International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-8 Issue-5, March 2019

Voltage Compensation Using PV-DVR with SEPIC Converter

N Saida Naik, V Praveen

Abstract*: This paper offers a Dynamic Voltage Restorer (DVR) is hooked up to Photo Voltaic (PV) cell array via SEPIC (Single Ended Primary Inductive Converter)converter for voltage (VL) compensation in distribution load method. Apart from the voltage compensation, the present DVR also lower the burden on utility grid. The control manner used on this paper is the minimal lower or injection of the voltage. The Perturb & realize (P&O) highest power factor monitoring (MPPT) algorithm useful to monitor the highest energy during the PV array. PV cluster is connects to SEPIC converter to expand the voltage score of the picture Voltaic (PV) cell array and elevated voltage given to DVR. Based on the case DVR compensate the voltage. The validate simulated results were awarded on this paper beneath one-of-a-kind load stipulations are simulated with aid of MATLAB/Simulink application.

Index Terms*: Dynamic Voltage Restorer, photo voltaic array, Perturb & observe MPPT algorithm, SEPIC converter.

I. INTRODUCTION

Daily growing of loads, energy consumptions and degradation of environment factors as a part of result of variation of oil prices and fossil fuels combustion in India has multiplied; using a untraditional energy sources is the vital utility of energy process. Voltage dip were determined as a decrease of RMS voltage (V_{RMS}) to 10%-90% of Voltagerated and Voltage swell were defined as increase of RMS voltage (V_{RMS}) to 110%-180% of Voltagerated.DVR is the combine of dc energy source, DC-AC converter, injection of transformer &filter. The DC link energy sourceis supply power required to compensate / inject voltage. If inject/ compensate voltage is high, DVR dc energy source has to increase so as then SEPIC is one type of buck-boost converter and used to increase voltage and decreaseburden on DVR dc energy source. PV centered DVR is the certainly one of favorable technique to the voltage issues in distributing system. Right here the PV cluster array energy generation method has some difficulty that's the PV cluster array can lose their output power capacity when irradiation level changes. To overcome this predicament and to monitor the highest energy from PV array uses the MPPT method. The achievement of PV cluster will also be elevated via using P&O MPPT algorithm. When three segment fault is taken place both on supply aspect or load aspect factors the voltage drops in all 3 phases. So as to clear the error fault as early as viable in any other case process could also be damaged. One more case surprising addition or removing of load on present loads explanations the voltage swellor voltage dip. DVR is one type of the custom energy devices to recompense voltage problems at distribution load process and protect the burden.

Manuscript published on 30 March 2019.
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II. SYSTEM DESCRIPTION

The proposed systems consist of Dynamic Voltage Restorer, photo voltaic array, Perturb & observe MPPT algorithm, SEPIC converter, series injection of transformer & filters.

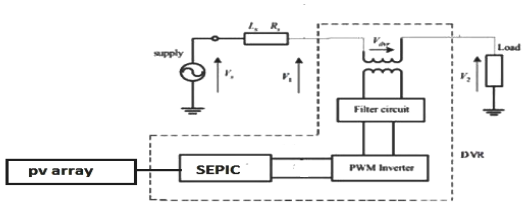

Fig. 1.Block diagram representation of the present systems

III. PV ARRAY MODELING

Photo voltaic system operates principles of photo voltaic effect and produces the electricity. Basically, thenumbers of PV modules may have arranged asparallel or series is called PV array [1] and to getrequired output

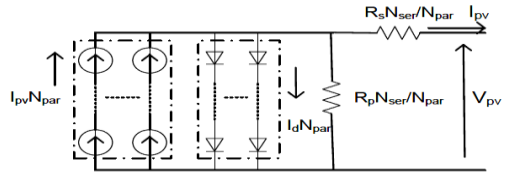

Fig. 2.PV array Equivalent circuit

The Mathematical model design of PV cell array is obtained from voltage (V)-current (I) relation is given below

$$V_{pv} = \frac{nkT}{qln(\frac{I_{sc}}{I_{pv}}+1)} (1)$$

$$I_{pv} = I_{pv}N_p - I_sN_p\left[\exp\left(\frac{q\left(\frac{V_{pv}}{N_s} + I_{pv}R_s\frac{N_s}{N_p}\right)}{aKTN_s}\right) - 1\right] - \frac{q\left(\frac{V_{pv}}{N_s} + I_{pv}R_s\frac{N_s}{N_p}\right)}{R_p\frac{N_s}{N_p}} (2)$$

Perturb & Observe MPPT Algorithm

The Perturb & Observe (P&O) Maximum point of power tracking algorithm is one method of hill climbing technique. Here, duty cycle ratiowill be converting andperturbed in P&O MPPT algorithm, the operation voltage to DC link or the PV cell array panel output voltage or the input terminals of converter is perturbed.

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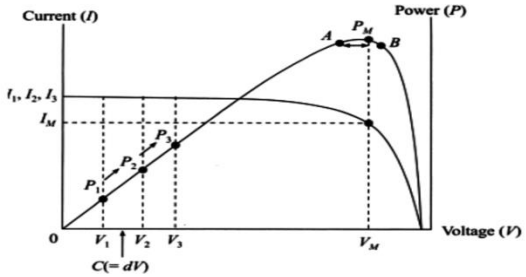

Fig. 3. Model graph of P&O MPPT algorithm

In this MPPT technique, the current perturbation is determined by signs of the preceding perturbations and increments. If the power is maximum increased by the previous perturbation, then later it would be in the alike direction, whereas whether it results in are duction of power, the path of the perturbation would be altered. The perturbations are carried out time after time until the MPP is attained.

IV. SINGLE ENDED PRIMARY INDUCTOR CONVERTER

SEPIC [2] is one type of DC to DC converter, that accepts the basic voltages at the output terminal should beequal, lesser than or higher of input terminal. The voltage atthe output terminals of Single-ended primary inductor converting will be controlled by duty cycleratio to MOSFET (metal oxide semiconductor filed effect transistor). SEPIC is also similar to conventionalbuck-boost converter, but it has pro of having non-inverted output voltage, itmeans coupling of energy from input to output via series capacitor. When a MOSFET is turn off,thevoltage at output terminals drops to zero Voltage. SEPIC is used inpracticalapplications like charging of batteries where voltageoutput can below or above of the ratedvoltageoutput.

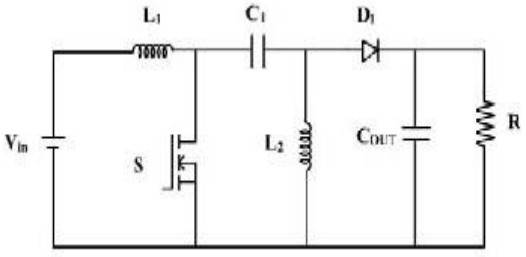

Fig. 4. SEPIC convertercircuit

V. DYNAMIC VOLTAGE RESTORER

DVR [3] is oneamong the series controlled distribution FACTS device and which is capable to control the voltage problems at remote end users in all possible operating conditions.DVR is the combine of DC link, voltage converter, series injection of transformer &filter circuit.

The main use of DVR is for maintaining the voltage under different operating conditions. In every operating condition DVR restore or compensate [4] the base voltage at remote end users. Hence, it is a one among the customers; so the device is called as customer power devices.

DVR operates in two models of operation the primary thing is it can compensate or restore the voltage in distribution line during the dip and swell conditions. The 2nd thing is normal operation, in this mode of operation DVR injected voltage is zero. The injected / compensated voltage by DVR is must satisfy the load demandin equation 3.

$$V_L = V_S + V_{DVR} \quad (3)$$

VI. SIMULATION RESULTS

CASE 1: SWELL AND SWAG COMPENSATION FOR RESISTIVE LOAD

The simulation modeldiagram in fig 5 having a 3phased programmable base voltage source withfrequency is 50Hz&440V voltage. Load used here is resistive load.

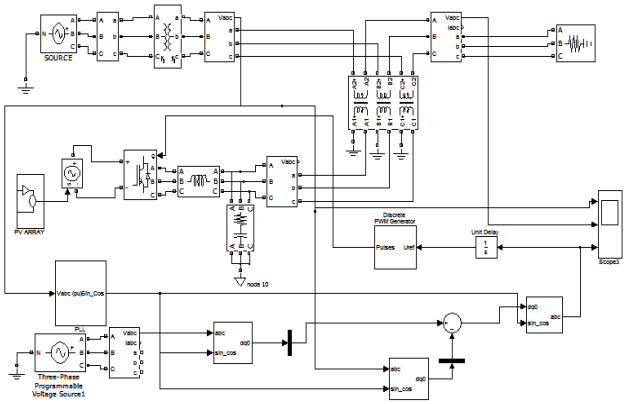

Fig. 5.circuit of the resistive load simulink

In figure 5, the voltage dip [5] is formed in the source side using programmable base voltage source with a step of -0.5pu to the normal 1pu voltage. The voltage dip is created from 0.3 seconds to 0.4 seconds in the total time period of 0.5seconds. DVR is injecting the 0.5pu voltage is in serial connection with the source input voltage and to make voltage atload is constant.

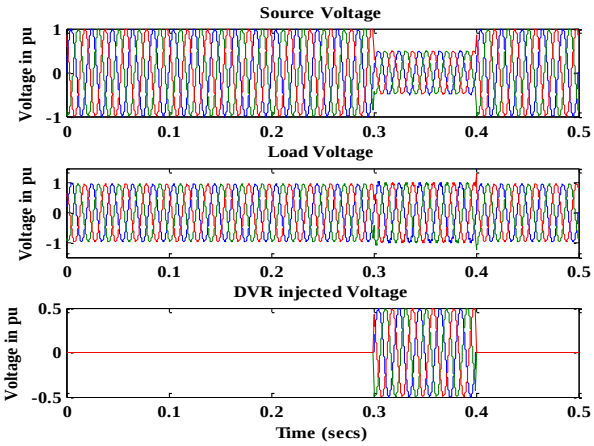

Fig. 6. Output waveforms of system underdip condition

In figure 5, the voltage swell has been formed in the source side using programmable base voltage source with a step of +0.5pu to the normal 1pu voltage. The voltage swell is created from 0.3 seconds to 0.4 seconds in the total time period is 0.5. DVR compensate the +0.5pu voltage &to make voltage at load is constant.

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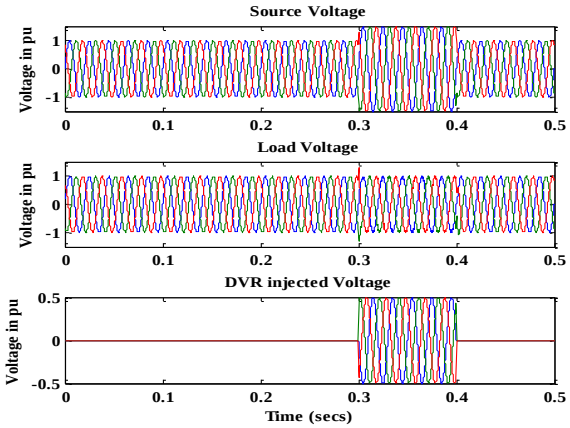

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Fig. 7.Output waveform of system under swell condition

CASE 2: SWELL AND SWAG COMPENSATION FOR MOTOR LOAD

The simulation model diagram is shown in below figure 8having a 3phase programmable base voltage source with frequency is 50Hz& 440V voltage. Here, asynchronous type motor is a load&the resistivity load in previous case is replaced bythis asynchronous motor.

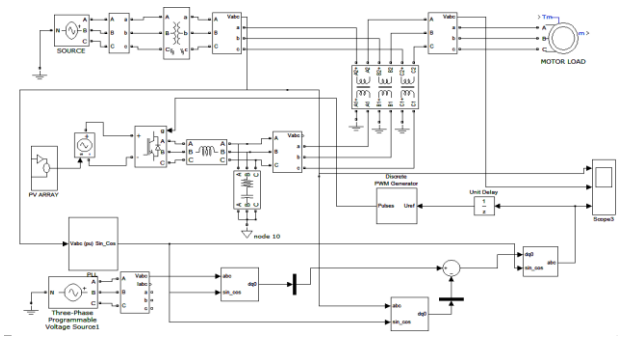

Fig. 8.circuit of the motor loadSimulink

In figure 8, the voltage dip will be created in the base source side using programmable base voltage source with a point of -0.5pu to the normal 1pu voltage. The voltage dip is created from 0.3 seconds to 0.4 seconds in the total time period is 0.5seconds. DVR is injecting the 0.5pu voltage willin serial with the inputbase voltage and to make voltage at load is constant.

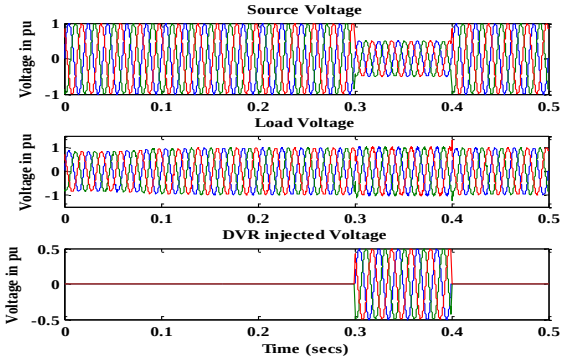

Fig. 9.Output waveform of system underdip condition

In figure 8, the voltage swell will be created in the base source side using programmable base voltage source with a step of +0.5pu to the normal 1pu voltage. The voltage swell is created from 0.3 seconds to 0.4 seconds in the total time period is 0.5. DVR compensate the +0.5pu voltage and to make voltage at load is constant.

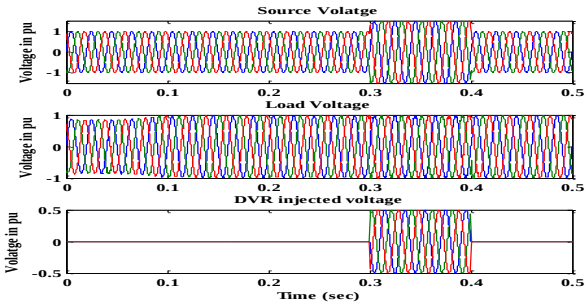

Fig. 10. Output waveform of system under swell condition

CASE 3: BALANCED THREE PHASE FAULT AT SOURCE SIDE

The simulation modeldiagram is shown in fig 5 having a 3phase programmable source voltage withfrequency is 50Hzand440v voltage. Load used here is resistive load.At source endthree phase balanced fault is appliedby using three phase fault element block with resistive load along with a three phase transformer instead of creating aproblem in three phase programmable source voltage. The fault time period is 0.3 to 0.4 seconds in the total time period is 0.5seconds.

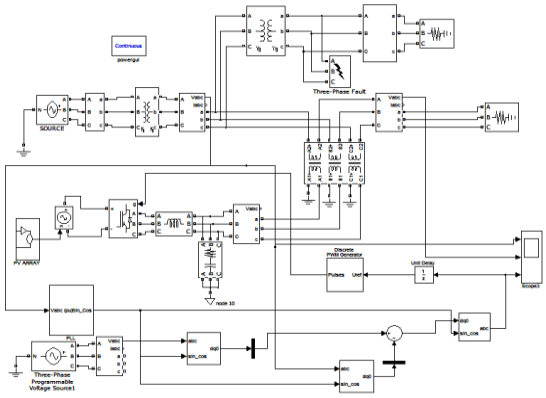

Fig. 11.diagram of the system with source side fault simulink

The sudden fault causes 0.3pu dip in supply end.Thisdip voltage is injected by the DVR. DVR injects the 0.3pu voltage in serial way with the base input voltage and to make voltage at load is constant.

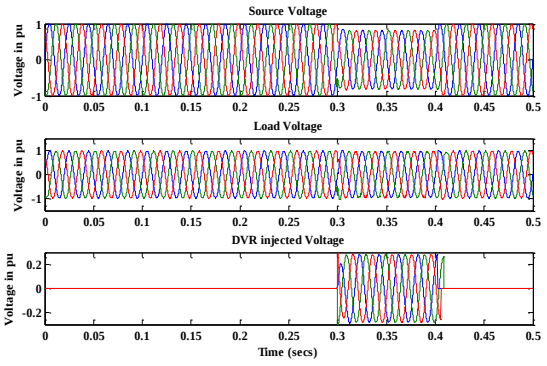

Fig. 12.Output waveform of system with source side fault

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VII. CONCLUSION

This paper gives the modeling of PV array, SEPIC converter and DVR with the help of SIMULINK/MATLAB. The proposed present system is to control the voltage problems in distribution load system. The present system is operating under different cases and a validate results are presented.

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