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# Mitigations of Voltage Sag and Swells for Power Quality Improvement Using Dynamic Voltage Restorer (DVR)

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**ABSTRACT:** Energy top quality issues such as voltage sags and swells are currently important issues in the economic field. This document discuss about the minimization of power top quality interference in reduced volts submission system due to volts grows using one of the highly effective power customized gadgets namely Powerful Dynamic Voltage Restorer (DVR). The dynamic voltage restorer (DVR) is a sequence settlement device that mitigates volts sag issues. Due to the nonlinearity of the DVR dynamic features, the paying efficiency of the DVR is impacted much by its control technique. The DVR normally set up between the source voltage and critical or sensitive loads. The new settings of DVR have been suggested using enhanced d-q-o operator technique. The models are executed using Matlab/Simulink's software.

**KEYWORDS:** Dynamic voltage Restorer, d-q-ocontroller, voltage swells, voltage sags, distribution system, sensitive load& Matlab Simulink.

## I. INTRODUCTION

Among the ability quality issues (sags, grows, harmonics…) volts sags are the most severe disruptions. To be able to get over these issues the concept of customized energy gadgets is presented lately. One of those gadgets is the Dynamic Voltage Restorer (DVR), which is the most efficient and effective modern customized energy program used in energy submission systems[1]. DVR is a lately suggested sequence connected strong state program that inserts volts into the program in to control the fill side volts. It is normally installed in a submission program between the supply and the critical fill bird birdfeeder at the point of common coupling (PCC). Other than volts sags and grows settlement, DVR can also add other features like: line volts harmonics settlement, reduction of transients in volts and mistake current restrictions[2].

DVR is an important tool to mitigate disturbances related to power quality problems in the distribution network. One of the crucial disturbances in the electrical network is voltage swells. The existing DVR as shown in Figure 1, consists of a Voltage Source Inverter (VSI), series injection transformer, filtering scheme and an energy storage device may that be connected to the dc-link

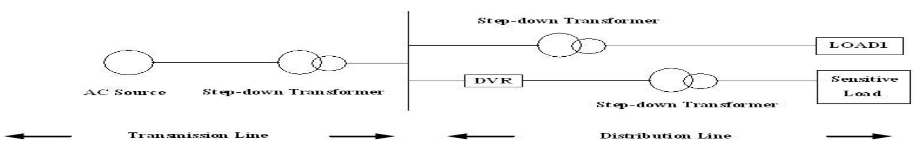


*Fig. 1: Location of DVR*

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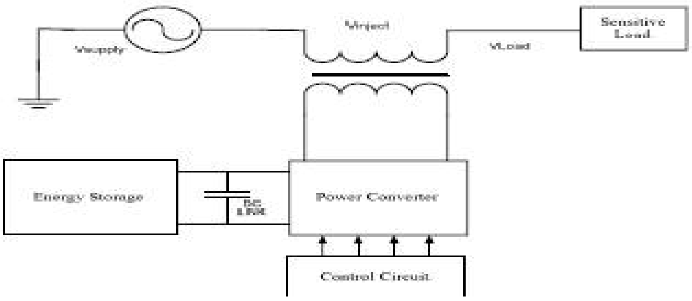


Fig. 2: Schematic diagram of Conventional DVR

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 flywheels[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].

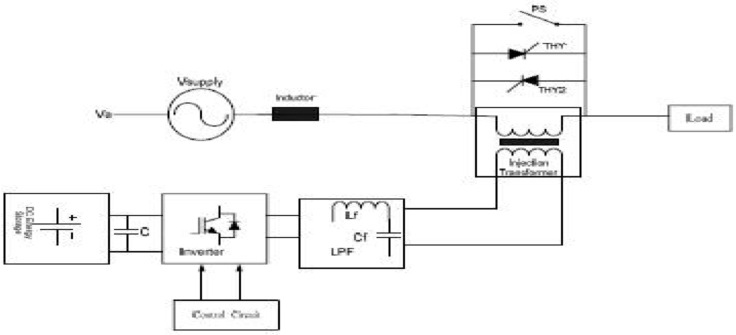


Fig 3: Typical DVR circuit topology (single-phase representation).

Figure3. Reveals the current has a VSI and the injection transformer. The VSC comprises of six IGBT's, three ac inductors and capacitors respectively, one dc capacitor and power storage space. The choice of IGBT's, interfacing inductor; dc capacitor and the narrow are as per the style for a powerful voltage restorer.

**OPERATING MODES OF DVR:**

The basic function of the DVR is to provide a dynamically managed volts Voltage DVR generated by a forced commutated ripper in sequence to the bus volts through a enhancer transformer. The temporary amplitudes of the three treated stage currents are managed such as to get rid of any damaging effects of a bus mistake to the fill volts V_L. This indicates that any differential currents due to temporary disruptions in the ac bird birdfeeder will be paid by the same volts produced by the ripper and treated on the method volts level through the enhancer transformer. The DVR has three ways of function which are: protection method, stand by method, injection/boost method.

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## II.THE NEW PROPOSED CONFIGURATION OF DVR

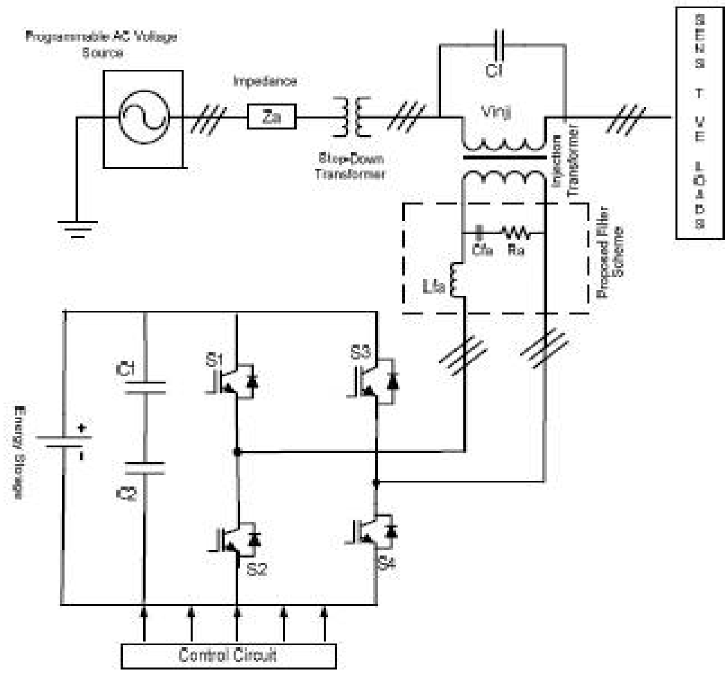


Fig 4 : The Proposed Configuration of DVR

The new configuration of the proposed DVR is shown in Figure 4.
In this research the sequence hypodermic injection transformer was designed as delta/open. The DVR power routine comprises of the 3-leg inverter which has 6 IGBT changes and battery power as a dc energy storage space. The low successfully pass filtration are used to turn the PWM upside down beat waveform from DC to AC transformation in the VSI. In these settings, filtrations are set up in both the holly wood part and the low volts part. When it is place in low volts part, great order harmonics from the three stage volts source PWM inverter is missing by the filtration settings and its effect on the hypodermic injection current ranking can be ignored. The type of these filtration settings can also remove changing ripples generated by the ripper.
When it is place in low volts part , great purchase harmonics from the three stage volts resource PWM inverter is by-pass by the filtration settings and its effect on the hypodermic injection present ranking can be ignored. The type of these filtration settings can also remove changing ripples created by the ripper. As for the filtration settings is placed in the holly wood part. In this case, great purchase harmonic voltages will go through the hypodermic injection and it will bring the harmonic voltages. When make up the volts sag/swell at the crucial fill, DVR build a harmonics distortions fed from sequence transformer as an hypodermic injection volts to the crucial fill. Using the Quick Fourier Convert (FFT) research to evaluate the Complete Harmonic Distortion (THD) for the volts indication. The suggested of the filtration settings outcomes a THD value of about 1.58%.

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## III.THE CONTROL SHCEME OF DVR SYSTEM

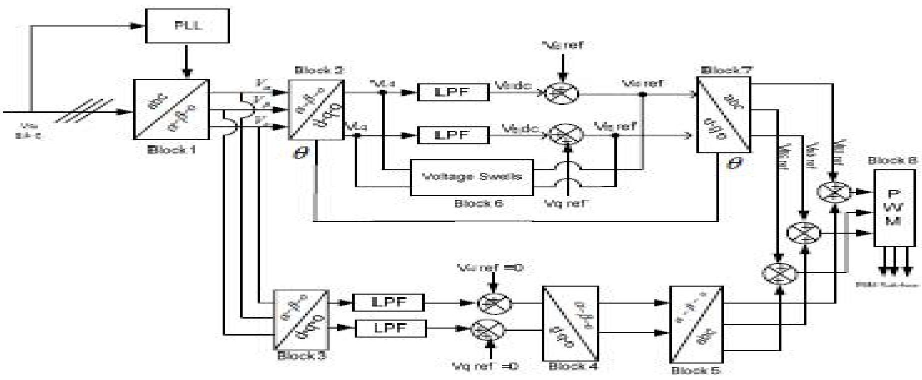


Fig 5: Block Diagram Control Scheme of DVR for Voltage Swells

The Management plan of the suggested settings of DVR program using d-q-o Park's modification strategy.

**D-Q-O Park's transformation:**

The direct-quadrature-zero (DQZ or DQ0 or DQO, sometimes lowercase) modification or zero-direct-quadrature (0DQ or ODQ, sometimes lowercase) transformation is a tensor that moves the referrals structure of a three-element vector or a three-by-three factor matrix in an attempt to make simpler research. The DQZ convert is the item of the Clarke convert and the Recreation area convert, first suggested in 1929 by John H. Park

The DQZ convert is often used in the perspective of electric technological innovation with three-phase tour. The convert can be used to move the referrals supports of ac waveforms such that they become dc alerts. Simple computations can then be taken out on these dc amounts before executing the inverse convert to restore the real three-phase ac outcomes. As an example, the DQZ convert is often used to be able to make simpler case study of three-phase synchronous devices or to make simpler computations for the management of three-phase inverters. In research of three-phase synchronous devices the modification exchanges three-phase stator and blades amounts into only one spinning referrals structure to get rid of impact of time-varying inductances.

The DQZ convert is created from the Recreation area and Clarke modification matrices. The Clarke transform) onverts vectors in the ABC referrals structure to the XYZ(often αβz) referrals structure. The main value of the Clarke convert is identifying that aspect of the ABC-referenced vector which is found in all three elements of the vector; it isolates the common-mode factor (i.e., the Z component). The power-invariant, right-handed, uniformly-scaled Clarke modification matrix is

$$\sqrt{\frac{2}{3}}\begin{bmatrix} 1 & \frac{-1}{2} & \frac{-1}{2} \\ 0 & \frac{\sqrt{3}}{2} & -\frac{\sqrt{3}}{2} \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{bmatrix} = \begin{bmatrix} \frac{\sqrt{2}}{\sqrt{3}} & 0 & \frac{-1}{\sqrt{3}} \\ 0 & 1 & 0 \\ \frac{1}{\sqrt{3}} & 0 & \frac{\sqrt{2}}{\sqrt{3}} \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & \frac{1}{\sqrt{2}} & \frac{-1}{\sqrt{2}} \\ 0 & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{bmatrix}$$

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## IV. SIMULATION RESULTS

The simulink model for DVR as shown in figure 6.

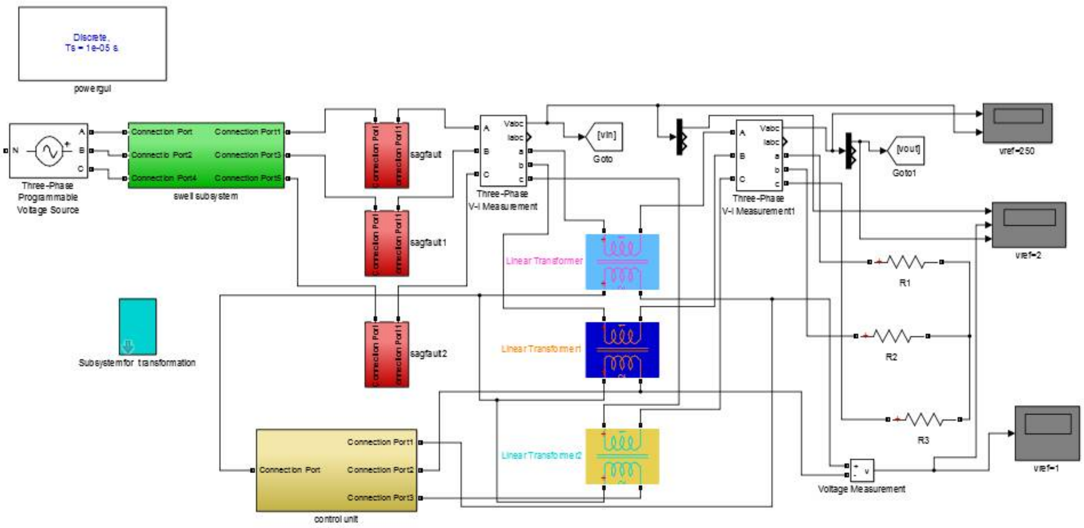


Fig6..Simulation diagram for DVR

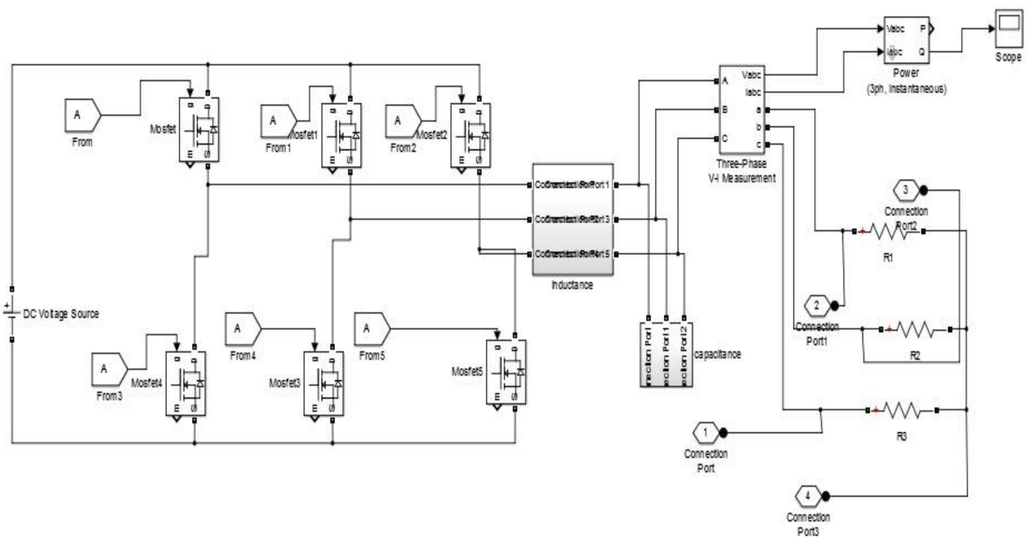


Fig7.Subcircuit of control unit

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Table 1: MAIN SPECIFICATION OF THE DVR

| PARAMETER | VALUE |
|---|---|
| Nominal grid voltage | 200V (L-L) |
| Nominal load voltage | 120V(L-L) |
| Maximum series voltage Injection | 100V(L-L) |
| Switching/sampling frequency | 10 KHz |
| Max.inverterdc-bus voltage | 120 V |
| Capacitor of dc- bus | 26uF |
| Filter inductance | 2.7mF |
| Filter capacitance | 50uF |

The performance of the designed DVR, as shown in Figure 4, is evaluated using Matlab/Simulink. Table I provides the specification of the simulation and experimental results of the DVR.
The corresponding output voltage waveform of this DVR is shown in fig 8.
Research on the DVR performance can make sure through examining under various disruptions condition on the resource volts. The suggested control criteria was tested for balanced and uneven currents grows in the reduced volts submission system. In case of stability volts expand, the resource volts has increased about 20-25% of its affordable value. The simulator results of the total amount volts grows as shown in Determine 8(a),8(b)&8(c) . The grows currents occur at the time duration of 0.06s and after 0.12 s the volts will recover back to its normal value. The function of the DVR will inserts the missing volts in order to control the burden volts from any interference due to immediate change of resource volts. The recover volts at the burden side can be seen in Determine 8(d). The Determine shows the potency of the operator reaction to identify volts grows quickly and provide an appropriate volts.

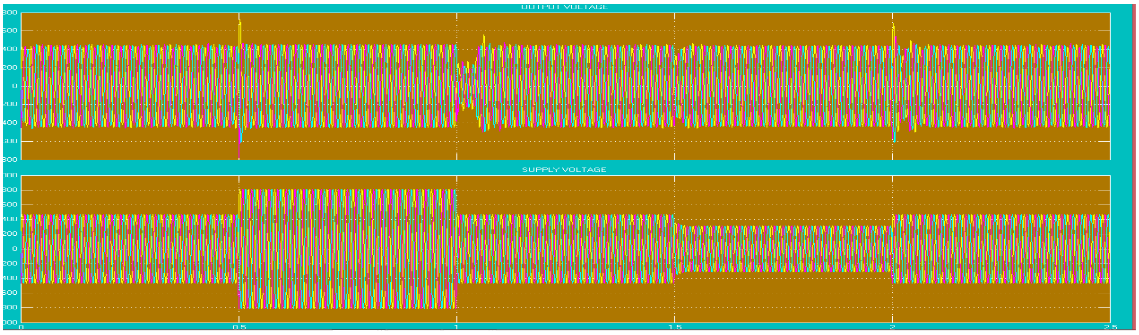


Fig 8(a): Restored voltage after injecting the voltage by using DVR

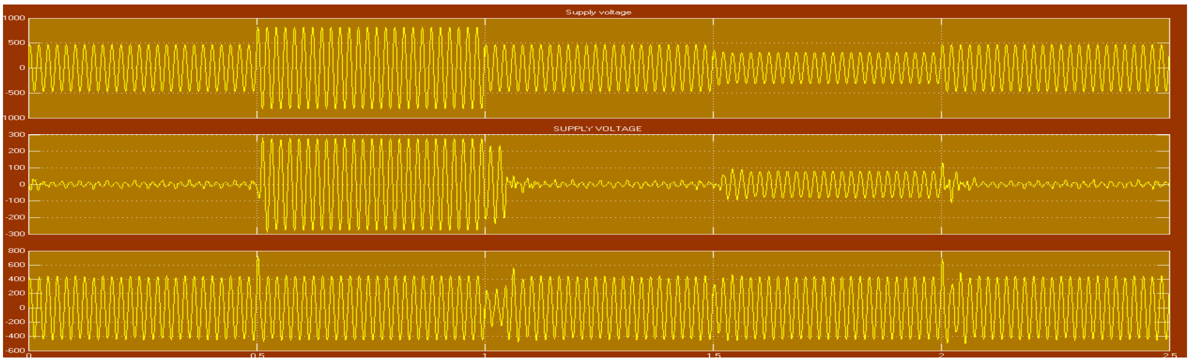


Fig 8(b): Restored voltage before injecting the voltage by using DVR

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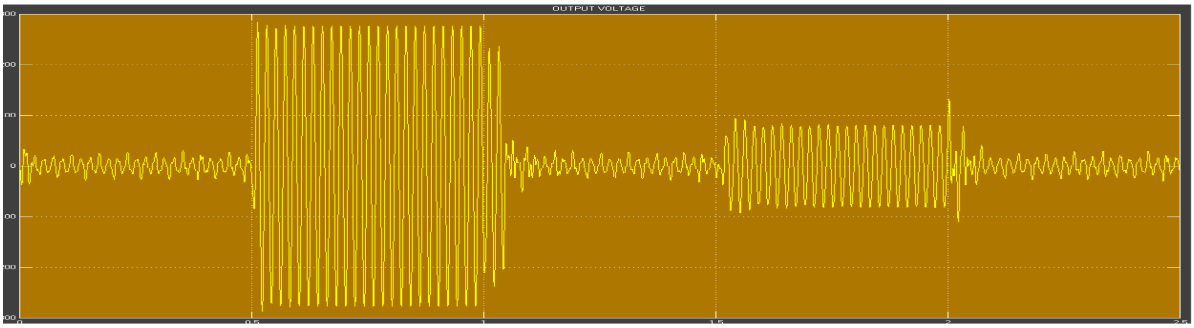


Fig 8(c): Restored voltage after DVR

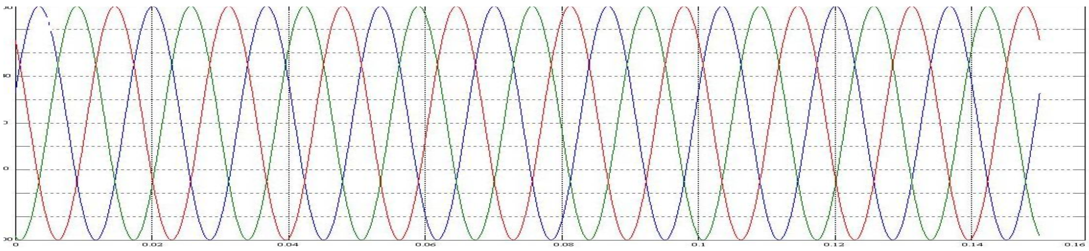

Fig 8(d): Load voltage after restoration

**THD Values for DVR:**

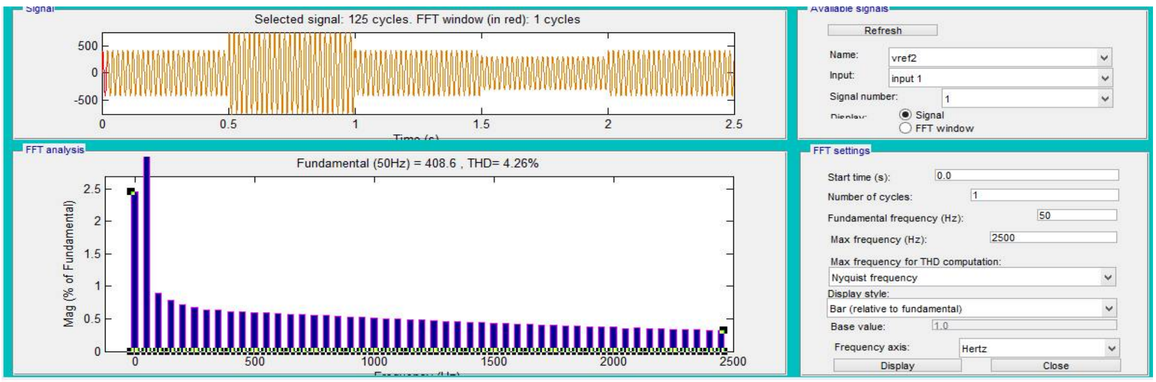


Fig 9(a): FFT analysis of supply voltages

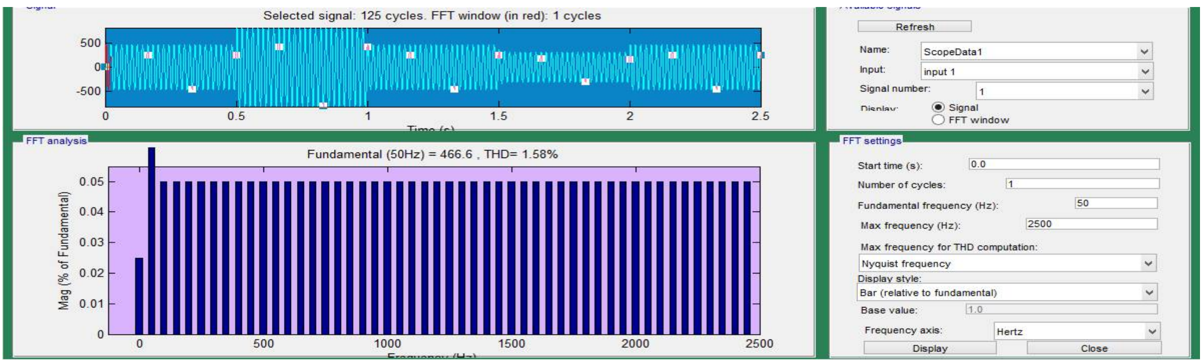


Fig 9(b):FFT analysis of output voltages

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By using FFT research the DVR has decreasing complete harmonic disturbances with 1.58 % proven in above determines.

## V. CONCLUSION

A new settlement volts management plan was suggested in this document. This document talks about the aspect related with the requirements and management of the DVR for volts expand minimization in reduced volts submission network. The suggested method can protect customer's equipment from potential volts grows. This was shown with several simulator and trial outcomes. These outcomes confirm the suggested strategy for the recognition and management of the DVR. These outcomes also shown that the DVR settlement is fast and the source volts mistake can be paid by sequence volts linear injection transformer.

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