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Modeling and Design of Control Reduced-Rating of DVR With a Battery Energy Storage System

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Abstract:-In the midst of the past presences a while, In this suspect, assorted voltage implantation anticipates dynamic voltage restorers (DVRs) are investigated with particular spotlight on another technique used to minimize the rating of the voltage source converter (VSC) used as a piece of DVR. Another control technique is proposed to control the capacitor-upheld DVR. The control of a DVR is appeared with a reduced rating VSC. The reference load voltage is assessed using the unit vectors. The synchronous reference frame hypothesis is utilized for the change of voltages from pivoting vectors to the stationary edge. The compensation of the voltage sags, swell, and harmonics is exhibited utilizing a decreased rating. The purposes behind minimize the rating of the voltage source converter (VSC) utilized as a part of DVR permit the compensation of current consonant fixings, consolidating unequal current made in single-stage nonlinear weights. The key pay of the executed with diminished rating of DVR and took after control arrangement for pay conditions is presentations for the way of power through test results by MATLAB/SIMULINK.

Key words: Dynamic voltage restorer (DVR), power quality, unit vector, voltage harmonics, voltage sag, voltage swells.

I. Introduction

POWER QUALITY issues in the present-day dissemination frameworks are tended to in the literature [1]–[6] because of the expanded utilization of delicate and critical equipments, for example, correspondence system, process commercial enterprises, and exact assembling forms. Power quality issues, for example, transients, sags, swells, and different bends to the sinusoidal waveform of the supply voltage influence the execution of these hardware pieces. Advances, for example, custom power devices are developed to give security against power quality issues. Custom power devices are for the most part of three classifications, for example, arrangement associated compensators known as dynamic voltage restorers (DVRs), shunt-associated compensators, for example, circulation static compensators, and a mix of arrangement and shunt-associated compensators known as unified force quality conditioner [2]–[6]. The DVR can manage the heap voltage from the issues, for example, sag, swell, and harmonics in the supply voltages. Subsequently, it can shield the basic buyer loads from stumbling and ensuing misfortunes [2]. The custom force gadgets are produced and introduced at purchaser point to meet the force quality models.

Voltage lists in an electrical lattice are not generally conceivable to stay away from in view of the finite clearing time of the flaws that cause the voltage hangs and the proliferation of droops from the transmission and dispersion frameworks to the low-voltage loads. Voltage droops are the normal purposes behind intrusion underway plants and for end-client gear glitches by and large. Specifically, stumbling of gear in a generation line can bring about creation interference and significant costs because of loss of generation. One answer for this issue is to make the hardware itself more tolerant to lists, either by canny control or by putting away "ride-through" vitality in the gear. An option arrangement, rather than changing every segment in a plant to be tolerant against voltage lists, is to introduce a plant wide uninterruptible force supply framework for more power intrusions or a DVR on the approaching supply to alleviate voltage hangs for shorter periods [8]–[23].

DVRs can dispense with the greater part of the sags and minimize the danger of burden stumbling for profound droops, however their primary downsides are their standby misfortunes, the gear cost, furthermore the security plan required for downstream shortcircuits. Numerous arrangements and their issues utilizing DVRs are accounted for, for example, the voltages in a three-stage framework are adjusted [8] and a vitality advanced control of DVR is talked about in [10]. Modern case of DVRs are given in [11], and distinctive control techniques are investigated for various sorts of voltage hangs in [12]–[18]. A correlation of various topologies and control techniques is introduced for a DVR in [19]. The configuration of a capacitor-upheld DVR that secures hang, swell, bending, or unbalance in the supply voltages is examined in [17]. The execution of a DVR with the high-recurrence join transformer is talked about in [24]. In this paper, the control and execution of a DVR are exhibited with a diminished rating voltage source converter (VSC). The synchronous reference Frame (SRF) hypothesis is utilized for the control of the DVR.

II. OPERATION OF DVR

The schematic of a DVR-connected system is shown in Fig.1

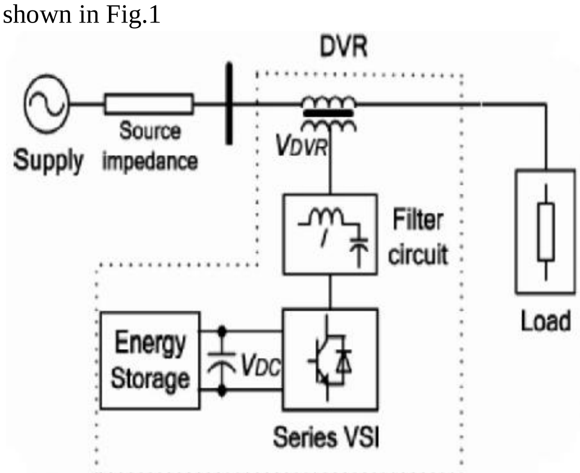


Fig.1 Basic circuit of DVR

The voltage Vinj is embedded such that the heap voltage Vload is steady in extent and is undistorted, in spite of the fact that the supply voltage Vs is not consistent in size or is misshaped.

Fig. 2 shows a schematic of a three-phase DVR connected to restore the voltage of a three-phase critical load. A three-phase supply is connected to a critical and sensitive load through a three-phase series injection transformer.

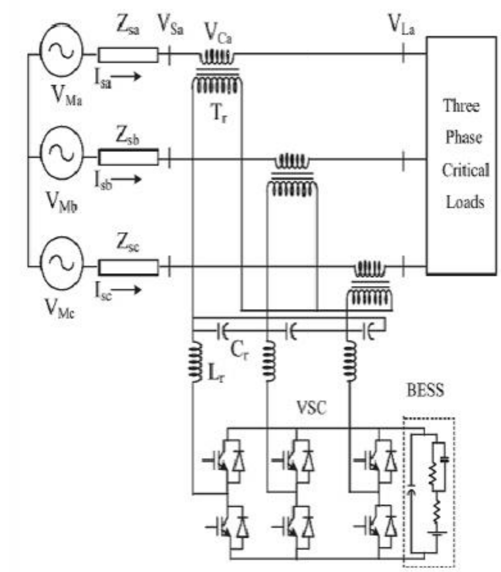


Fig.2. Schematic of the DVR-connected system

The comparable voltage of the supply of stage VMa is associated with the purpose of basic coupling (PCC) VSa through short out impedance Zsa. The voltage infused by the DVR in stage VCa is such that the heap voltage VLa is of evaluated size and undistorted. A three-stage DVR is associated with the line to infuse a voltage in arrangement utilizing three single-stage transformers Tr. Lr and Cr speak to the filter parts used to filter the swells in the infused voltage. A three-leg VSC with protected door bipolar transistors (IGBTs) is utilized as a DVR, and a BESS is associated with its dc transport.

III. CONTROL OF DVR

The sectional diagram of current control scheme is shown in Fig.3

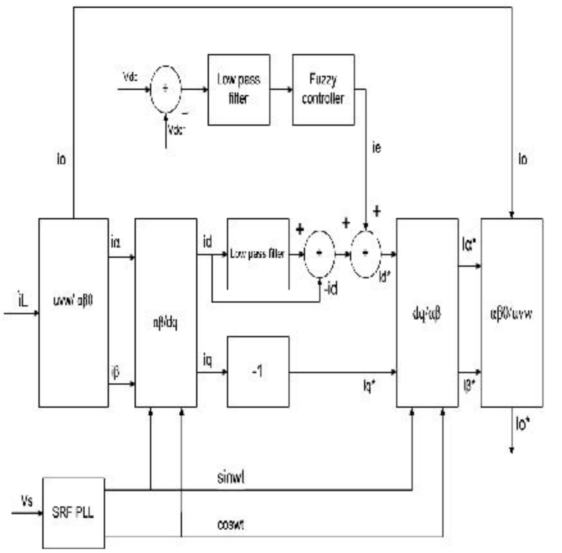


Fig.3 Control Block of the DVR that uses the SRF Method of Control.

The present control proposition is fundamentally required to current references, that are utilized to repays the undesirable burden parts. In this area the source voltage, load current and the dc-voltage converter are measured, while the common streams are produced precisely from the present reference generator. Fig. 3 demonstrates a control piece of the DVR in which the SRF hypothesis is utilized for reference signal estimation. The voltages at the PCC Versus and at the heap terminalVLa detested for determining the IGBTs' door signals. The reference load voltage V∗L is separated utilizing the inferred unit vector [23]. Load voltages (VLa,VLb,VLc) are changed over to the pivoting reference outline utilizing abc−dqochange utilizing Park's change with unit vectors(sin,θ,cos,θ) determined utilizing a stage bolted circle as

$$\begin{bmatrix} V_{Lq} \\ V_{Ld} \\ V_{L0} \end{bmatrix} = \frac{2}{3}\begin{bmatrix} \cos\theta & \cos\left(\theta - \frac{2\pi}{3}\right) & \cos\left(\theta + \frac{2\pi}{3}\right) \\ \sin\theta & \sin\left(\theta - \frac{2\pi}{3}\right) & \sin\left(\theta + \frac{2\pi}{3}\right) \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \end{bmatrix} \begin{bmatrix} V_{Laref} \\ V_{LBref} \\ V_{Lcref} \end{bmatrix} \quad (1)$$

Thus, reference load voltages (V∗La,V∗Lb,V∗Lc)and voltages at the PCCVsare additionally changed over to the pivoting reference outline. At that point, the DVR voltages are acquired in the turning reference outline as

$$V_{Dd} = V_{Sd} - V_{Ld} \quad (2)$$

$$V_{Dq} = V_{Sq} - V_{Lq} \quad (3)$$

The reference DVR voltages are obtained in the rotating reference frame

$$V_{Dd}^{*} = V_{Sd}^{*} - V_{Ld} \quad (4)$$

$$V_{Dq}^{*} = V_{Sq}^{*} - V_{Lq} \quad (5)$$

The error between the reference and actual DVR voltages in the rotating reference frame is regulated using two logic controllers. Reference DVR voltages in the abc frame are obtained from a reverse Park's transformation taking ∗Dd from (4),V∗Dq from (5),V^{*}_{D0} as zero as

$$\begin{bmatrix} V_{dvra}^{*} \\ V_{dvrb}^{*} \\ V_{dvrc}^{*} \end{bmatrix} = \begin{bmatrix} \cos\theta & \sin\theta & 1 \\ \cos\left(\theta - \frac{2\pi}{3}\right) & \sin\left(\theta - \frac{2\pi}{3}\right) & 1 \\ \cos\left(\theta + \frac{2\pi}{3}\right) & \sin\left(\theta - \frac{2\pi}{3}\right) & 1 \end{bmatrix} \begin{bmatrix} V_{Dq}^{*} \\ V_{Dd}^{*} \\ V_{D0}^{*} \end{bmatrix}$$

(6)

Reference DVR voltages (v∗dvra,v∗dvrb ,v∗dvrc) and actual DVR voltages(vdvra,vdvrb,vdvrc) are used in a are used in a pulse width modulated (PWM) controller to generate gating pulses to a VSC of the DVR.

Voltages at the PCC vS are converted to the rotating reference frame using abc−dqo conversion using Park's transformation. The harmonics and the oscillatory components of the voltage are eliminated using low pass filters (LPFs). The components of voltages in the d- and q-axes are

$$V_d = V_{ddc} + V_{dac} \quad (7)$$

$$V_q = V_{qdc} + V_{qac} \quad (8)$$

The remunerating methodology for pay of voltage quality issues considers that the heap terminal voltage ought to be of appraised size and undistorted. With a specific end goal to keep up the dc transport voltage of the self-upheld capacitor, a Fuzzy controller is utilized at the dc transport voltage of the DVR And the yield is considered as a voltage Vcap for meeting its misfortunes

$$V_{cap(n)} = V_{cap(n-1)} + K_{p1}\big(V_{de(n)} - V_{de(n-1)} + K_{i1}V_{de(n)}\big) \quad (9)$$

Where vde(n) =v dc−vdc(n) is the error between the reference v∗dc and sensed dc voltages vdc at then the sampling instant.The referenced-axis load voltage is therefore expressed as follows:

$$V_d^* =_{ddc} - V_{cap} \quad (10)$$

The amplitude of load terminal voltage VL is controlled to its reference voltage V ∗ L using another logic controller. The output of the controller is considered as the reactive component of voltage vqr for voltage regulation of the load terminal voltage. The amplitude of load voltage VL at the PCC is calculated from the ac voltages (VLa,VLb,VLc) as

$$V_L = (2/3)^{1/2}(V_{La}^2 + V_{Lb}^2 + V_{Lc}^2)^{\frac{1}{2}} \quad (11)$$

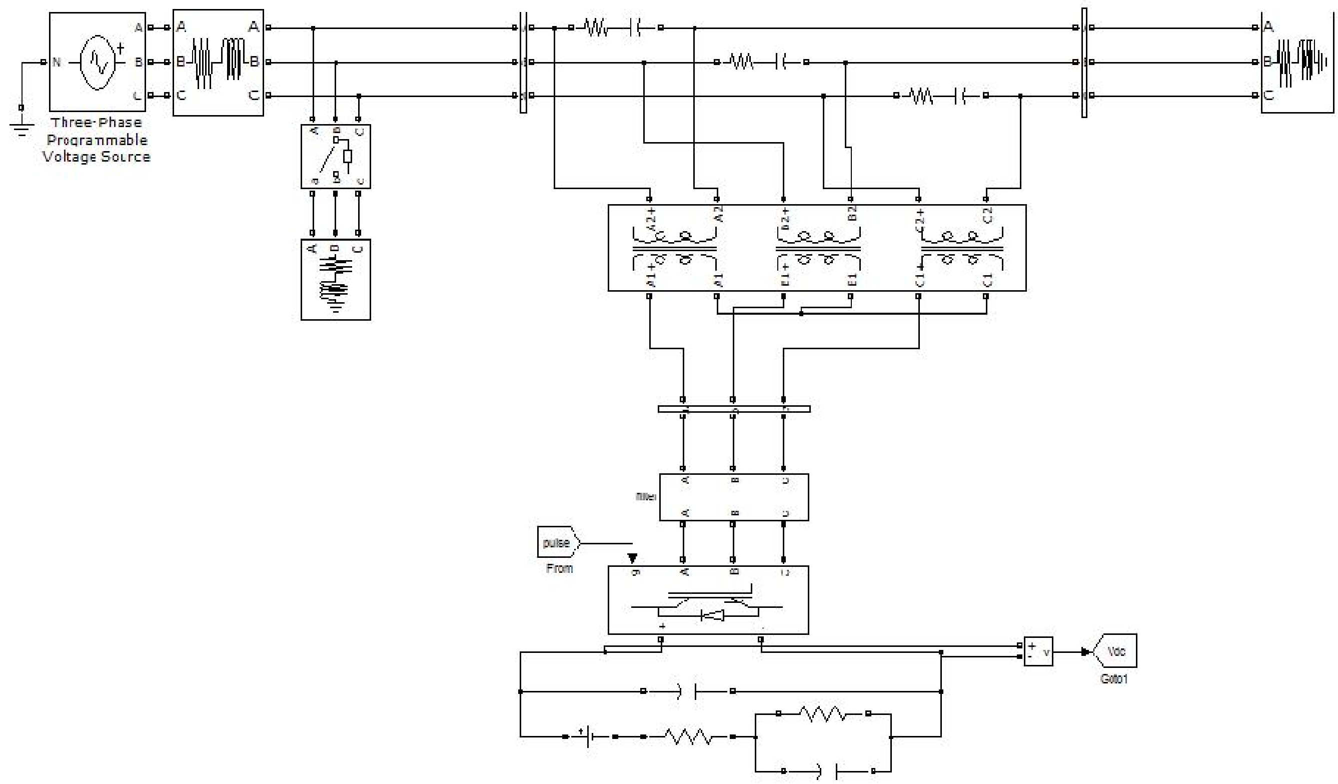
Where vte(n) =V ∗ L−VL(n) denotes the error between the reference V∗L and actual VL(n) load terminal voltage amplitudes at then the sampling instant. The reference load quadrature axis voltage is expressed as follows:

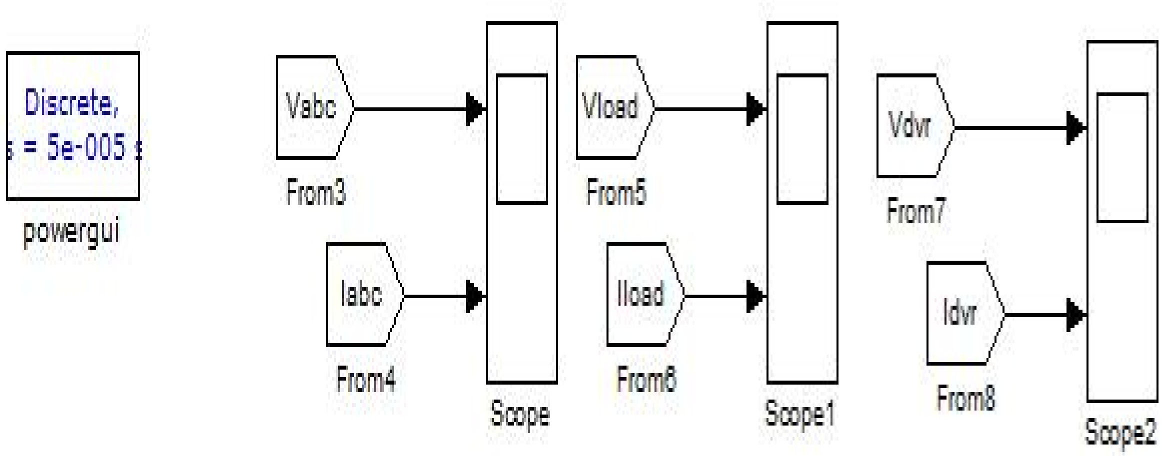
$$V_q^* = V_{qdc} + V_{qr} \quad (12)$$

Reference load voltages (v ∗ La ,v ∗Lb ,v ∗Lc) in the abc frame are obtained from a reverse Park's transformation as in (7). The error between sensed load voltages (VLa,VLb,VLc)and reference load voltages is used over a controller to generate gating pulse to the VSC of the DVR.

IV. MODELING AND SIMULATION

The DVR-connected system consisting of a three-phase supply, three-phase critical loads, and the series injection transformers shown in Fig. 2 is modeled in MATLAB/Simulink environment along with a simpower system toolbox and is shown in Fig.4


Three-Phase
Programmable
Voltage Source
pulse
From
Vdc
Goto1


Discrete,
s = 5e-005 s
powergui
Vabc
From3
Iabc
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Scope
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Iload
From6
Scope1
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From7
Idvr
From8
Scope2

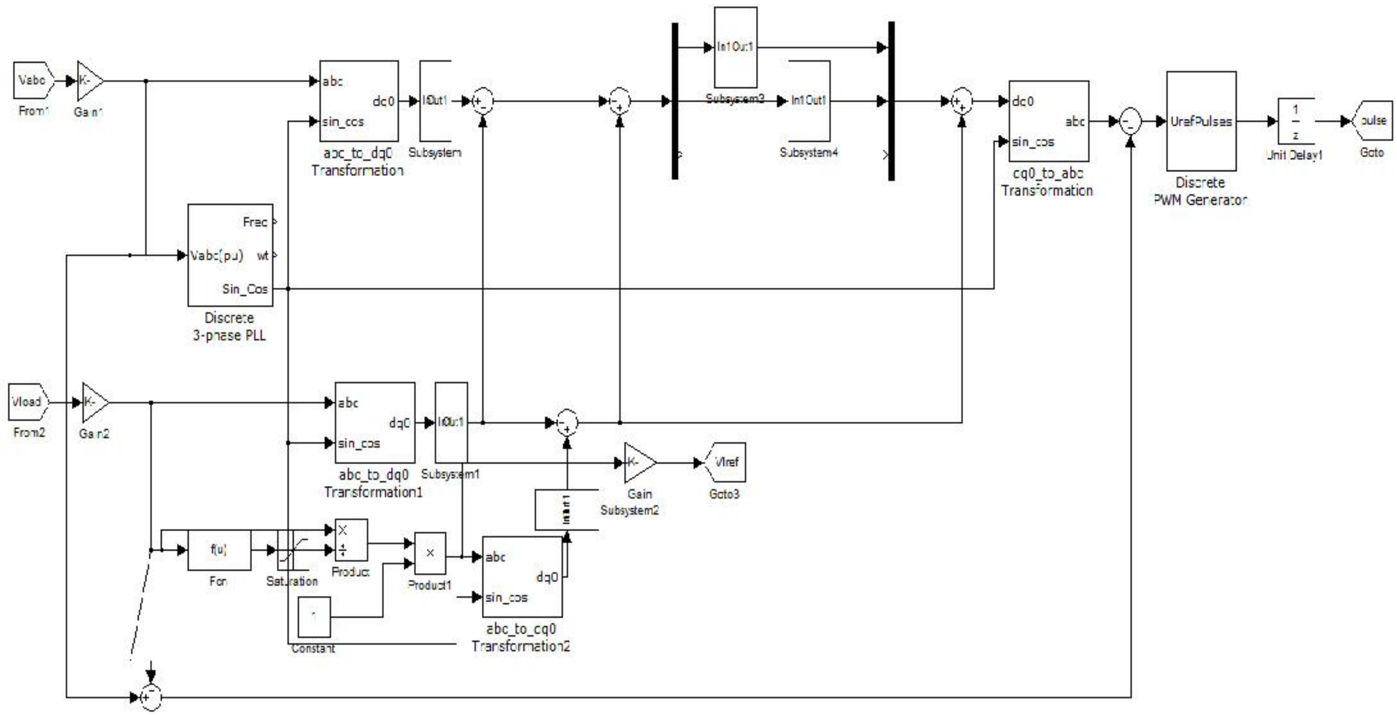

Fig.4Matlab based model of the BEES- supported DVR connected system.

IV MODELING AND SIMULATION RESULTS::

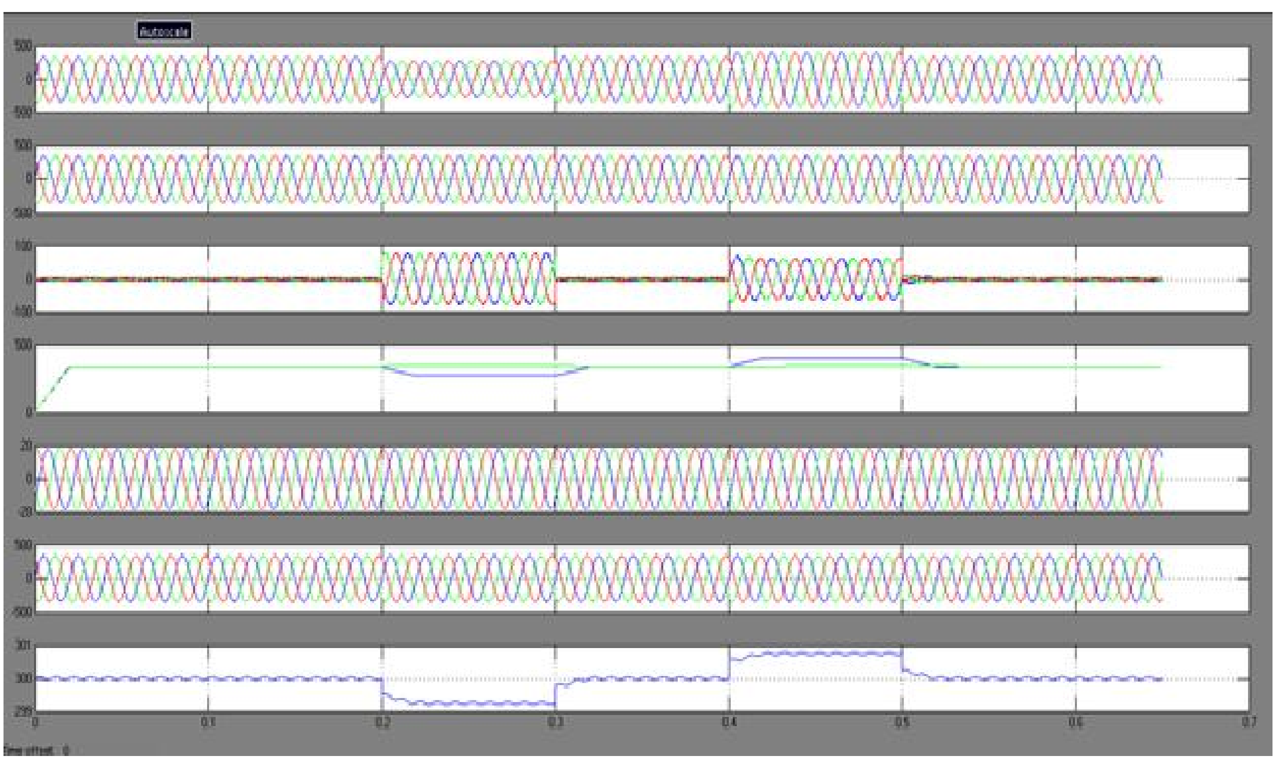

Fig5. Dynamic performance of DVR with in phase injection during voltage sag and swell applied to critical load.

V PERFORMANCE OF DVR

The execution of the DVR is exhibited for various supply voltage unsettling influences, for example, voltage hang and swell. Fig.4 demonstrates the transient execution of the framework under voltage list and voltage swell conditions. At 0.2 s, a droop in supply voltage is made for five cycles, and at 0.3 s, a swell in the supply voltages is made for five cycles. It is watched that the heap voltage is directed to steady plentifulness under both droop and swell conditions. PCC voltages Versus, load voltages VL, DVR voltages VC, sufficiency of burden voltage VL and PCC voltage Versus, source streams Is, reference load voltages VL ref, and dc transport voltage Vdc are additionally delineated in Fig3. The heap voltage is kept up sinusoidal by infusing appropriate pay voltage by the DVR. The total harmonic distortions(THDs) of the voltage at the PCC, supply current and burden voltage are appeared in Figs. 6-7, separately.

It is watched that the heap voltage THD is lessened to a level of 0.51% from the sourcevoltage of 6.41%. The sizes of the voltage infused by the DVR for alleviating the same sorts of hang in the supply with various edges of infusion are watched. . The infusion of voltage in quadrature with the line current.

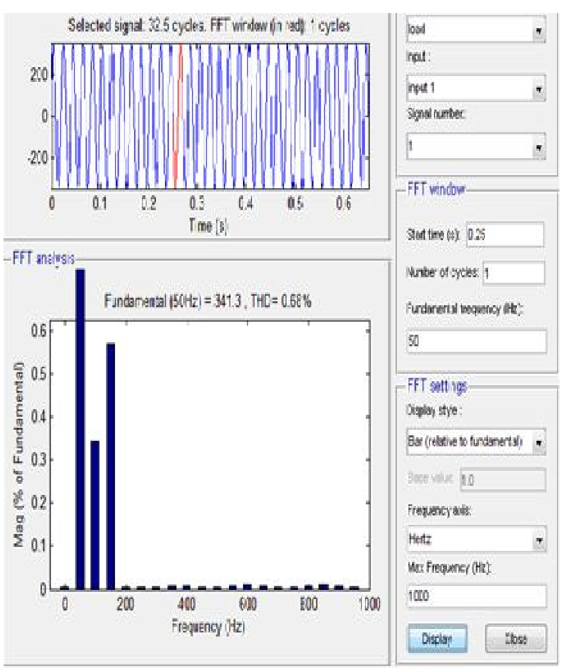

Fig.6. Load voltage and harmonic spectrum during Disturbance

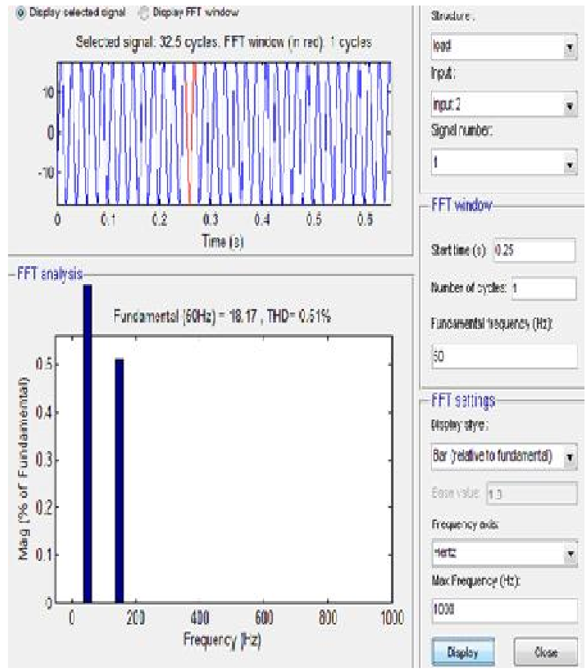

Fig.7. Load current and harmonic spectrum during the disturbance.

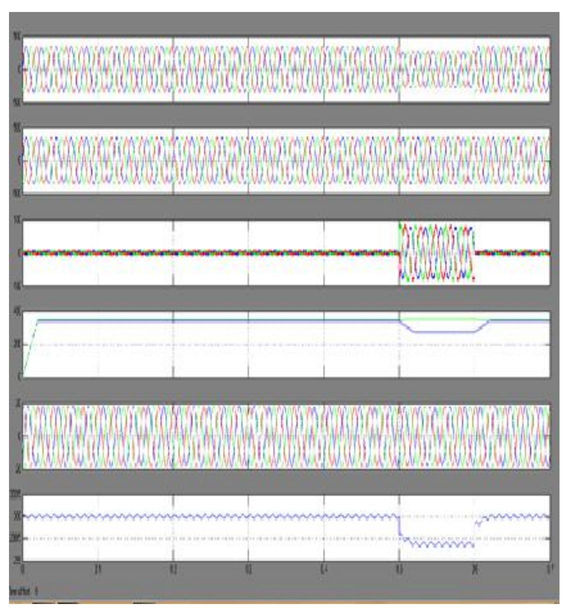

Fig.8.Dynamic performance of the capacitor–supported DVR During a Voltage Sag.

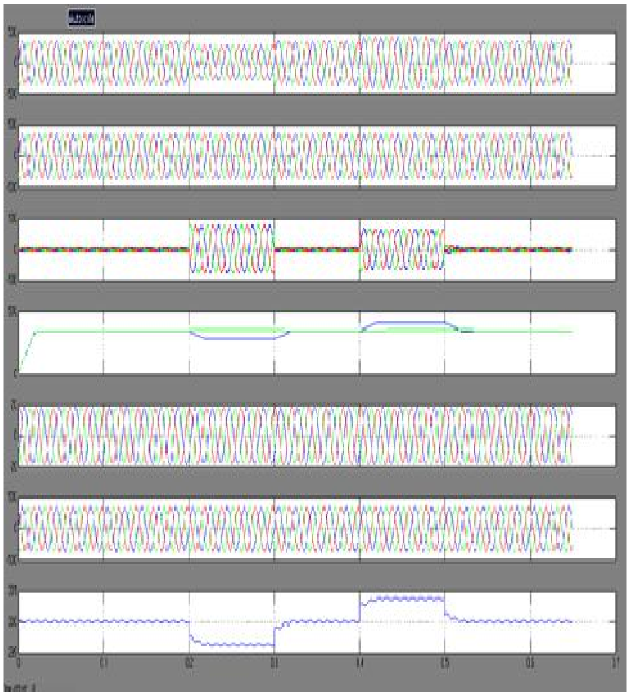

Fig.9.Dynamic performance of the capacitor – supported DVR During a Voltage Swell.

VI CONCLUSION

This paper shows the operation of a DVR has been shown with another control method utilizing different voltage infusion plans. An examination of the execution of the DVR with various plans has been performed with a diminished rating VSC, including a capacitor-upheld DVR. The reference load voltage has been evaluated utilizing the technique for unit vectors, and the control of DVR has been accomplished, which minimizes the blunder of voltage infusion. The SRF hypothesis has been utilized for assessing the reference DVR voltages. It is inferred that the voltage infusion in-stage with the PCC voltage results in least appraising of DVR yet at the expense of a vitality source at its dc transport.

APPENDEX

AC line voltage: 415 V, 50 Hz
Line impedance: Ls=3.0mH,Rs=0.01 Ω
Linear loads: 10-kVA 0.80-pf lag
Ripple filter: Cf =10μF,Rf =4.8Ω
DVR with BESS
DC voltage of DVR: 300 V
AC inductor: 2.0 mH
PWM switching frequency: 10 kHz
DVR with dc bus capacitor supported
DC voltage of DVR: 300 V
AC inductor: 2.0 mH
DC bus voltage PI controller: Kp1=0.5, Ki1=0.35
PWM switching frequency: 10 kHz
Series transformer: three-phase transformer of rating 10 kVA, 200 V/300 V.

REFERENCES

[1] M. H. J. Bollen, *Understanding Power Quality Problems—Voltage Sagsand Interruptions*. New York, NY, USA: IEEE Press, 2000.
[2] A. Ghosh and G. Ledwich, *Power Quality Enhancement Using Custom Power Devices*. London, U.K.: Kluwer, 2002.
[3] M. H. J. Bollen and I. Gu, *Signal Processing of Power Quality Disturbances*. Hoboken, NJ, USA: Wiley-IEEE Press, 2006.
[4] R. C. Dugan, M. F. McGranaghan, and H. W. Beaty, *Electric Power Systems Quality*, 2nd ed. New York, NY, USA: McGraw-Hill, 2006.
[5] A. Moreno-Munoz, *Power Quality: Mitigation Technologies in a Distributed Environment*. London, U.K.: Springer-Verlag, 2007.
[6] K. R. Padiyar, *FACTS Controllers in Transmission and Distribution*. New Delhi, India: New Age Int., 2007.
[7] *IEEE Recommended Practices and Recommendations for Harmonics Control in Electric Power Systems*, IEEE Std. 519, 1992.
[8] V. B. Bhavraju and P. N. Enjeti, “An active line conditioner to balance voltages in a three phase system,” *IEEE Trans. Ind. Appl.*, vol. 32, no. 2,pp. 287–292, Mar./Apr. 1996.
[9] S. Middlekauff and E. Collins, “System and customer impact,” *IEEE*

Trans. Power Del., vol. 13, no. 1, pp. 278–282, Jan. 1998.
[10] M. Vilathgamuwa, R. Perera, S. Choi, and K. Tseng, “Control of energy optimized dynamic voltage restorer,” in *Proc. IEEE IECON*, 1999, vol. 2,pp. 873–878.
[11] J. G. Nielsen, F. Blaabjerg, and N.Mohan, “Control strategies for dynamic voltage restorer compensating voltage sags with phase jump,” in *Proc.IEEE APEC*, 2001, vol. 2, pp. 1267–1273.
[12] A. Ghosh and G. Ledwich, “Compensation of distribution system voltage using DVR,” *IEEE Trans. Power Del.*, vol. 17, no. 4, pp. 1030–1036,Oct. 2002.
[13] A. Ghosh and A. Joshi, “A new algorithm for the generation of reference voltages of a DVR using the method of instantaneous symmetrical components,” *IEEE Power Eng. Rev.*, vol. 22, no. 1, pp. 63–65,Jan. 2002.
[14] I.-Y. Chung, D.-J.Won, S.-Y.Park, S.-I.Moon and J.-K. Park, “The DC link energy control method in dynamic voltage restorer system,” *Int. J. Elect. Power Energy Syst.*, vol. 25, no. 7, pp. 525–531,Sep. 2003.
[15] E. C. Aeloíza, P. N. Enjeti, L. A. Morán, O. C. Montero-Hernandez, and S. Kim, “Analysis and design of a new voltage sag compensator for critical loads in electrical power distribution systems,” *IEEE Trans. Ind. Appl.*, vol. 39, no. 4, pp. 1143–1150, Jul./Aug. 2003.
[16] J. W. Liu, S. S. Choi, and S. Chen, “Design of step dynamic voltage regulator for power quality enhancement,” *IEEE Trans. Power Del.*, vol. 18,no. 4, pp. 1403–1409, Oct. 2003.