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Voltage Sag /Swell Compensation Using Dynamic Voltage Restorer

S.Raj Kumar[1], M.Pavani[2], M.Pournami[3], S.Hari Krishna[4], G.Rajkumar[5], Ch.Samith[6]

Assistant Professor, Dept. of EEE, Nigama Engineering College, Karimnagar, Telangana, India[1]

UG Student, Dept. of EEE, Nigama Engineering College, Karimnagar, Telangana, India[2]

ABSTRACT: This paper introduces a new system design for voltage sag and swelling compensation using a Dynamic voltage restorer based on a Solar Photovoltaic Inverter (SPVI-DVR). The common DVR topics listed here have some shortcomings, such as high-cost, more harmonic, and easier electromagnetic interference, and are only used to mitigate voltage disturbances. It consumes more energy from the utility grid to compensate for long-distance voltage sag and swelling that can be overcome with the SPVI-DVR intended to mitigate deep, voltage-disturbing voltage bags. Hence, the voltage regulation of the inverter voltage is reduced due to the proposed SPVI-DVR. It reduces the power consumption from the grid by removing the utility grid from the load. The SPVI design reduces the inverter switching loss. The proposed design also injects the reactive power into the sensitive load. The SPVI-based DVR system consists of a PV system with a low-power and high-power DC-DC booster converter, a series injection transformer, and semiconductor switches. SPVI-DVR execution is simulated under dynamic conditions and the load contains various parameters such as steady-state error, Efficiency, and Total Harmonic Distortion (THD). All of these conditions are performed in MATLAB-Simulink software

KEYWORDS: Dynamic Voltage Restorer, Distributed Energy Resources, Harmonic Compensation, SPVI-DVR,MATLAB

I.INTRODUCTION

With the rapid developments in the manufacturing industry, power quality becomes very important because sensitive loads are tied in the industry. The quality of power can be defined as current and voltage quality with respect to frequency variation. The power quality issue can affect the distribution side which results in the failure or malfunction of the sensitive load. It can be classified as short-term voltage variations, long-distance voltage fluctuations, waveform distortion, crossover, voltage imbalance, and voltage flicker. Various power quality issues include voltage sag, voltage swelling, and more sensitive harmonics in the distribution system. A dynamic voltage restorer based on a photovoltaic solar inverter (SPVI-DVR) is used. A DVR is a series compensation device to alleviate voltage sag and voltage swelling. It is also used as a series active filter to attenuate harmonics. In this work, photovoltaic and inverter cells are modeled and combined to make a perfect model. The Solar-Based Photovoltaic Inverted Dynamic Inverter (SPVI-DVR) is used to provide an economical solution to compensate for voltage sag. The DVR voltage and swell compensation DVR using with PI controller on the side of the inverter is applied and can be compensated with the voltage sag and swelling in the sensitive load, but the compensating power of compensation in the load is not perfectly matched [1-3]. DVR plays an essential role in the control program and DVR provides an enhanced control scheme using dual velocity control (DVC) with cascading delayed signal cancellation (CDSC) under unbalanced and distorted phase conditions [4-5]. Improve power quality by using DVR and improve three-phase performance. LVRT integrated low voltage rider with a combined distributed generation (DG) system. The combined system PV generator and Wind Power Generator (WPG), which is an essential advantage for the load to the continuous power [6-9]. Provide a dynamic dynamics voltage adapter (DVR) with the fuzzy regulator. Particle weapon optimization (PSO) -based simulation technique and the fuzzy system are used to adjust the parameters such as, steady state error, THD. The power generation provides a predicted voltage control scheme to control the Transformer's smaller DVR. A predicted voltage control scheme uses a unique model of a voltage source inverter circuit (VSI) and an interface filter to generate the process of switching inverter switches.

In addition, this system does not require any linear controller or modulation technique. The performance of the conventional DVR is poor due to the non-linear structure of the control system and limited energy storage element in the DVR, rather than special circuits for the detection of voltage disturbances. VSIs are widely used in conventional DVRs to convert DC power to AC power, which is then sent to the series primary injection transformer. The dynamic voltage regenerator based on Photovoltaic Inverter (SPVI-DVR) improves the performance of the DVR with solar energy. The new nonlinear load and the control methods intended to effectively support non-dynamic DVR conditions are being explored.

II.SYSTEM MODEL AND ASSUMPTIONS

SPVI-DVRSystem

The Solarphotovoltaic (SPV) clusterisamixedPVcell thatchangessunlight-based energy into electrical energy. In this proposed model DVRbased PV has an associatedDC-to-DC converter for giving in the steadiness DCvoltage to the voltage source converter, the circuit outline of the SPV-DVRframework is represented in Figure 1. It has been presented between thephotovoltaicandbatterybankof theDCassociation.

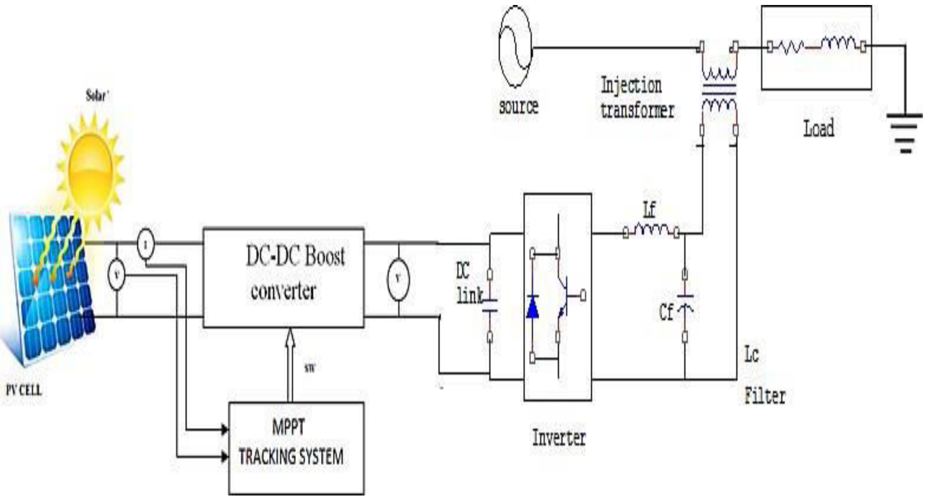

Figure1:SPVI-DVRsystem

The rapid change in climatic conditions to solar energy produced is unstable and requires a DC-DC converter to supply a constant voltage to the DVR inverter. It works with solar radiation intensity, as well as cell transition and temperature. Basic equations for battery voltage are being developed, including PV array temperature change and voltage radiation intensity property. One purpose of the photocatalyst is that the output voltage of the battery is often defined by the load current associated with the amount of solar radiation.

SPVI-DVR Control Strategy

The control strategy for an SPVI-DVR system based on direct converters was proposed. In order to reduce the number of switches a new simplified topology with a series center-tapped transformer on the output side of the direct converter is introduced. The direct converter is made by using three bidirectional control switches. The DVR can properly compensate for prolonged, flat, and unbalanced voltage sag and swelling by taking power from the solar grid. The switches are driven by Pulse Width Modulation (PWM) signals. The typical 3-phase voltage source circuit design for a PWM inverter is presented in Fig. 2. R, R ′, Y, Y ′, B and B "of the six switches that deliver the output from Q1 to Q6. When an upper side transistor, i.e., R, Y or B 1, is turned on, turn off the lower side transistor, i.e., relative „a", „b" or „c". Thus, „Q1", „Q3", and „Q5" transistors are outputs on which settings can be used on and off to determine the voltage.

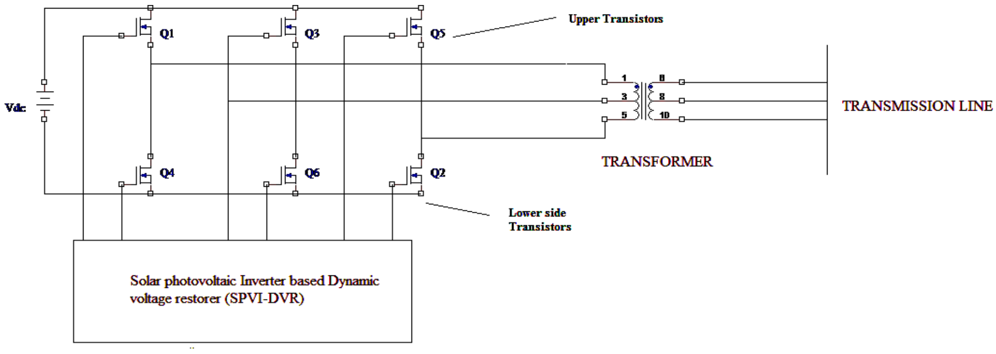

Figure2: SPVI-DVRcontrol

III. RESULTS AND DISCUSSION

The SPVI-DVR with Space Vector PWM controller (ESVPWM) is implemented in the MATLAB Simulink software system, and this design shown in figure 3, Enhanced Space Vector PWM (ESVPWM) technique provides power quality in the distributed system .

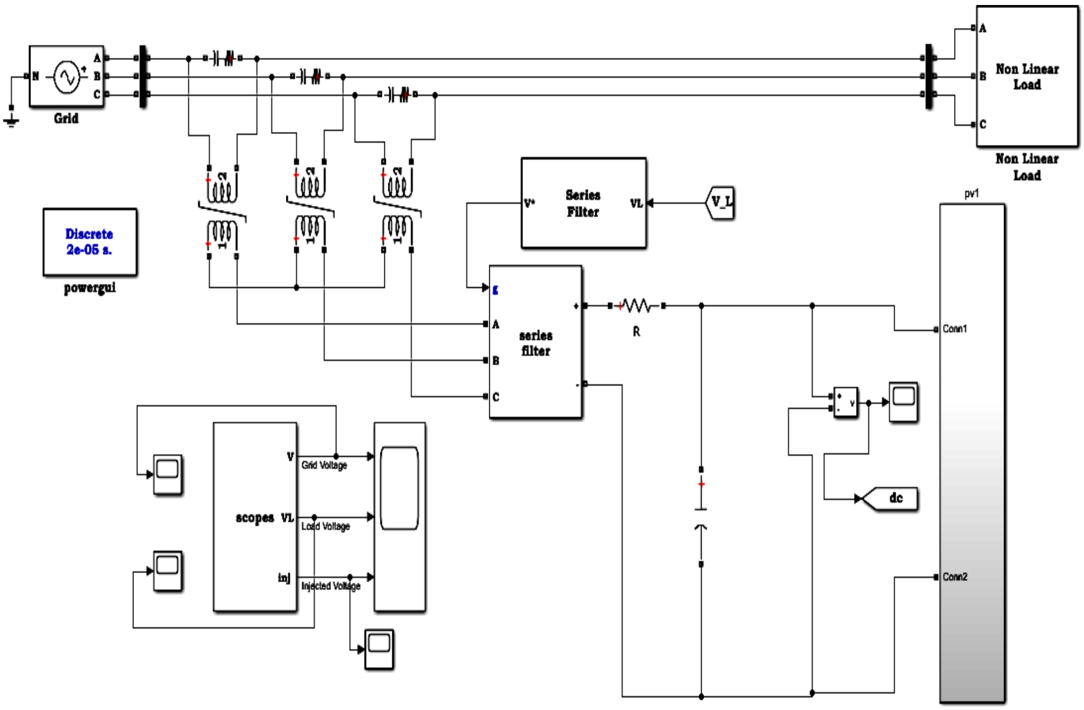

Figure 3: SimulinkModel SPVI-DVR

The simulation of SPVI-DVR, the input voltage are in threephase test system was consider. The sensitive loads take only the standed real and reactive power. Change the power source variation of a series filter that will act as the reactive power of the system and compensate for the power oscillation. At the initial stage, the harmonics present in the nonlinear load are high. After complete harmonic conversion of series filter, low current. The diversity of the proposed model with its output parameters such as source voltage, load voltage and injection transformer voltage is reflected in the scope of the system.The test systems of SPVI-DVR for three phase distribution system is consider and the system parameters are depicted in Table 1.The proposed SPVI-DVR result of line voltage was subjected to the voltage sag of 60% and time duration from01.sec. to 02.sec. the voltage swell subjected to 30% and time duration from 0.25 sec to 0.3sec. the performance of voltage sag and swell are shown figure.4.

Table1: System parameters of SPVI-DVR

Testvoltage	400V	
Supplyfrequency	50 Hz	
Ratingoftransformer	1:1,230V	
SessitiveLoad	ThreephaseR-Lload	
SPVI-DVRpower	200V,20Ah	
SwitchingfrequencyofSPV-Inverter	10 kHz	
DVR	L	1.5H
	C	1F
Harmoniccircuits	R	0.3ohm
	L	4mH
	C	20µF

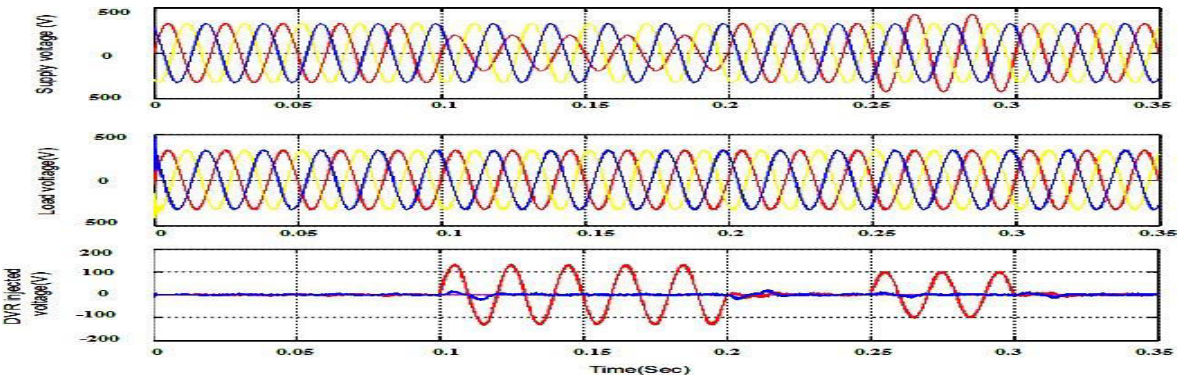

Figure 4: Simulation results of the proposed three phase DVR for single phase sagandswell

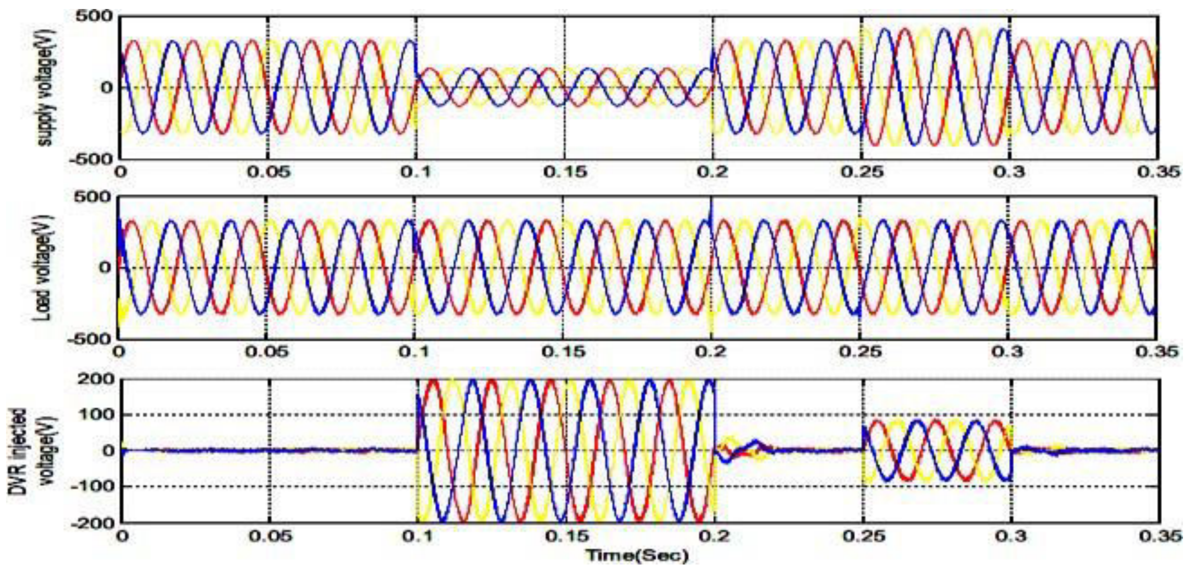

Figure 5: Simulation results of the proposed three phase DVR for three phase sagandswell

The simulation result of DVR three phase sag and Swell performance aredepicted in figure 5. The voltage sag and swell are subjected to 40% and 25%respectively.Thesagperformancefrom0.1secto0.2sec. andSwellfrom0.25sec to0. 3sec.TheseresultssuggestthattheproposedSPVI-DVRiscapableofmitigatingmajorsag and swellpowerqualityissuesin the three-phasedistribution networks. It is assumed that there is a single line fault in theground in the three-phase system.

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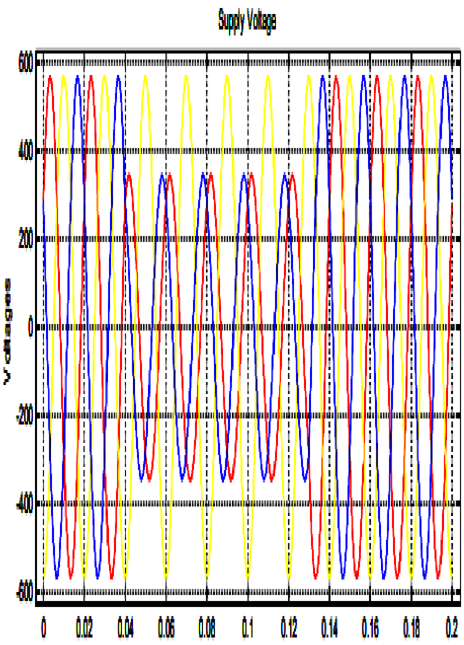
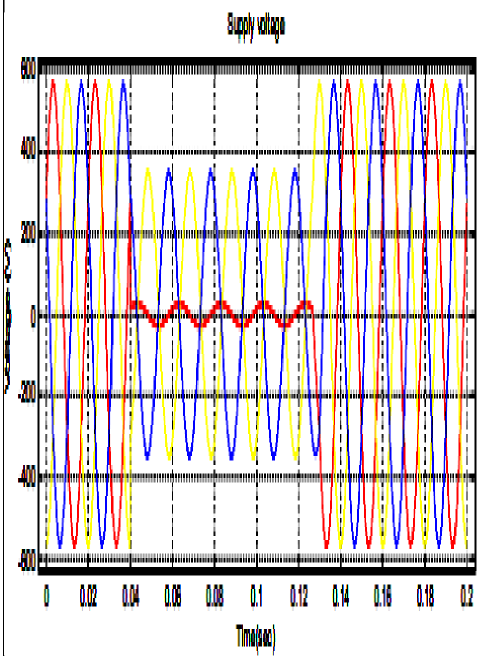
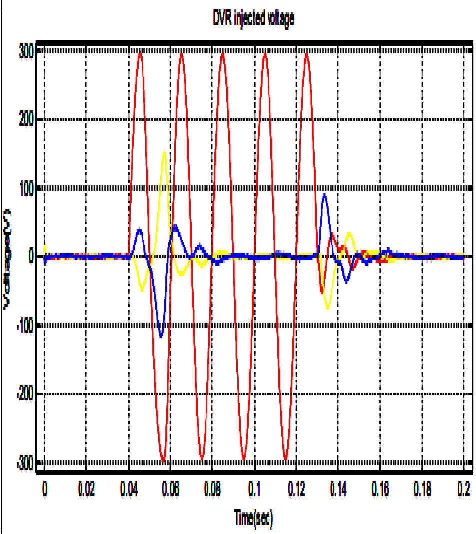
Line-to-line voltages are reduced betweenthe R&B and R&B phases. The DVR applied injection voltage per phase andline voltage through a compensated phase to line. A double line to groundfault is also imagined to study the performance of the DVR. one of the linevoltages becomes zero and in the other two line voltages to about 66%. TheDVR injection voltages in each phase. The line-to-line load compensationvoltageisshowninFigure6.



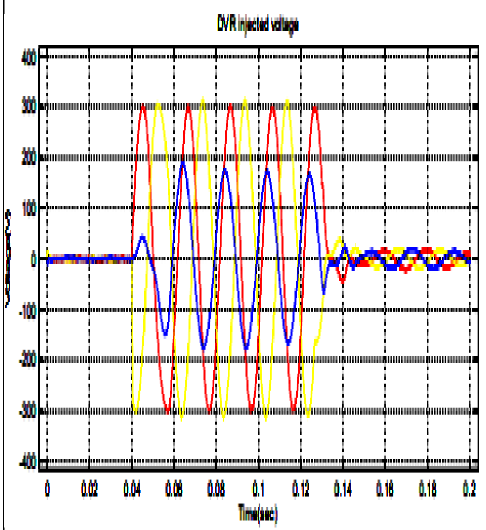
(a) ThreephasevoltagesduringLG fault



(b)ThreephasevoltagesduringLLGfault



(c) InjectedvoltagesbytheDVRduringLGfault



(d)DVRinjectedvoltagesduringLLGfault

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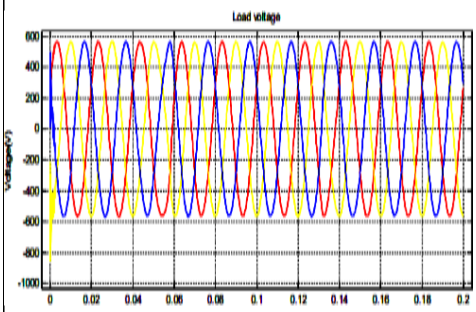
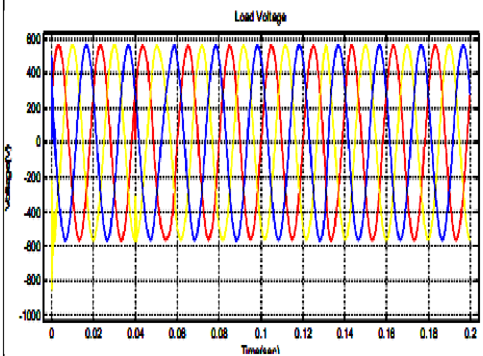


(e)LoadvoltagesaftercompensationduringLG fault



(f)CompensatedloadvoltagesduringLLG fault

Figure 6: Simulation results of the proposed three phase system with SPVI-DVRcontroller

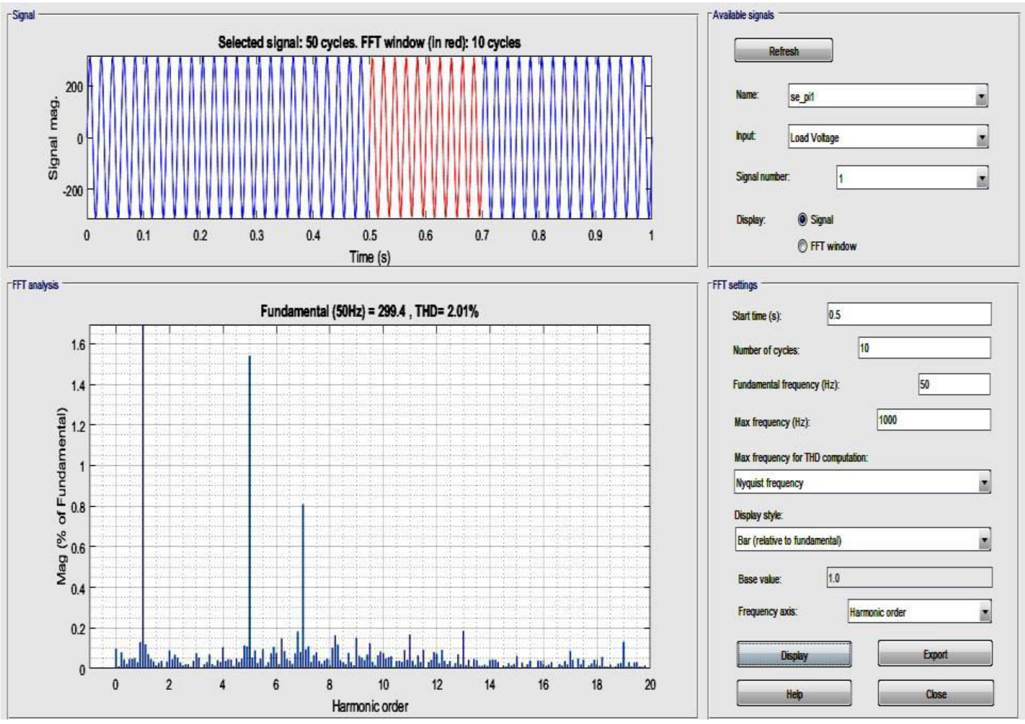


Figure 7:THD Analysis of the proposed control system with DVR

Figure 7 above shows the THD investigations of the proposed PWMEnhanced Space Vector (ESVPWM) method, which produces the THD of2.01%.Withabasic frequencyof 50HZ.

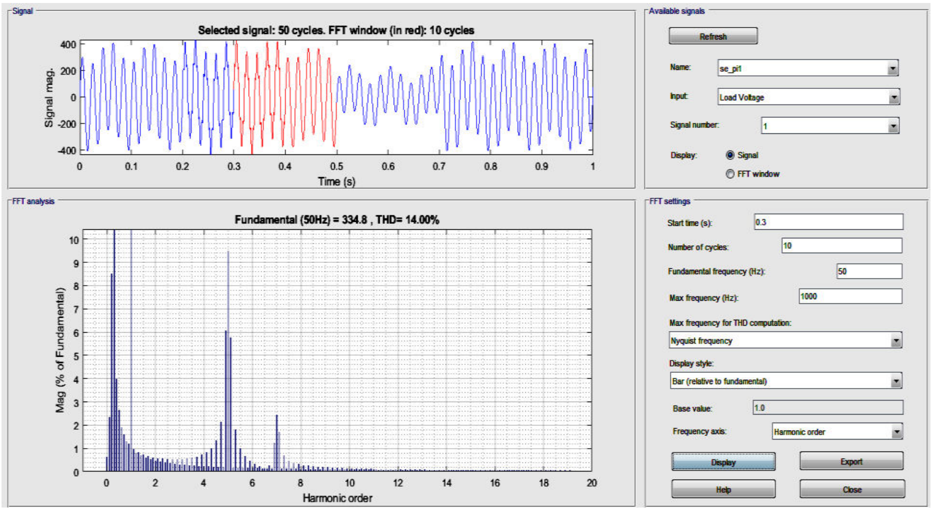


Figure 8: THD Analysis of the proposed control system without DVR

Figure 8 shows the THD analysis of the proposed system without DVR compensation present that the load-side THD value is 14.00%.

IV. CONCLUSION

In this work the three-phase balanced distribution system was considered and which was analyzed the DVR in the distribution network. It can compensate for power quality issue like voltage sag and swell in sensitive loads. A new control technique was introduced in the DVR, the Solar Photovoltaic Inverter DVR (SPVI-DVR) can reduce the switching losses in the inverter operation at the time of voltage sag injection, minimize the energy storage losses and also analysis with various parameters such as steady state, efficiency and Total Harmonic (THD) distortion with dynamic current condition. In addition to that, the sag compensation time is very fast comparatively to conventional DVR. The SPVI-DVR suppresses the THD which is 2.2% and also the overall performance of SPVI-DVR was increased which is reflected in the output waveform. The maintenance cost of the SPVI-DVR is less.

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