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Mitigation of Voltage Sags/Swells Using Z-Source Inverter with Discrete Pi Controller Based on Dynamic Voltage Restorer (DVR)

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Abstract: This project provides voltage sag/swell minimization program in power distribution systems. Voltage sag/swell is one of the most important power quality problems complexes the application market. Voltage sag/swell can be paid for v as well as hypodermic injection into distribution program. The DVR is the excellent program for highly effective responses. A new topology focused on Z-source inverter emerged so they can boost the voltage restoration property of DVR. The created controllers are focused on the right support damping hypodermic injection plan. The acting of Z- source based DVR is performed factor sensible and their actions are analyzed using MATLAB software. The simulation reveals that the control method very effective and results in excellent agreement for voltage sag/swell minimization.

Keywords: Dynamic Voltage Restorer (DVR), Z-Source Inverter, PI Controller, Matlab, Simulink.

I. INTRODUCTION

Modern power techniques are complex techniques, where hundreds of generating stations and thousand of complete features are connected through long power transferring and distribution techniques.

The main priority of customer is the common and stability power resource at various complete features. Even though power generation in most well-developed countries is fairly reliable, the common of offer is not.

Power distribution system should preferably offer their customers an continuous flow of power with sleek sinusoidal v at the reduced scale and regularity[1]. However, in practice power system especially the distribution system, have numerous non straight line loads, which are significantly affect the common of power resource. As a result, the hygiene of waveform of offer lost. This ends up producing many power top quality problems.

To make up the sag/swell in a process, appropriate devices need to be set up at appropriate locations have lately been recommended as an alternative energy modification concept as they have both voltage buck and improve capabilities. The Z source ripper uses a unique X-shaped impedance program on its dc part for achieving both v money and improve capabilities this developments that cannot be obtained in the regular voltage-source and current-source converters.

In this paper the acting and control of v sag/swell agreement using Z-Source inverter centred highly effective v restorer are simulated using MATLAB application. The simulation solutions are offered to show the strength of the recommended control technique[4].

II. DYNAMIC VOLTAGE RESTORER (DVR)

The DVR uses IGBT solid-state power-electronic modifying devices in a pulse-width modulated (PWM) inverter framework and is capable of producing or taking in independently controllable real and delicate energy at its ac result international airport terminal. Its dc feedback international airport terminal is connected to an source of your or a energy hard drive of appropriate capacity. The DVR is a solid-state dc to ac modifying energy ripper that places a set of three-phase ac result v in sequence and synchronism with the distribution voltages[8]. The DVR is limited energy to the fill a standard rechargeable energy e connected to the DVR dc international airport terminal. For large modifications (sags) in the voltages are different thereby enabling control of the volts conditions following the sag the energy storage space delicate energy exchange between the DVR and the product is empowered from the ac system by the DVR.

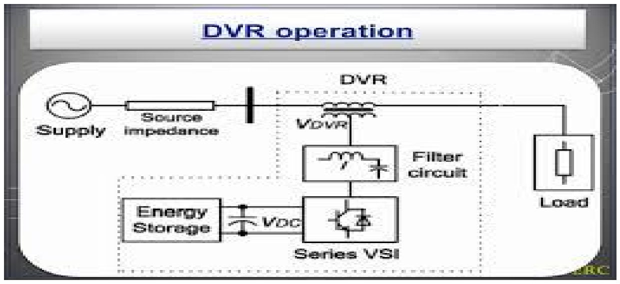

Fig 1. Block diagram of DVR

DVR is linked in sequence between the source volts or lines and delicate plenty through injection transformer. There are a variety of storage devices are used in the DVR such as battery power, superconducting coils, and fly wheels [3]. These kinds of storage devices are very essential in order to supply effective and delicate power to DVR. The operator is an integral part of the DVR for changing reasons. The changing ripper is accountable to do transformation process from DC to AC. The inverter helps to ensure that only the swells or sags volts are treated to the hypodermic injection transformer [4].

III. Z-SOURCE INVERTER

Z-source inverter has X-shaped impedance system on its DC side, which relationships the origin and inverter H-bridge.. The impedance system comprises of separated inductors and two capacitors. The supply can be DC v resource or DC existing resource or AC resource. Z-source inverter can be of existing resource type or v resource type. Fig. 2 shows the regular avoid plan of Z-Source inverter.

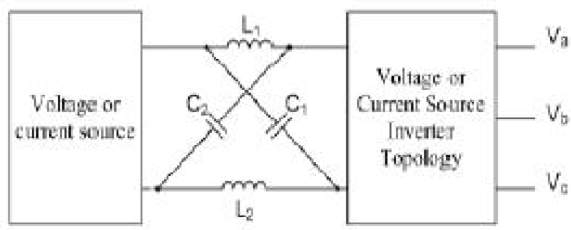

Fig .2 .Block diagram of Z-Source inverter

Z-Source inverter function is managed by several beat size modulation and the production of the Z-Source inverter is managed by using beat size modulation technique, generated by evaluating a pie trend indication with an flexible DC and hence the work pattern of the changing beat could be different to synthesize the required transformation. A flow of overcome size modulation is produced to control the switch as shown in fig.3[7].

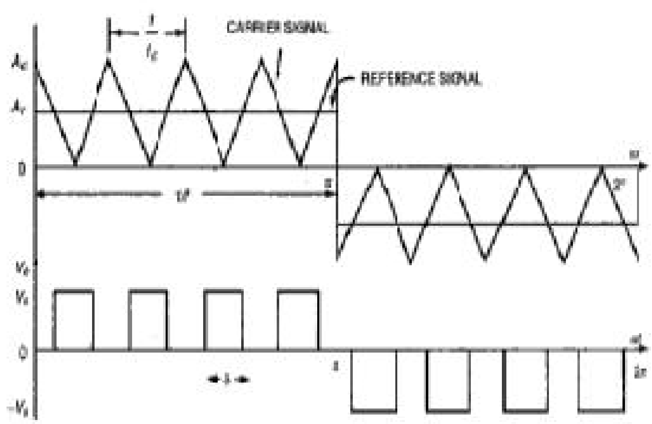

Fig:3 Multiple Pulse Width Modulation

Switching time table for single-phase Z-Source inverter as shown in Table I.

TABLE I. SWITCHING MODES

S_4	S_3	S_2	S_1	Switching mode
1	0	0	1	Active mode
0	1	1	0	
0	1	0	1	Zero mode
1	0	1	0	
0 or 1	0 or 1	1	1	Shoot-through mode

When source voltage is applied to load, two zero modes in which the inverter's output terminals are short circuited by *S1* and *S3* or *S2* and *S4* switches and a shoot-through mode which occurs as two switches on single leg are turned on.Z-Source inverter based on to the two modes of operation.

A. Shoot through mode

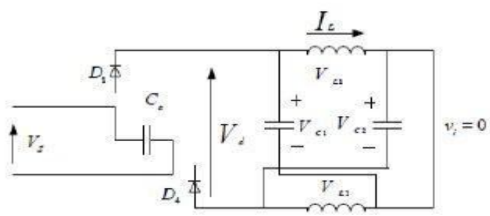

Fig. 4. Shoot through mode

In a symmetrical impedance network, the following equations are valid.

$L1 = L2 = L$ ---------------- (2)

$I_{L1} = I_{L2} = I_L$------------------------ (3)

$V_{C1} = V_{C2} = V_C$----------------------- ((4)

The voltage of capacitors in a symmetric impedance network is as follows:

$V_i = \beta V_{dc}$ -----(5)

$\beta = 1/[1 - 2(T0/T)$ ---------(6)

Where, *T0* and *T* show the shoot-through mode application period and switching period, respectively. Also, the following relation is valid in symmetric impedance networks:

$Vi = 2VC - V dc$------------(7)

voltage. Diodes *D1* and *D4* are turned on if the input voltage of rectifier is positive. Diodes *D3* and *D2* are turned on if the input voltage of rectifier is not positive.

B. Active mode

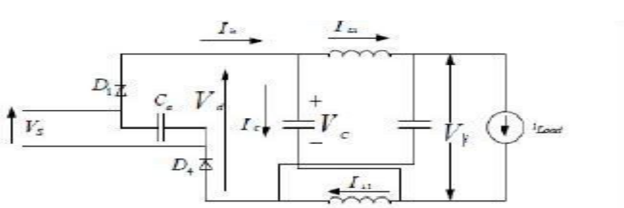

Fig . 5. Active mode

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The equivalent circuits of rectifier fed ZSI in shoot- through and active modes are presented in Figs. 5 and 6 respectively. Fig. 7 shows the equivalent circuit of inverter in shoot-through mode. The following is obtained according to that equivalent circuit:

Vd = VL1 +VC2----------(8)

VL1 =VC1--------------(9)

Where *Vd* is the impedance network input voltage. Considering (4), (8) and (9), the following relation is obtained:

Vd = 2VC--------------(10)

In shoot-through mode operation, the rectifier is not able to inject current and energy to impedance network. Fig. 6 shows the equivalent circuit of ZSI in active mode. Considering Fig. 5, the following relation is obtained,

Vd = Vs (t) - 2Vg------------------ (11)

IV. COMPENSATION METHODS IN DVR

The type of the agreement strategy mainly depends on the reducing factors such as DVR power ratings, various circumstances of complete, voltage sag type. Some plenty are sensitive towards stage angel jump and some are sensitive towards change in scale and others are immune to these. Therefore, the control techniques depend upon the type of complete characteristics; there are three different methods of DVR v hypodermic injection which are: (a) Pre-sag agreement strategy (b) In-phase agreement strategy (c) Volts tolerance strategy with smallest energy hypodermic injection.

A. Pre-Sag/Dip Compensation Method

The pre-sag technique paths the provide volts consistently and if it finds any disruptions in provide volts it will provide the difference volts between the sag or volts at PCC and pre-fault situation, so that the fill volts can be renewed back to the pre-fault situation. Settlement of volts sags in the both stage angle and plenitude. Delicate plenty would be obtained by pre-sag compensation technique as shown in figure 6.

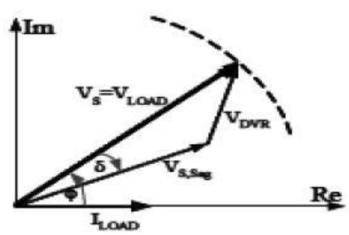

Fig .6. Pre-Sag compensation

In this method the injected active power cannot be controlled and it is determined by external conditions such as the type of faults and load conditions. The voltage of DVR is given below:
VDVR = Vpre fault – Vsag

B. In-Phase Compensation Method

In this method the injected voltage is in phase with the supply side voltage irrespective of the load current and pre- fault voltage as shown in Figure7.

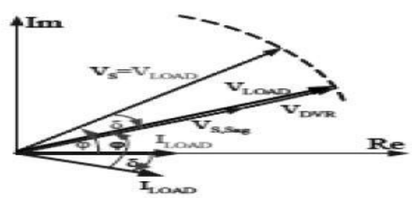

Fig.7. In-phase Compensation (Magnitude compensation only)

The stage perspectives of the pre-sag and fill volts are different but the most important requirements for power quality that is the continuous scale of fill volts are pleased. The burden volts are given below:

$|VL| = |V_{pre\text{-}fault}|$.

One of the advantages of this approach that the plenitude of DVR hypodermic injection volts are minimum for certain voltage sags in comparison with other strategies.

C. Voltage Tolerance Method with Minimum Energy Injection

A little drop in voltage and little jump in level place can be accepted by the complete itself. If the v range can be found between 90%-110% of cost-effective v and level place variations between 5% -10% of cost-effective state that will not affect the operation features of plenty. Both range and level are the control parameter for this procedure which can be obtained by little energy hypodermic injection. In this procedure, the level place and range of set complete voltage within the area of complete voltage tolerance are changed. The small voltage drop and phase angle jump on load can be tolerated by load itself.

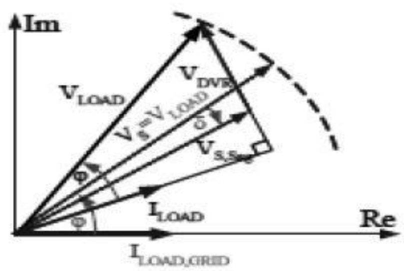

Fig 8.Voltage Tolerance Method

V. VOLTAGE SAG COMPENSATION BY USING Z- SOURCE INVERTER BASED ON DVR SYSTEM

To get to know the need of ongoing voltage control, closed pattern operate is finished for the recommended value of the voltage according to the need. The Simulink type of closed pattern control over v sag agreement in a DVR system is caved the Fig9. Initially the system was encountered with v sag at t=650ms and remains up to t=900ms with the complete voltage sag duration of 350ms, in a run of 1500ms.

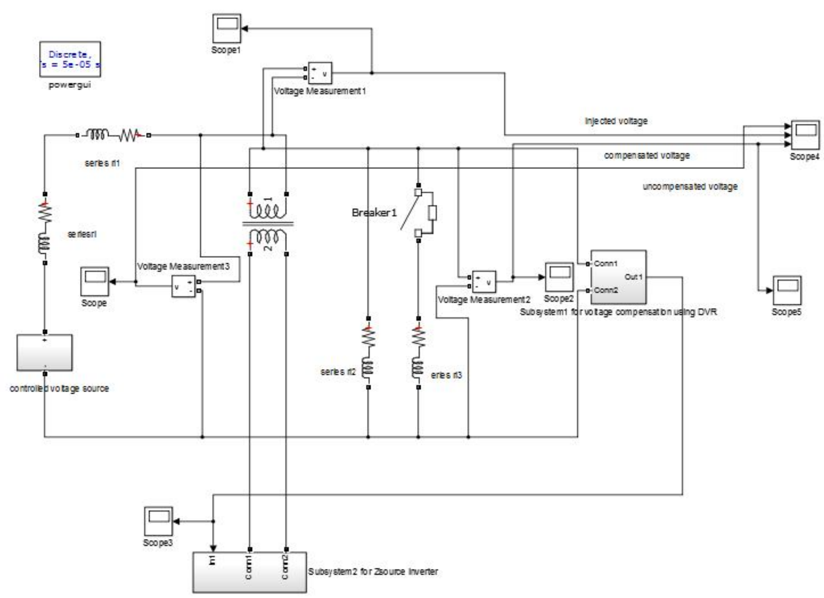

Fig 9.Closed Loop Control of Voltage Sag Compensation in a DVR System

Fig.10 shows the subsystem 1 of the closed pattern DVR system. It contains the PI operator. The AC result voltage is limited to DC offer and then a recommendations voltage is given for the error. This error is sent to the PI operator. The saturator value is given as signals for cash Z- Source inverter.

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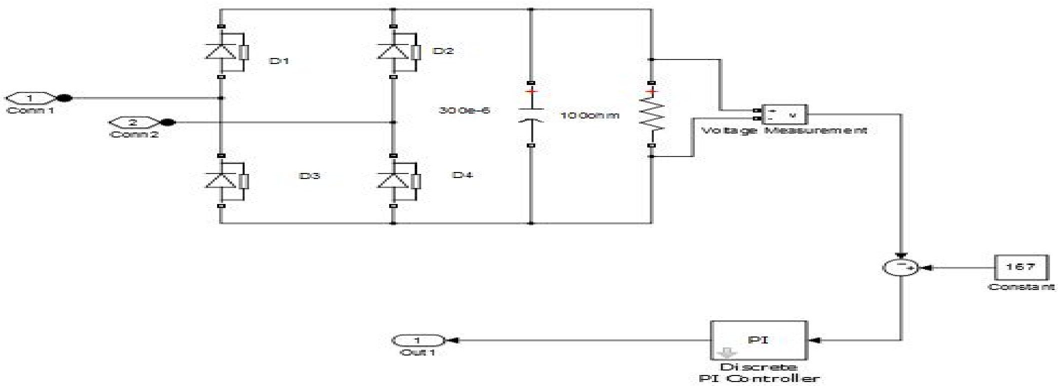

Fig . 10. Subsystem 1 of Closed Loop Control of Voltage Sag Compensation in a DVR System

In the Fig. 11, subsystem 2 contains the Z- Resource inverter which is being handled by the PI operator. The Z-Source starts executing when it gets the defeat from the saturator. Fig.12 shows the result waveform of closed loop control of voltage sag settlement.

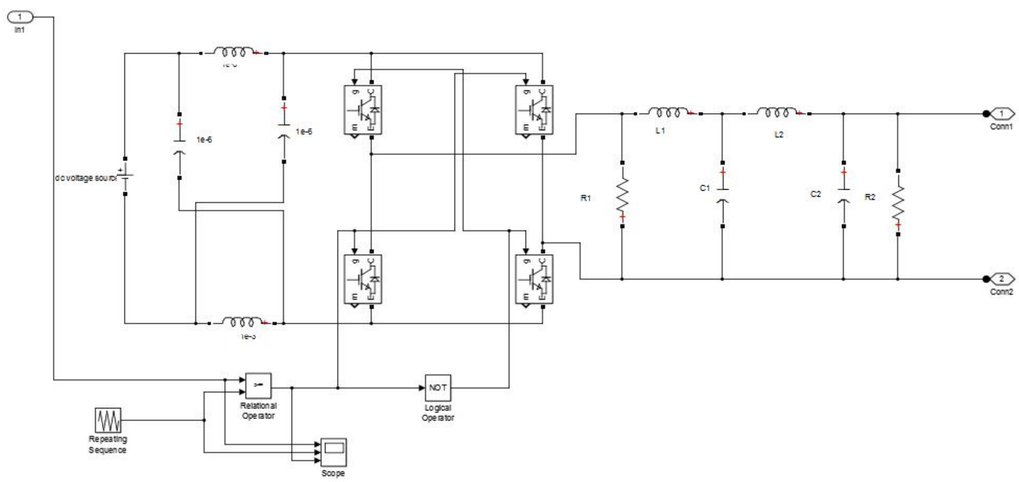

Fig. 11 Subsystem 2 of Closed Loop Control of Voltage Sag Compensation in a DVR System.

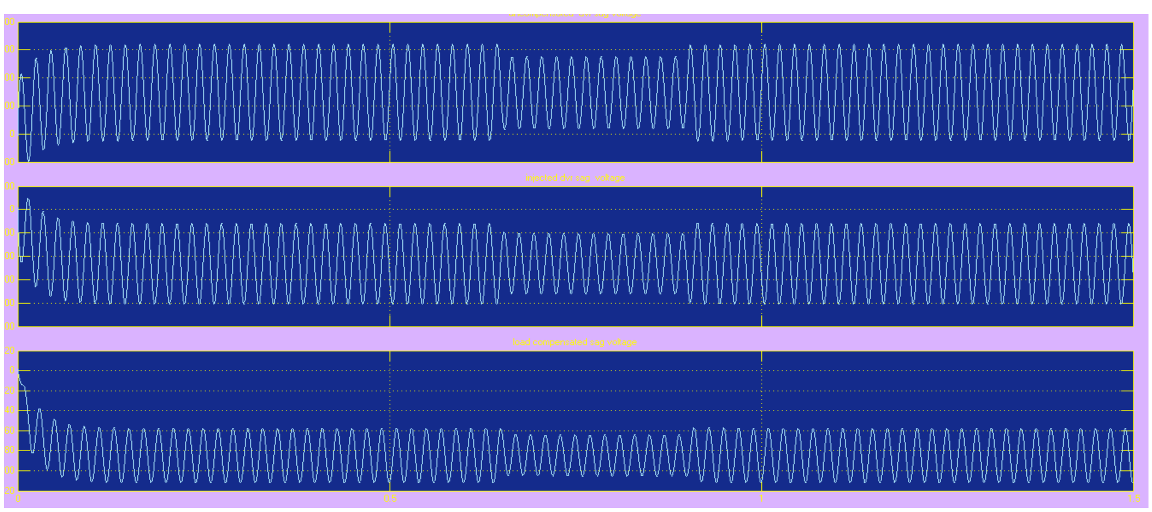

Fig. 12(a). Shows the uncompensated AC voltage with sag. Fig. 12b). Shows the handled DVR voltage. Fig. 12(c). Gives the compensated result voltage

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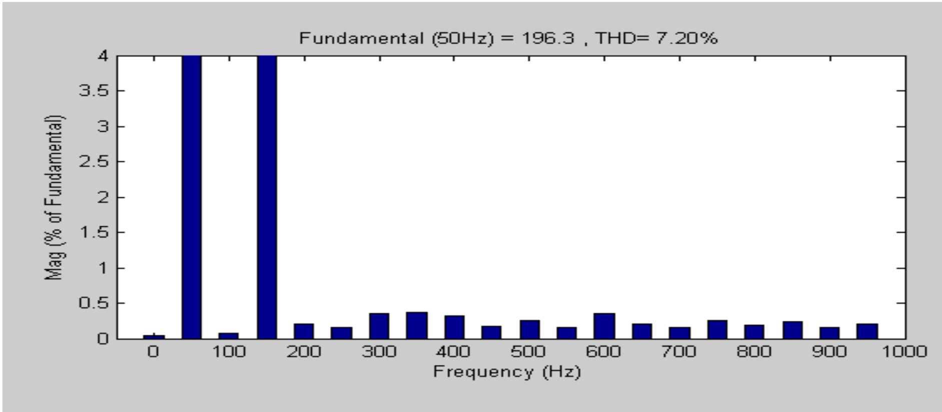


Fig. 13, the Fast Fourier Transform (FFT) analysis is performed for the compensated output voltage.

In Fig. 13, the Fast Fourier Transform (FFT) analysis is performed for the compensated output voltage. Here the Total Harmonic Distortion (THD) value is 7.20%. The simulation was done under transient performance at the sag front and recovery was observed.

VI. VOLTAGE SWELL COMPENSATION BY USING Z SOURCE - INVERTER BASED ON DVR SYSTEM

The simulink style of closed pattern control over v increase agreement in a DVR system is confirmed in the Fig.14 Initially this method was revealed to voltage increase at t=650ms and is constantly on the be up to t=900ms with the finish voltage increase duration of 400ms, in a run time of 1500ms.

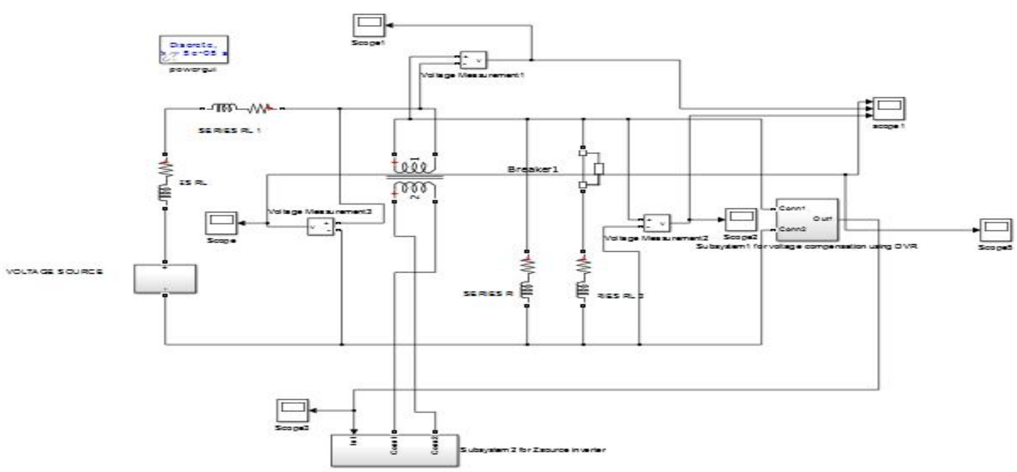


Fig 14.Closed Loop Control of Voltage Swell Compensation in a DVR System

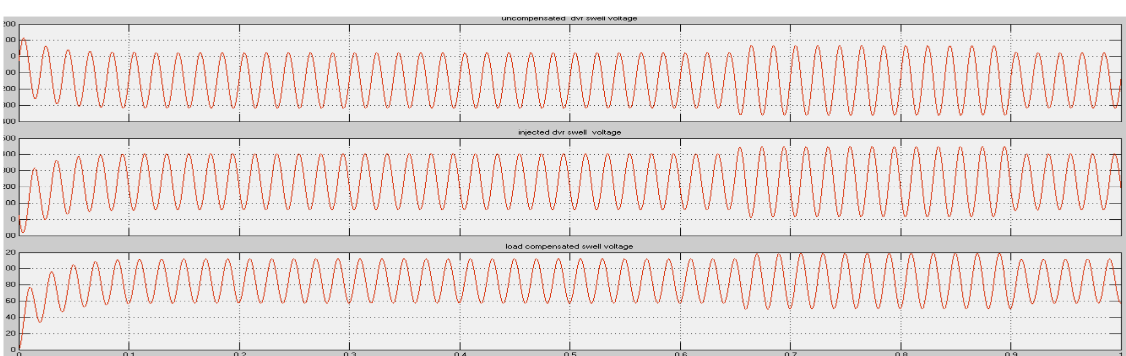


Fig. 15.(a) shows the uncompensated AC voltage with swell. Fig. 15.(b) is the injected DVR voltage. Fig. 15.(c) shows the compensated output voltage.

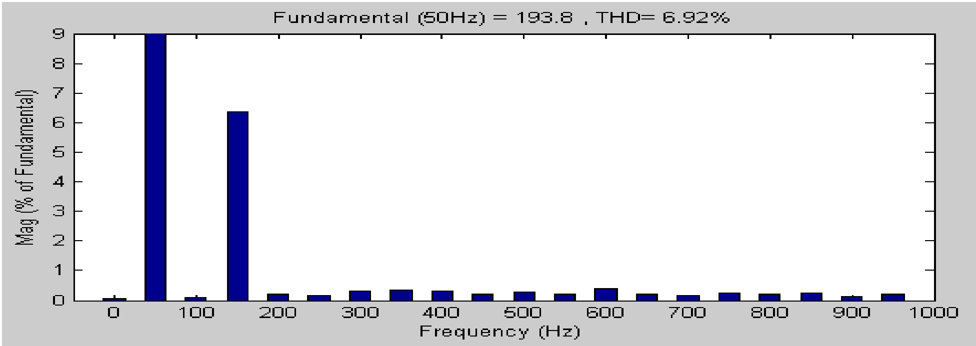


Fig.16 THD values of voltage compensation using swells

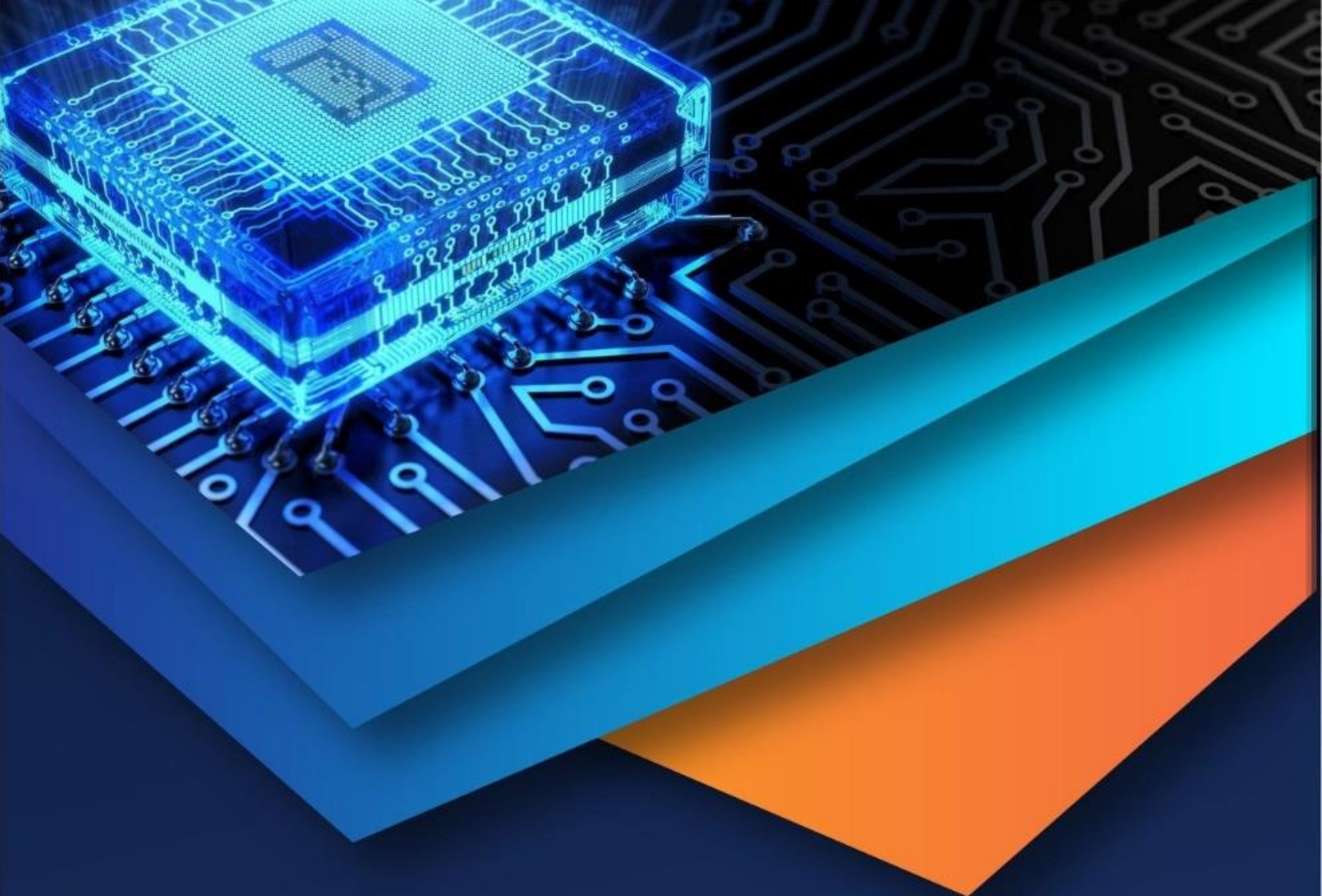
In Fig. 16, FFT research is completed for the paid outcome volts. Here the THD value is 6.92%. The simulator was done under temporary efficiency at the expand front and restoration was noticed. The burden volts are managed at the same value throughout the simulator. Thus volts expand settlement using shut cycle control is simulated.

VII. CONCLUSION

In this papers voltage sag/swell agreement using Z-Source inverter centred highly effective Dynamic Voltage Restorer is considered. The control technique developed using in-phase agreement and used a closed pattern control system to recognize the dimensions error between voltage during pre-sag and sag times. The acting and simulation of closed pattern control of voltage sag/swell minimization were taken out using MATLAB application.

REFERENCES

[1]. Minimum energy injection," IEEE Trans. Power Systems, vol.15, pp. 51-57.
[2]. Gajanayake C. J, Vilathgamuwa D. M, and LohP. C (2005) "Smallsignal and signal-flow-graph modeling of switched Z-source impedance network," IEEE Power Electronics Letters, vol. 3, pp. 111-116.
[3]. Jimichi T, Fujita H., and Akagi H. (2005) "Design and experimentation of a dynamic voltage restorer capable of significantly reducing an energystorage element," in Conf. Record Industry Applications Conference,14th IAS Annual Meeting..
[4]. Loh P. C, Vilathgamuwa D. M, Lai Y. S, Chua G. T, and Li Y (2004) "Pulse-width modulation of Z-source inverters," in Conf. Record IEEE Industry Applications Conference, 39th IAS Annual Meeting.
[5]. Peng F. Z. (2003) "Z-source inverter," IEEE Trans. Industry Applications, vol.39, pp. 504-510.
[6]. Samra N. A, Neft C, Sundaram A, and Malcolm W (1995) "The distribution system dynamic voltage restorer and its applications at industrial facilities with sensitive loads," in Proc. Power Conversion ntell. Motion Power Quality Long Beach, CA.
[7]. Sira-Ramirez H and Ortega R (1995) "Passivity-based controllers for the stabilization of DC-to-DC power converters," in Proc. 34th IEEE Conference on Decision and Control.
[8]. Sng E. K. K, Choi S. S, and Vilathgamuwa D. M (2004) "Analysis of series compensation and DC-link voltage controls of a transformerless selfcharging dynamic voltage restorer," IEEE Trans. Power Delivery, vol.19, pp. 1511-1518.
[9]. Stones, J., & Collinson, A., "Power quality," Power Eng. Journal, vol.15, no.2, pp.58-64, April 2001.
[10]. Bollen, M. H. J., "What is power quality?" Electric Power Systems Research, vol.66, no.1, pp.5-14, July 2003.



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