ISSN (Online) : 2454-4159
International Journal of Advanced Research in Science Management and Technology
IJARSMT
Volume 2, Issue 2, February 2016

A Review on "Dynamic Voltage Restorer"

Chetana Patel[1], Prabodh khamparia [2]

PG Student, Dept. Of Electrical Engg., SSSUTMS, Sehore, M.P., India[1]

Assistant Professor, Dept. Of Electrical Engg., SSSUTMS, Sehore, M.P, India[2]

ABSTRACT— the dynamic voltage restorer (DVR) is usually a custom power device supposed to correct the voltage sag by injecting voltage as very well power in to ones system. your mitigation capability of these devices is actually mainly influence with the maximum load; power factor and maximum voltage dip to help always be compensated. Voltage Dips at a feeder is actually the ticks task pertaining to DVR system operation and appropriate essential voltage sag compensation. the actual paper is intended for you to assimilate The type of DC energy storage depends from voltage dip. This really is viewable inside a good practical manner for DVR power circuit. .

KEYWORDS- DC Energy Storage, Dynamic Voltage Restorer, Power Quality, Voltage Sag.

I. INTRODUCTION

One of any biggest queries within electricity industry at this point is power quality Disorders to help sensitive loads. Presently, the majority of power quality Disorders are usually due to help additional fault conditions. these kinds of Circumstances cause voltage sag [1]. Voltage sag could cause ones apparatus tripping, shutdown commercial, domestic ALONG WITH industrial equipment, AS WELL AS miss technique connected with drive system. Dynamic voltage restorer (DVR) can supply the cost effective method to mitigate voltage sag through establishing the suitable voltage quality level, essential via the customer [2, 3]. It is recently being taken Equally the active solution for voltage sag mitigation. The easy structure of your DVR will be viewable in Fig.1. The idea is divided straight into six to eight categories: (i) Energy Storage Unit: This is responsible intended for energy storage inside DC form. Flywheels, batteries, superconducting magnetic energy storage (SMES) and super capacitors can be utilized Just like energy storage devices. It is offers your current real power Specifications of an system when DVR is actually consumed pertaining to compensation [3]. (ii) Capacitor: DVR offers a large DC capacitor to make sure that stiff DC voltage input to inverter. (iii) Inverter: an Inverter process can be supposed to convert dc storage directly into ac form [4]. Voltage source inverter (VSI) of low voltage AND ALSO high current inside step up injection transformer will be taken with this purpose at the DVR Compensation program [3]. (iv) Passive Filters: Filters are used to help convert the inverted PWM waveform in to a sinusoidal waveform. That is accomplished by eliminating the unwanted harmonic components generated VSI action. Higher orders harmonic components distort ones compensated output voltage [1]. (v) By-Pass Switch: That isused for you to protect your inverter fromhigh currents in the presence connected with faulty conditions. on the event of a good fault as well as the short circuit at downstream, the DVR changes into the bypass condition where your own VSI inverter can be protected against more than current flowing by the power

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semiconductor switches. the rating of your DVR inverters becomes a great limiting factor with regard to normal load current seen in the primary winding AND reflected towards the secondary winding of the sequence insertion transformer. intended for line currents exceeding the rating, a great bypass scheme is actually incorporated to help protect the power electronics equipment [5]. (vi) Voltage Injection Transformers: throughout a three-phase system, either three single-phase transformer devices or perhaps solitary three phase transformer unit can be utilized pertaining to voltage injection purpose. [1].

Basic principal associated with DVR is usually to help transfer the voltage sag compensation code coming from DC side of the inverter to be able to the injected transformer soon after filter. your own compensation capacity of a great Personal DVR depends to the maximum voltage injection capability and the active power The idea can be supplied by your current DVR. Any time DVR's voltage disturbance occurs, active power or maybe energy Just in case become injected coming from DVR to help the distribution process [6]. the DC system, that\'ll be connected to the inverter input, includes an large capacitor for storage energy. The idea provides reactive power to the fill throughout faulty conditions. Whenever ones energy is actually drawn with the energy storage capacitors, the capacitor terminal voltage decrease.

Therefore, there can be a minimum voltage essential below which the inverter of any DVR cannot build the necessitate voltage thus, size AND rating associated with capacitor is usually very keys to press for DVR power circuit [7]. your current DC capacitor program code regarding a good three phase system is usually derived [8]. ones most keys to press advantage of these capacitors is the capability to help provide high current pulses repeatedly for hundreds connected with thousands of cycles. menus of capacitor rating will be discussed towards the basis connected with RMS value associated with a capacitor current, rated voltage of any capacitor AND VA rating of your own capacitor [9].

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II. CONTROL PHILOSOPHY

Voltage sag will be designed with populate terminals from a great three-phase fault As viewable throughout Fig.3. fill up voltage will be sensed AND passed through a great series analyzer. the magnitude is actually compared with reference voltage (Vref). Pulse width modulated (PWM) control program is applied for inverter switching therefore Equally to produce a three phase 50 Hz sinusoidal voltage for the load terminals. Chopping frequency is in the variety of any few KHz.

The IGBT inverter is controlled in PI controller to maintain 1 p.u. voltage for the load terminals i.e. taken as base voltage =1p.u. A proportional-integral (PI) controller (shown within Fig. 2) drives your own plant to become controlled using a weighted amount associated with the error (difference between this sensed output and desired set-point) and the integral associated with The item value. a advantage of a good proportional plus integral controller is usually The idea it\'s integral term causes the steady-state error in order to be zero regarding a good step input.

PI controller input is actually an actuating rule that'll be the difference between ones Vref AS WELL AS Vin. Output of any controller block will be of an application form of an angle δ, that will introduces additional phase-lag/lead at the three-phase voltages. The output of error detector is

Vref - Vin. **(1)**

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Vref equal to 1 p.u. voltage

Vin voltage in p.u. at the load terminals

The controller output when compared at PWM signal generator results in the desired firing sequence.

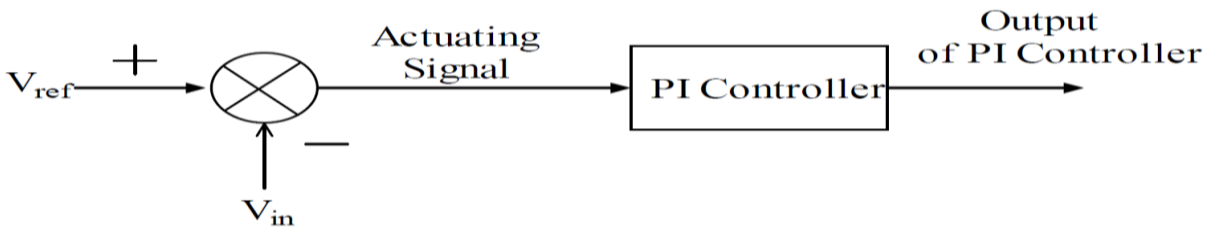

Fig.1. Schematic of a typical PI Controller

The modulated angle is applied to the PWM generators in phase a good Just like available within (2). The angles pertaining to phases B AND C are shifted by 120o AND ALSO 240o, respectively In the same way exhibited with (3) ALONG WITH (4). In the actual PI controller singular voltage magnitude is actually recognized In the same way a feedback parameter on the control scheme [4]. The sinusoidal rule V control is phase-modulated through means of your angle 6 plus the modulated three-phase voltages are given by

$V_a = sin(\omega t + \delta)$ (2)
$V_b = sin(\omega t + \delta + 2\pi/3)$ (3)
$V_c = sin(\omega t + \delta + 4\pi/3)$ (4)

III. PARAMETERS OF DVR TEST SYSTEM

Electrical circuit model associated with DVR test method is usually shown in Fig.3. method parameters are usually listed within Table 1. Voltage sag is created on load terminals via a three-phase fault Just as shown in Fig.3. load voltage is sensed AS WELL AS passed while in a sequence analyzer. the magnitude is actually compared with reference voltage (Vref).

TABLE 1: SYSTEM PARAMETERS

S.No.	System Quantities	Standards
1	Inverter Specifications	IGBT based,3 arms , 6 Pulse, Carrier Frequency =1080 Hz, Sample Time= 5 μs
2	Transmission Line Parameter	R=0.001 ohms ,L=0.005 H
3	PI Controller	K_P=0.5 K_i=50 Sample time=50 μs

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4	Load-1	Active power = 1 Kw Inductive Reactive Power =400 Var
5	Load-2	Active power = 1 Kw Inductive Reactive Power =400 Var

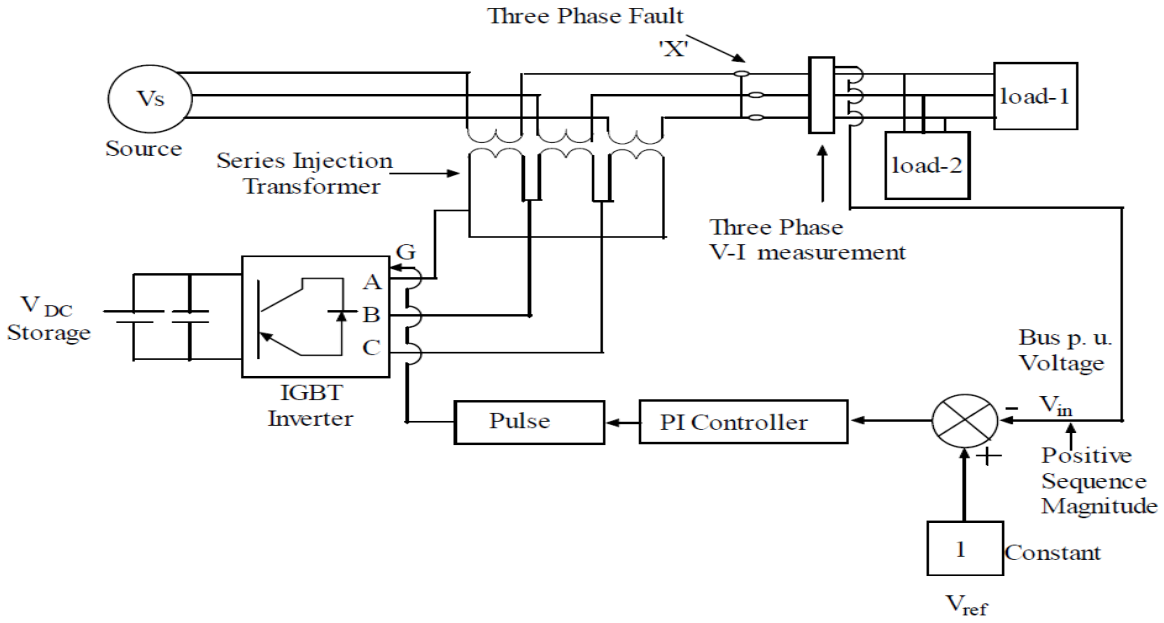

Fig.2. Circuit Model of DVR Test System

MATLAB Simulation diagram of the test system is shown in Fig.4. System comprises of 13 kV, 50 Hz generator, feeding transmission lines through a 3-winding transformer connected in Y/Δ/Δ, 13/115/ 11 kV.

IV. SIMULATION RESULTS

Detailed simulations are generally performed towards the DVR test system applying MATLAB SIMULINK. method performance is analyzed pertaining to compensating voltage sag inside other DC storage capacity thus Just as in order to achieve rated voltage on a given load. Various cases of some other fill condition are generally obtained to study your current impact DC storage with sag compensation. These various cases are usually discussed below: Case I: a good three-phase fault is actually developed on point X from a resistance regarding 0.66 Ω of which results in an voltage sag connected with 17.02 %. Transition night out due to the fault will be taken via 0.4 sec to 0.6 sec As exhibited within Fig. 5. The simulation results without DVR compensation technique are generally viewable with Fig. six to eight at p.u basis. Fig. 7 shows the DVR performance with presence regarding capacitor rating of 750×10-6 F inside energy storage devices viz. 3.1kv. .

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International Journal of Advanced Research in Science Management and Technology
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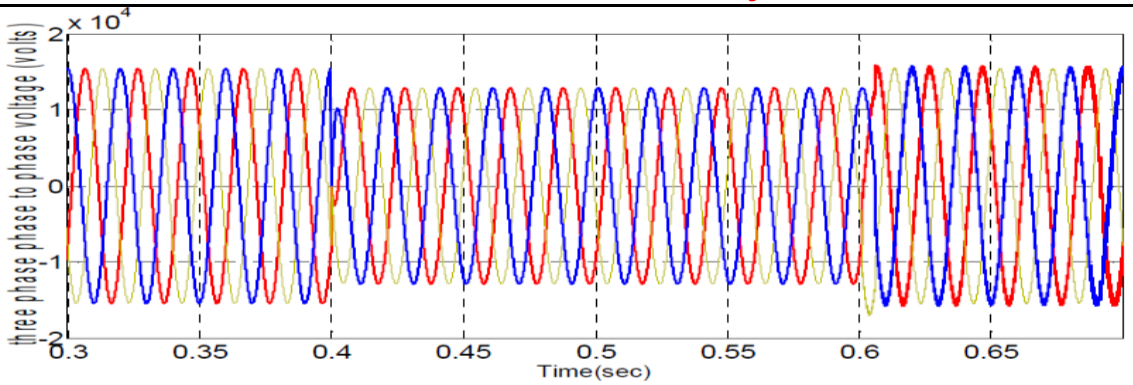

Fig.4. Three Phase, Phase to Phase Voltage with Out DVR Energy Storage

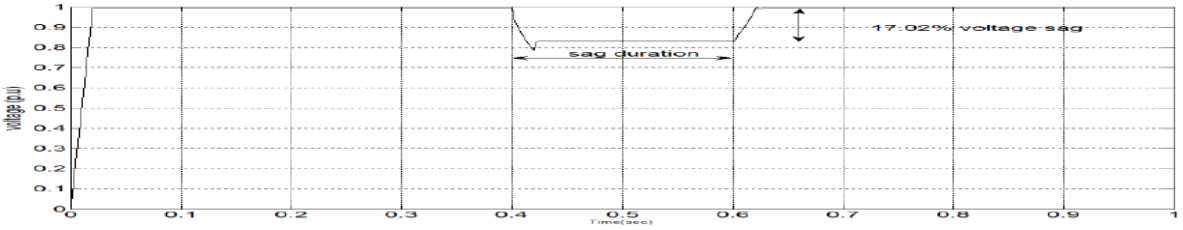

Fig.5. Voltage p.u. at the Load Point without DVR System

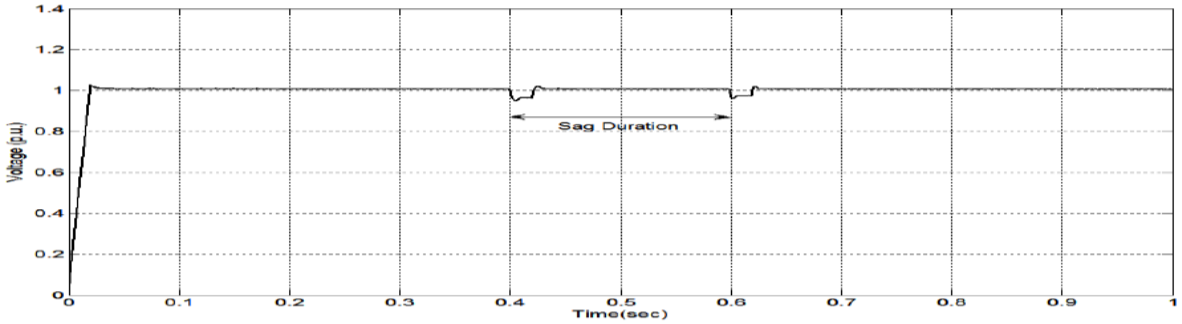

Fig.6. Voltage p.u. at the Load Point with DC storage of 3.1 kV

Case II: a three-phase fault is usually produced on point X through a resistance of 0.60 Ω of which results inside a great voltage sag associated with 19 %. Transition time because of its fault is usually obtained from 0.4 sec to be able to 0.6 sec As available throughout Fig. 8. The simulation results without DVR compensation technique usually are available with Fig. 9 at p.u basis. Fig. 10 shows the DVR performance with presence regarding capacitor rating of 750×10-6 F with energy storage devices viz. 3.3 kV.

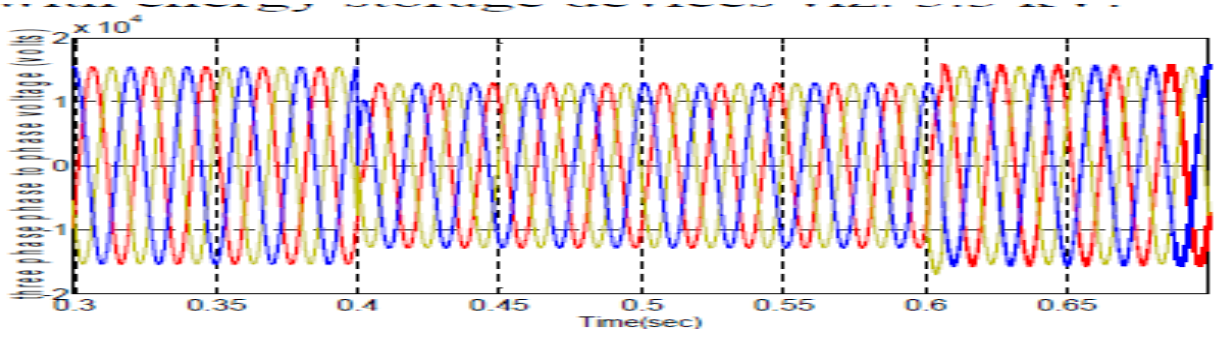

Fig.7. Three Phase, Phase to Phase Voltage with Out DVR Energy Storage

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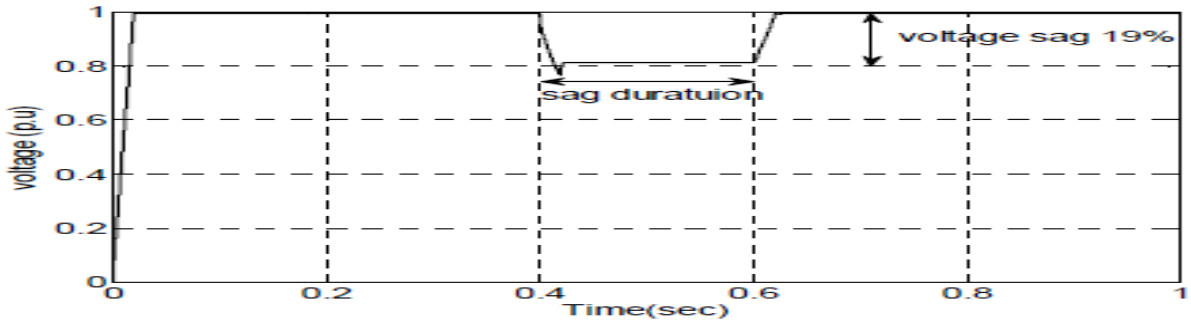

Fig.8. Voltage p.u.at the Load Point without DVR System

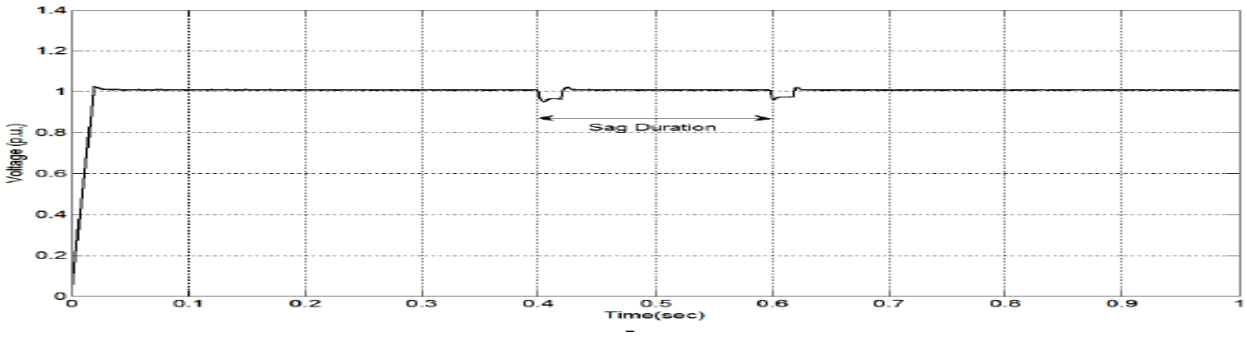

Fig.9. Voltage p.u. at the Load Point with DC storage of 3.3 kV

Case III: an three-phase fault can be created in point X coming from a resistance regarding 0.50 Ω that results throughout a voltage sag regarding 23 %. Transition time frame for the fault will be obtained from 0.4 sec to be able to 0.6 sec As displayed with Fig. 11.The simulation results without having DVR compensation technique are generally shown throughout Fig. 12 with p.u basis. Fig. 13 shows the DVR performance with presence involving capacitor rating of 750×10-6 F throughout energy storage models viz. 3.5 kV.

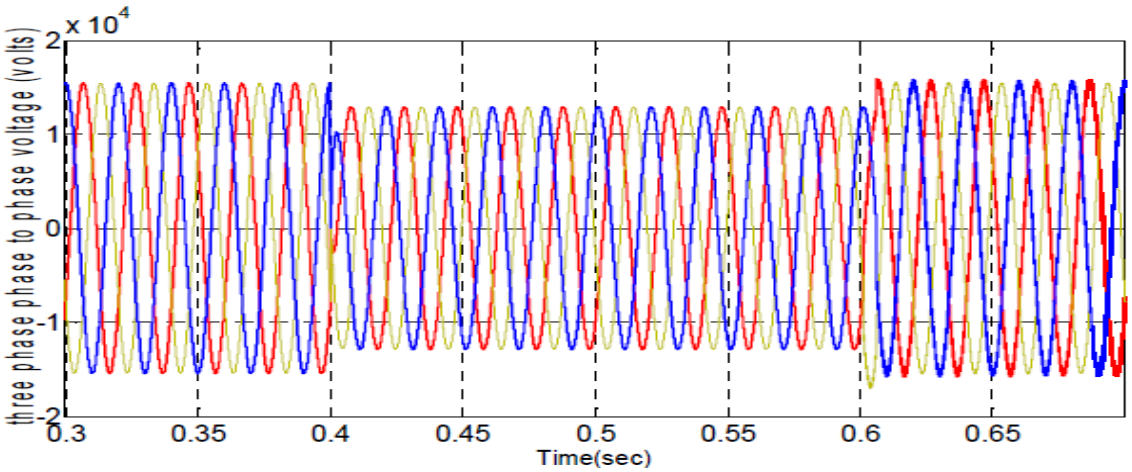

Fig.10. Three Phase, Phase to Phase Voltage with Out DVR Energy Storage

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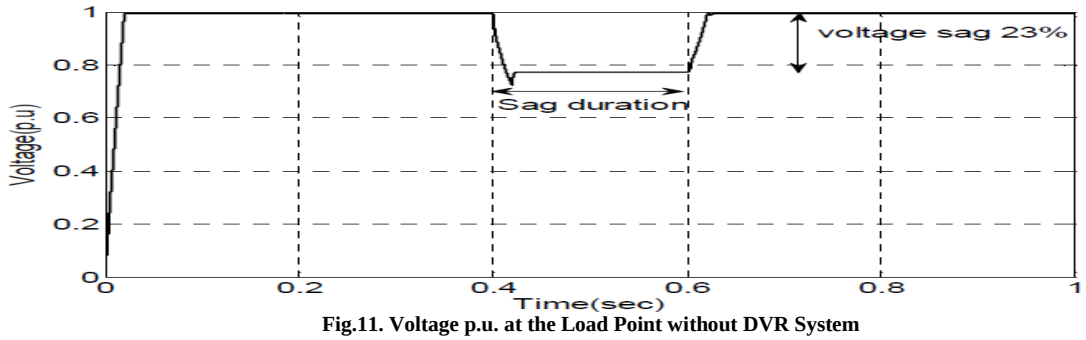

Fig.11. Voltage p.u. at the Load Point without DVR System

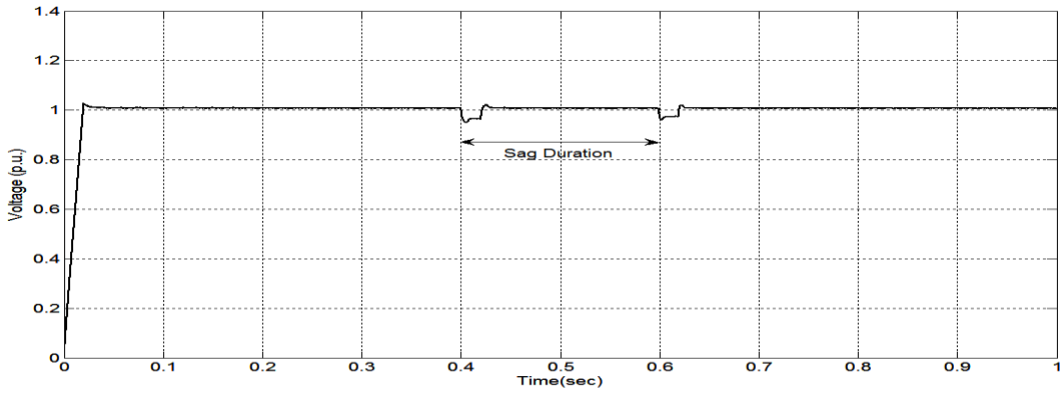

Fig.12. Voltage p.u. at the Load Point with DC storage of 3.5 kV

Case IV: the three-phase fault can be developed from point X from a resistance regarding 0.45 Ω that will results inside a great voltage sag involving 26 %. Transition day because of its fault can be obtained from 0.4 sec to help 0.6 sec In the same way shown within Fig. 14. The simulation results without DVR compensation technique are displayed in Fig. 15 with p.u basis. Fig. 16 shows the DVR performance inside presence regarding capacitor rating of 750×10-6 F throughout other energy storage devices viz. 3.7kV.

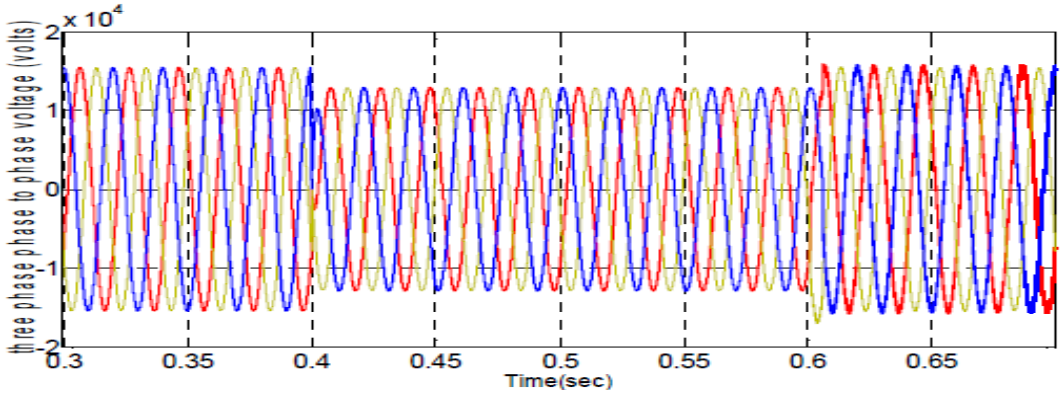

Fig.13. Three Phase, Phase to Phase Voltage with Out DVR Energy Storage

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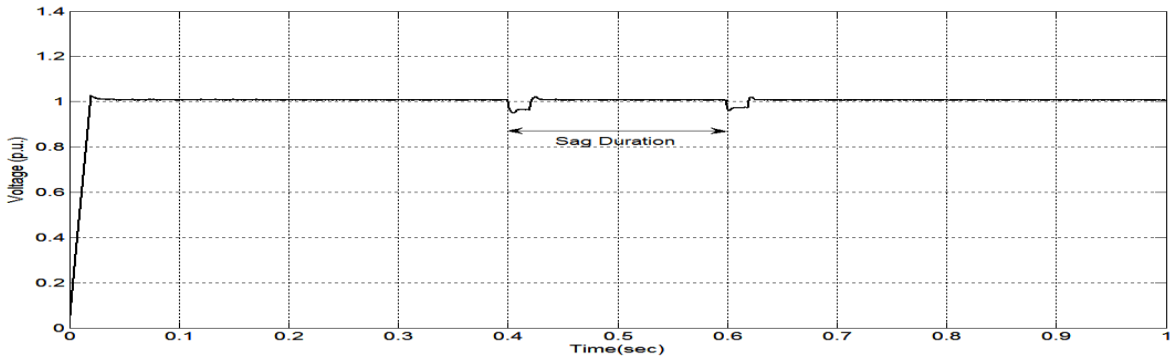

Fig.14. Voltage p.u.at the Load Point with DC storage of 8.5 kV

V. OVERALL DC STORAGE RATING PERFORMANCE WITH VOLTAGE DIP

Voltage sag is often due to the particular faults. It could be arise within method because of unbalance voltage in addition to present, within more than voltage, change regarding energy, below rate of recurrence, temperatures rise, energy move in addition to instability.In your above table This really is shown It needed DC storage values tend to be not same regarding some other voltage sag conditions, when The strain is fixed at 11 kV feeders. The kind of DC energy storage is usually increased within increase with the percentage voltage sag Just like available above via case i for you to IV. Could V, The idea is observed that whenever percentage voltage sag can be increased above 28% (approximate). You're per unit voltage fall below 1 per unit value AS WELL AS This really is continuously decreases in increase in percentage voltage sag regarding 11 kV feeder.

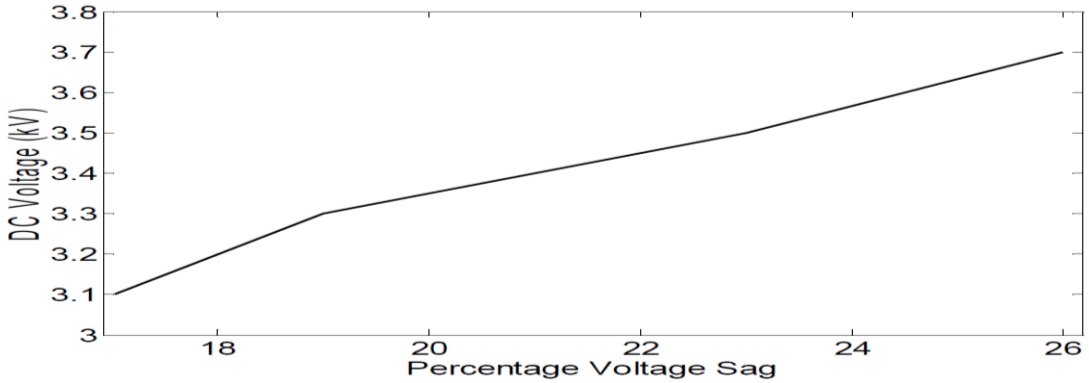

Fig.15. Percentage Voltage Sag Verses DC Storage (kV)

VI. CONCLUSION

Based towards the analysis associated with test system, It is mentioned that voltage sag values are largest details within estimating your own DC storage value. Investigations were performed pertaining to various cases of complete at 11kv feeder. your effectiveness of the DVR system mainly depends on your current rating regarding DC storage rating and the percentage voltage sag. on the test program This is observed This after the Particular amount regarding voltage sag, the voltage level with the populate terminal decreases.

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