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# A NOVEL DYNAMIC VOLTAGE RESTORER

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## ABSTRACT:

In this paper author has tried to present a new approach for integrating grid connected photovoltaic (PV) system together with a self supported dynamic voltage restorer (DVR). In this paper author has also tried to present different three topologies of DVR, the suggested three topologies are filtering schemes, dc-link capacitor and three phase four wire of a three phase transformer connection. The DVR has become popular as a cost effective solution for protection of important or sensitive loads from voltage dips and sags. The new methodology direct Quadrature based DVR technique is presented. While implementing this technique MATLAB power Simulink is used.

The most frequent occurring power quality problems in the distribution system are voltage variation. DVR technique is normally used for mitigation of voltage sag. The implemented system has a advantage of less no of switch devices and possesses good compensating capability in comparison with commonly used compensators. The static series compensator (SSR), commercially known as dynamic voltage restores (DVR), is best suited to protect sensitive load against such incoming supply variations.

## INTRODUCTION:

The fast reduction of conventional energy resources or consumption of fossil fuels, it is also increasing environmental concerns have made usage of renewable energy resources, mainly photo voltaic, wind and other progressive sources of electric power generation. Power generated by a PV cell is principally DC, it requires a DC-AC converters before connecting it to grid. The main component of a grid connected system is VSI (voltage source inverter). The primary function of VSI block is to enhance injected active power through maximum power point tracking (MPPT) control of PV array. Most frequent and most dangerous in the grid connected systems are control of PV array are grid voltage, voltage dips, voltage swells and other electrical faults. For maintaining the quality and reliable voltage at load terminals, various electronic power devices are used among one of them is DVR.

In recent trends computer, other communication devices are used widely in home, offices and factories. These devices are made to operate throughout a day, and for satisfactorily operation of these devices we require a highly reliable and quality input power. The advantage of using DVR it does not require any storage unit. DVR is basically divided in two types according to the connection pattern, the DVR can be connected in series to load through transformer is mostly adopted type and this method gives best result.

In the proposed DVR design, a PV system with low and high power DC–DC boost converters are incorporated to function as a high capacity DC voltage source.
Informative about photovoltaic cells are:

- Solar power is pollution free.
- Solar cells produce DC which must be converted to AC.

The location of the proposed PV based DVR in a single phase distribution. This Paper presents a simulation model of a PV based dynamic voltage restorer. In the daytime, DVR will act as online UPS to feed the generated power in PV system to battery and load.

- Reduced production end wastes and emissions.
- PV installations can operate for many years with little maintenance,

While implementing this, capital cost of the system is very high but running cost is low as compared to other technologies.

## POWER QUALITY PROBLEMS:

Power quality can be defined in many ways by different people. IEEE 1100 standard dedicated to power quality has defined power quality as "as "the concept of powering and grounding sensitive electronic equipment in a manner suitable for the equipment" . Power quality issues are associated with power systems with wide ranges of time frames such as short duration variations, long duration variations and other disturbances. All electrical devices are likely to undergo failure or malfunction when exposed to one or more power quality problems.

## SOURCES OF POWER QUALITY PROBLEMS:

- Starting of large induction motor takes high current which leads to voltage sag.
- Energizing capacitive banks or switching of a large load cause to voltage swell.
- Rural location remote from power source.
- Unbalanced load on three phase system.
- Long distance from a distribution transformer.
- Unreliable grid systems.

## SOLUTION TO POWER QUALITY PROBLEMS:

Power quality mitigation can be done by two ways i.e. one from consumer side or other utility side. First method is called conditioning, which ensures that the equipment is less sensitive to power disturbance, facilitates the operation even under significant voltage distortion. The other method of mitigation involves the installation of conditioning monitoring equipment that suppress or counteract the power variations at utility side. Currently they are based on PWM converters and connect to low and medium voltage distribution system in shunt or in series. Some of the effective and economic measures can be identified as following:

1. Lightning and surge Arresters
2. Thyristor Based Static Switches

3. Energy Storage Systems
4. Electronic tap changing transformer
5. Harmonic filter

## SYSTEM CONFIGURATIONS:

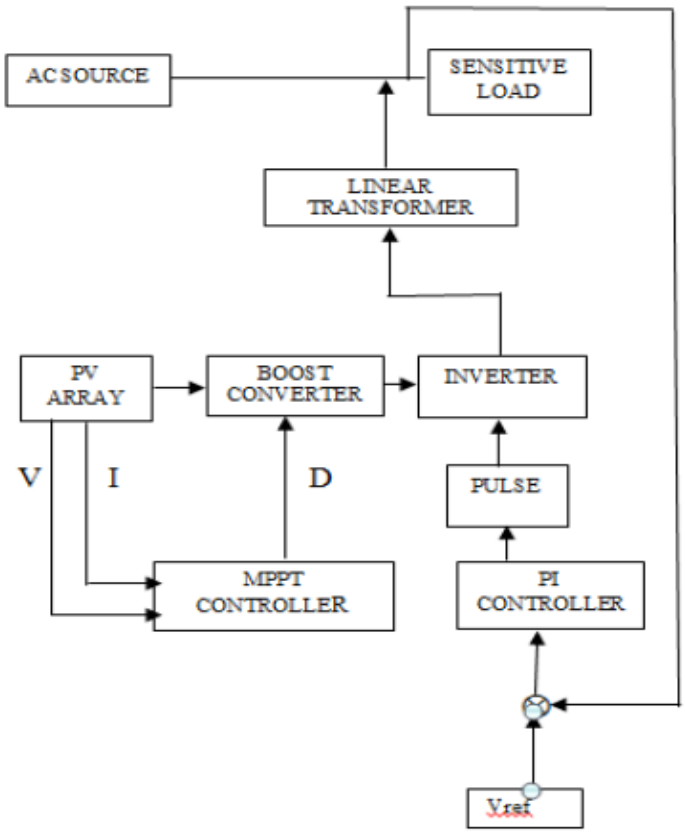


Fig. No. 1. System Configuration

## BASIC CONFIGURATION:

Basic elements of DVR are

- Converter
- Line-filter
- Injection transformer
- DC-link and energy storage

## CONVERTER:

The converter used in this case in voltage source converter (VSC), which pulse width modulates (PWM) the DC from the DC link/storage to AC voltages injected into the system. A VSC is comprises of power electronic components and also consisting of a storage device and electronic switching devices, which are able to generate a sinusoidal voltage at any required frequency, magnitude, and phase angle. In the DVR application, the VSC is used to temporarily purpose replace the supply.

## INJECTION TRANSFORMER:

The DVR is capable of injecting a voltage by using injection transformer to ensure galvanic isolation and for simplification of converter topology and protection equipment in most DVR applications. The injection transformer are also called as booster applications, this are specially designed transformer that tried to limit the noise coupling and transient energy from the primary side to secondary side. And the major of functions of injection transformers are

1) For connection of the DVR to the distribution network via the HV-windings and couples the injected compensating voltages generated by the voltage source converters to the incoming supply voltage.

2) The Injection / Booster transformer isolates the Load from the system (VSC and controlling mechanism).

## DC-LINK VOLTAGE AND ENERGY STORAGE:

A DC link voltage is used by the VSC for synthesizing an AC voltage into the grid and during minor or major voltage dips for this active power injection is necessary for restoring the supply voltages.

The charging circuit is provided has following major two tasks.

1) The first task is to charge the energy source after a sag compensation event.

2) The second task is to maintain dc link voltage at the nominal dc link voltage.

Fig. No.1. shows the block diagram of the implemented PV based DVR. The implemented system consists of photovoltaic array, low and high power DC/DC boost converters, battery and PWM inverters, semiconductor switches and injection transformer. The power semiconductor is normally controlled by the voltage sensor and some logical components. An injecting transformer is as usual connected in series with the load for restoring voltage sag and swell and it can be reconfigured in parallel using semiconductor switches.

In normal condition, the supply voltage is equal to the load voltage with zero angle. At the time of sag, the supply voltage reduces to a value less than its prescribed value. The DVR reacts to the sag event and adds a compensating voltage in phase with the supply voltage to restore the voltage at nominal value. The injected voltage of a DVR ($V_{DVR}$) can be expressed as

$$|V_{inj}| = |V_{Presag}| - |V_{sag}| \quad (1)$$

Main component of the DVR is inverter. Its control will affect directly the dynamic performance of the DVR. A sinusoidal PWM (SPWM) scheme is used in a novel DVR. The carrier waveform is a triangular wave with higher frequency (1080 Hz). The modulation index varies according to the input error signal from the PI controller. The basic idea of SPWM is to compare a sinusoidal control signal of normal frequency 50 Hz with a triangular carrier signal. When the control signal is greater than the carrier signal, the switches gets turned on and their counter switches are turned off. The output voltage of the inverter mitigates the sags, swells and outages. The DC voltage may be used from PV array if available. Otherwise, the line voltage is rectified and the DC energy is stored in batteries. When the source is recovered, the compensating voltage is removed by cutting off the gate signals for the inverter. The switch turns on to supply power from the source. The measured

source voltage is sent to the phase-locked loop to obtain the unit sine signal, which is needed to calculate the reference value for instantaneous sag detection. Once the sag is detected, the inverter injects a sinusoidal voltage. The unit sine from the phase-locked loop is sent to the gate pulse generator for the switches.

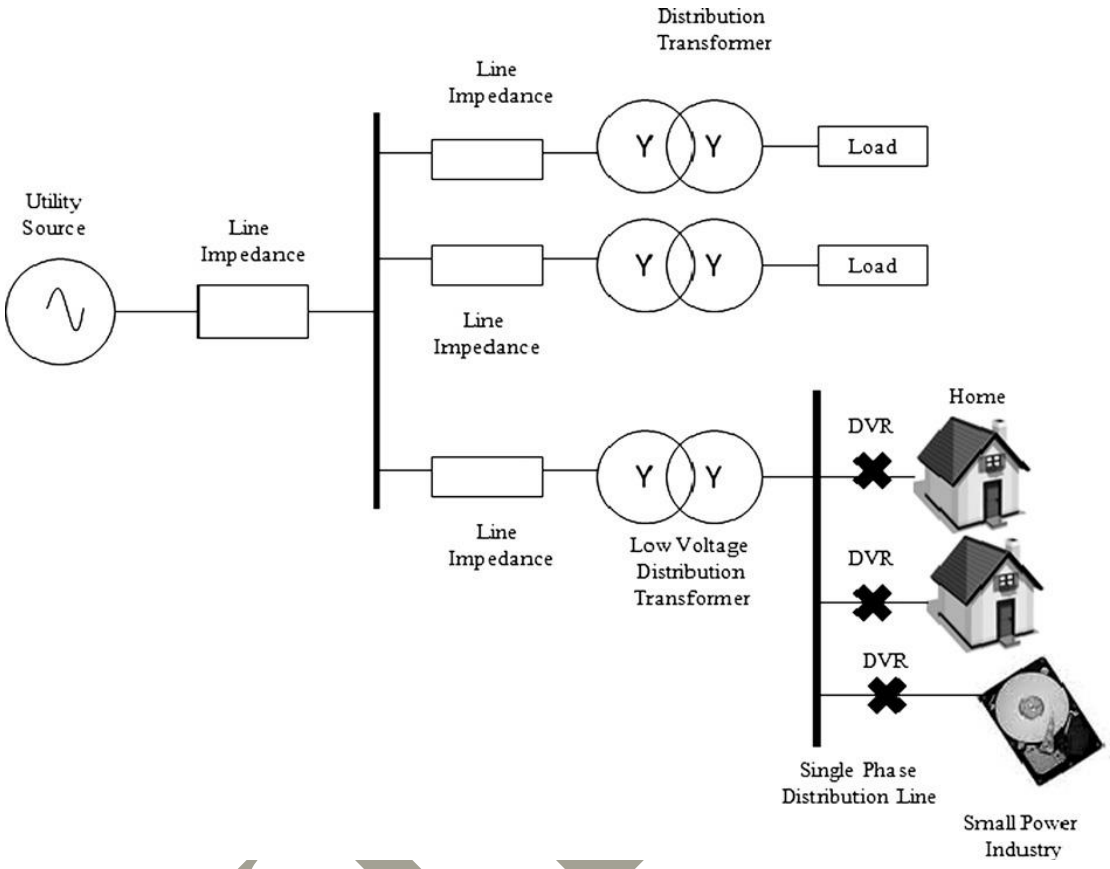


Fig. No.2. Configuration of Proposed 3-Phase Line-Interactive DVR

As shown in fig. No. 2, Dynamic Voltage Restorer is a series connected apparatus modelled to keep up a constant RMS voltage value across a sensitive load. The DVR cogitated contains of:

- A Control System
- An Energy Storage
- A 3 level bridge
- A Harmonic Filter And
- An Injection / Series Transformer.

## CONCLUSION:

The main aim of the DVR is saving sensitive loads from voltage variation form the network. If a fault occurs on other lines, the main work of the DVR is to inject a series voltage and maintain the voltage profile. The DVR works individualistically of the class of fault or any problem that occurs in the system, provided that they are connected to supply grid and line breaker in healthy condition. By doing compensation the positive and negative sequence

components of the voltage disturbance seen at the input of the DVR, the most economical design can be implemented. DVR with solar panel is an effective device for improvement in power quality as it has quick response and high reliability.

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