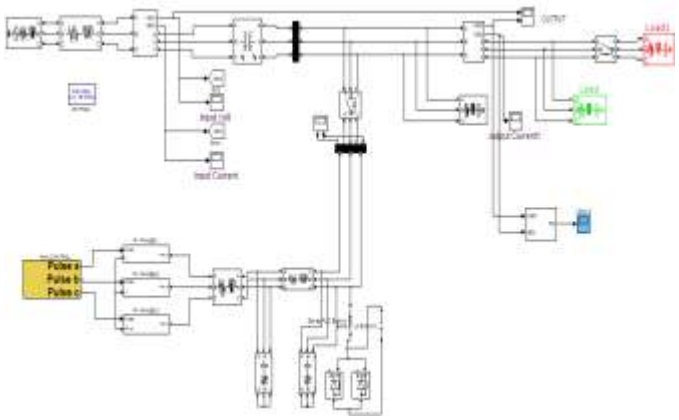

Figure-2: Simulation diagram

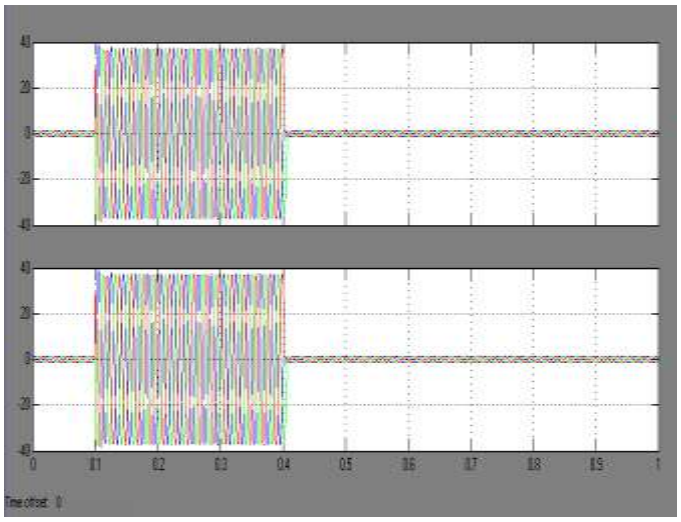

Figure-3: Input Source and Load Current

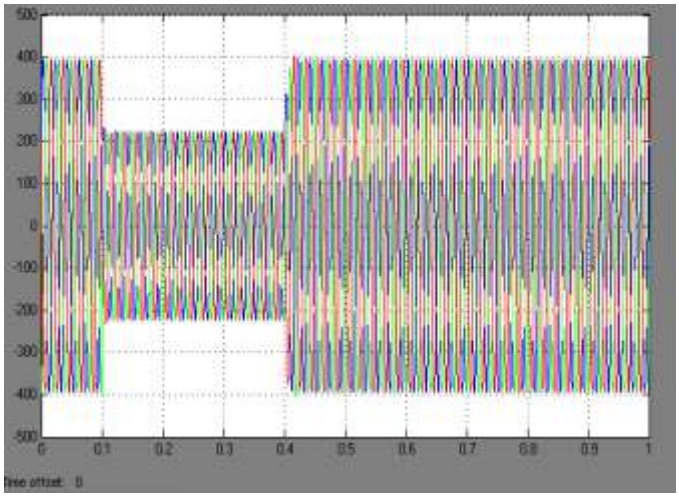

Figure-4: Without DVR Voltage Sag

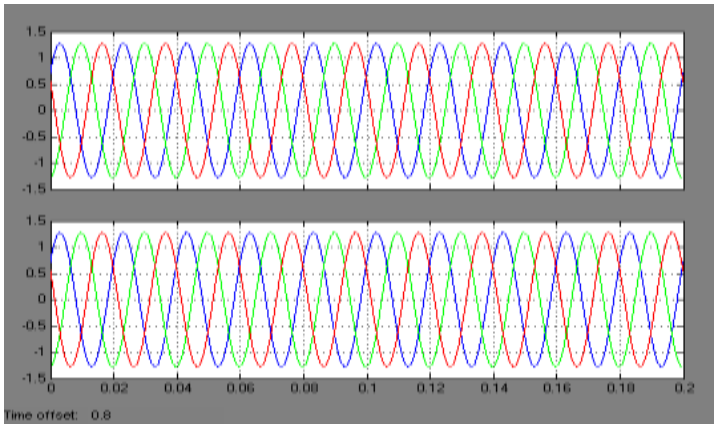

Figure-5: With DVR Output Current

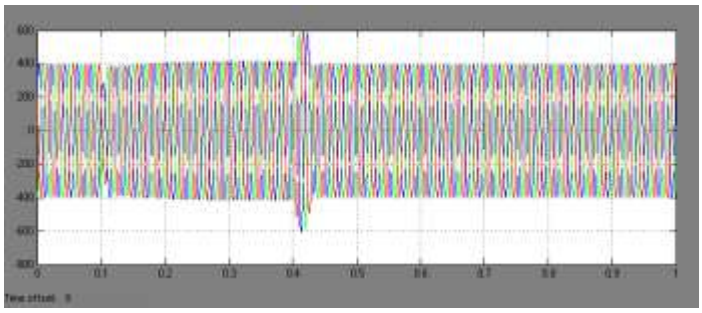

Figure-6: With DVR Output Voltage

Advantages

- It does not need any line-frequency step-up isolation transformer.
- DVR obtains the required active power from the energy storage feeding the dc link of the multilevel converter
- Better THD can be obtained using fuzzy controller.
- Cost of generation of power is very less
- It does not emit any harmful gases
- The source of power is free and available in plenty
- The is no power interruptions

Applications

- Used in substation
- Industry application
- Cells are used for powering small devices such as electronic calculator
- Photovoltaic arrays generate a form of renewable electricity.
- Remote radio telephones, water pumping applications, Earth orbiting satellites and space probes.

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V. CONCLUSION

In this paper, the concept of integrating photovoltaic solar panel rechargeable energy is stored in DVR system to improve its voltage restoration capability. This integration, the DVR will be able to compensate for faults on the grid with independently voltage sags and swells without relying on the grid. Average current mode control is used to regulate the output voltage of the dc–dc converter due to its inherently stable characteristic. The simulation of the photovoltaic system, which consists of the solar, dc–dc converter, and the grid-tied inverter, is carried out using PSCAD. Hardware experimental setup of the integrated system is presented and the ability to provide temporary voltage sag and swell compensation in all three phases to the distribution grid dynamically is tested. Results for transient response during voltage sags/swells in two phases will be included in the full-version of this paper.

VI. FUTURE WORK

The concept of integrating Renewable energy sources-based rechargeable energy storage to the DVR system to improve its voltage restoration capabilities is explored. With this integration, the DVR will be able to independently compensate voltage sags and swells without relying on the grid to compensate for faults on the grid. Zigbee controller and Neutral network inverter to be used. The high amounts of output to be simulate.

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