Mitigation of Power Quality Disturbances in Power System using DVR

Riyatri Roy, Abisanka Bhattacharya, Suddhadipta Paul, Saptarshi Chatterjee, Beauty, P. Suresh

Abstract--- ***The main aim of this paper is to identify and restore the faults that occurred in a Power System. This Paper carries a decent comprehensive characterization of the faults along with the overcoming techniques of it. During a fault, the current and voltage waveforms are disturbed. In order to overcome the disturbances, we are using DVR (Dynamic Voltage Restorer) that acts as a compensator. The vital role of DVR is to provide a smooth flow of the voltage waveforms without any disturbances in the system .The principle of DVR follows the injection of voltage and frequency which is necessary for the restoration of voltage at the load side of desired value. In this paper, the voltage and current waveforms are also demonstrated after the incident of fault.***

Keywords--- DVR, Voltage Sag, UnsymmetricalFault.

I. INTRODUCTION

Technically our world has a high velocity up gradation, which leads to the enhancement of the demand of electricity day by day. Today, electricity is transmitted in most parts of the world. During transmission sometimes there forms some faults.

In a Power System, any abnormality in the flowing of electric current is referred to as a fault. For example if there is any failure in the circuit, then the fault is said to be an open circuit fault. A fault is classified as Transient faults,Persistent faults, Symmetrical faults and Unsymmetrical faults.

A transient fault is a fault where the fault is diminished as soon as the power is disconnected for a very short period of time.For example: tree contact, animal contact, lightning strikes etc.

A persistent fault is a fault that cannot diminish itself as soon as the power is disconnected. For example: mechanical damages.

Asymmetrical fault is a fault that occurs on all the three phases of the power system equally. Generally this falls under rare case fault category fault, nearly 5% of the total faults can be considered as the symmetrical faults.For example: line to line to line fault (that is the fault between all the lines) and line to line to ground fault (that is fault between the lines and ground)

An unsymmetrical fault is a fault that is unbalanced in nature and portrays an effect in each of the three phases. This fault can further be classified as: a) Line to line fault (the fault occurring between two lines of the power system)b) Line to Ground fault (the fault occurring between a line and ground) and c) Double line to ground fault (the fault occurring between the two lines and the ground) Power Quality demands much attention as it plays a very vital role that ensures the quality delivery of the power to the customers.

Power Quality Disturbances can be classified as Variations and Events. Variations can be defined as a steady state disturbances that requires persistent scrutinization of voltage magnitude variations, frequency variations etc.

On the contrary, voltage transients, voltage swell, voltage sag, voltage interruptions are the power quality disturbances derived from Power Quality events. Power Quality disturbances may be categorized as voltage sag, swell, transient, harmonics, voltage flicker and notch. The study of various types of phenomena which forms power quality disturbances and lead to the formation and development of mitigation energy.

In order to develop a proper mitigation strategy, understanding the phenomena of power quality disturbances and its root cause falls under its utmost importance. Simulation of Power Quality disturbances is possible due to the decent up gradation of the technology in terms of software. In this paper the proper

Simulation is executed by MATLAB which is a high level language for performing technical computations. This interactive system is a basic set of elements of dimensionless arrays.

II. PROPOSED WORK

The schematic diagram represents IEEEstandard 9 bus system as the proposed work. The Power system network comprised three generators, two non-linear loads, nine buses, one DVR model and one fault block for creation of faults.

At the generating side, 25 kV, 15 kV and 18 kV are generated at Buses 1, 5 and 9 respectively. One of the non-linear loads is installed in Bus 6 and the other is in Bus 7. A fault is generated between Bus 6 and Bus 8. In a parallel

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manner, we have also installed a DVR (Dynamic Voltage Restorer) which compensates the voltage sag. The switching components of DVR are mainly IGBT's, which are connected in H-bridge and

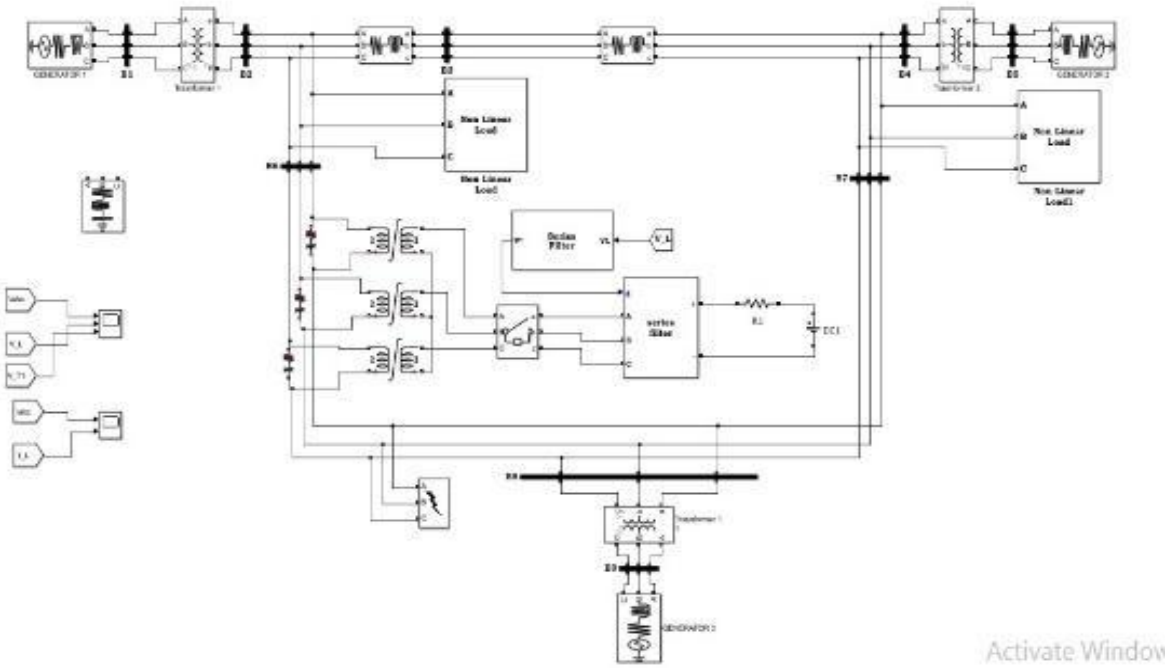

Fig. 1: Proposed Circuit Model

the pulses are generated by PWM techniques. DVR compensates the voltage sag by converting DC supply to AC. DVR can also play a role of generating or absorbing controllable real and reactive powers at the load side. As a power switching converter it infuses a three phase ac output voltage in series and in a synchronous manner with the transmission and distribution line voltages.

The features of DVR includes a) fast dynamic responses b) not expensive c) Power flow can be controlled. This paper is a modified version of the base paper, where no compensators were introduced. The base paper focused about the current and voltage waveforms and analyzed the flow of power in the buses. Our upgraded paper focused upon the continuity of the voltage waveforms using a compensator which enhances the efficiency and moreover the safety of the load side components.

The table listed below shows the data of load and generating side:

Generator Data

Parameters	G1	G2	G3
Voltage	25kV	15kV	18kV
Frequency	50Hz	50Hz	50Hz
Source Resistance (ohms)	0.8929Ω	0.8929Ω	0.8929Ω
Source Inductance	16.58mH	16.58mH	16.58mH

Load Data

Parameters	L1	L2
Resistance	100Ω	100Ω
Inductance	0.01mH	0.01mH

The simulation of the Power system model was executed using the above table values.

The basic model of DVR is given below:

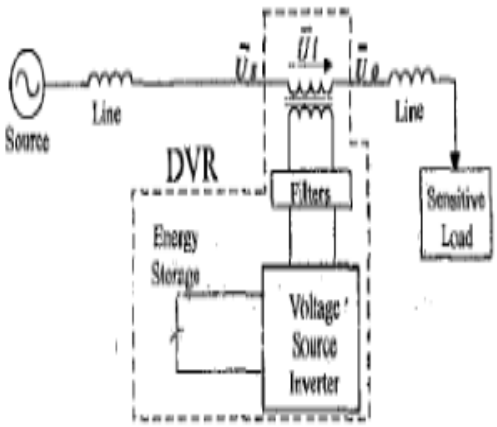

Fig. 2: DVR Model

The basic block diagram of the single line implementation of DVR model consists of a VSI (Voltage Source Inverter), a DC supply, a filter and a transformer.

Transformer data

Parameters	T1	T2	T3
Power	4000W	4000W	4000W
Frequency	50Hz	50Hz	50Hz
Voltage(Primary)	25e3kV	15e3kV	18e3kV
Voltage(secondary)	230V	230V	230V
R_1	0.02Ω	0.02Ω	0.02Ω
L_1	0.02H	0.02H	0.02H
R_2	0.02Ω	0.02Ω	0.02Ω
L_2	0.02H	0.02H	500H
R_m	500Ω	500Ω	500Ω
Lm	500H	500H	500H

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The DVR model diagram implemented on the paper is represented below:

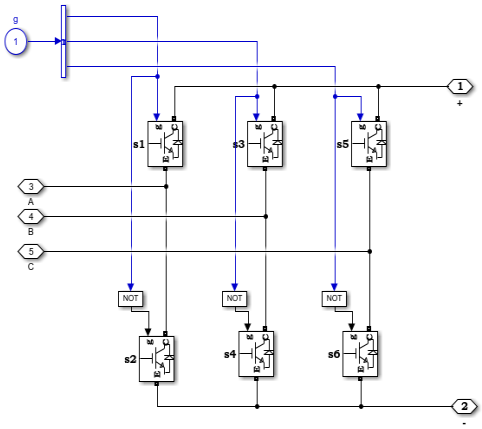

Fig. 3: DVR MODEL

III. RESULTS& DISCUSSIONS

As in the model, different types of faults are created between bus 6 and bus 8,the current and voltage waveforms of the different types of faults are listed below with and without using DVR compensator.

During no fault condition in the power system there is no disturbances in the load voltages and load currents thus attains an equilibrium condition as represented in Fig 4.

Whenever single line to ground faultoccurs in a power system as represented in Fig 5 and Fig 10**,** the voltage sag takes place and the current becomes maximum for the particular phase.

At the time of line to line fault, as represented in Fig 6 and Fig 11, the voltage of both the phases becomes minimum and current becomes maximum.

When double line to ground fault occurs, as represented in Fig 7 and Fig 12**,** the voltages at both the lines become minimum and thecurrent becomes maximum hence equilibrium condition breaks.

During triple line fault that falls under the category of symmetrical fault as represented in Figure 8 and Figure 13**,** the voltages at all the three phases become minimum and the current at all the three phases becomes maximum.

In triple line to ground fault which falls under the category of symmetrical fault as represented in Fig 9 and Fig 14**,** the voltages at all the three phases becomes minimum and the current at all the three phases becomes maximum.

For a line to ground fault, voltage and current after implementing the DVR compensator as represented in Fig 15 and Fig 18**,** the voltage sag is compensated by the DVR, which generates the compensated voltage injected to three phase faulted line. So to get a continuous voltage at the load side.

If line to line fault occursafter implementing the DVR compensator, thenthe voltage sag iscompensated, which generates the compensated voltage injected to three phase faulted line to get a continuous voltage at the load side which isrepresented in Fig 16 and Fig 19**.**

The formation of double line to ground faultafter the implementation of DVR compensator is represented in Fig 17 and Fig 20.Here, the voltage is compensated,which is injected to three phase faulted line, so to get a continuous voltage at the load side.

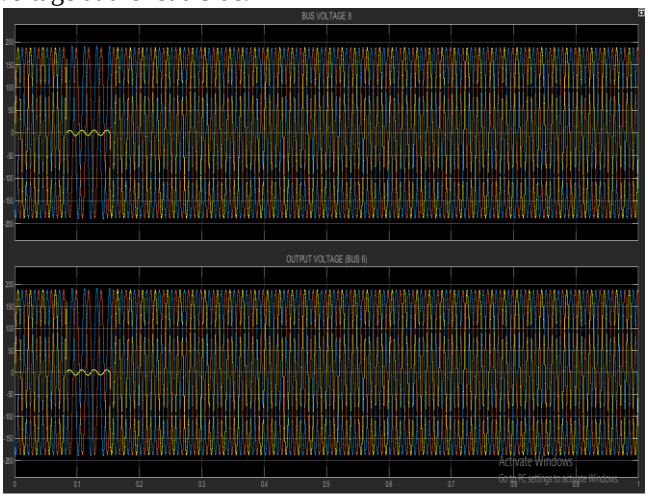

Fig. 4: Voltage Waveform with No Fault

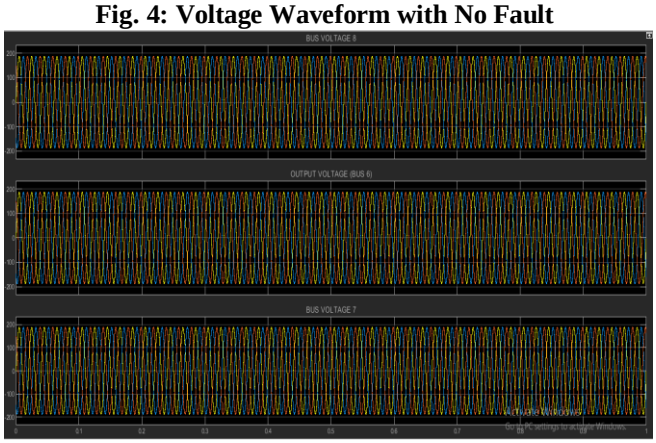

Fig. 5: Voltage Waveform during LG Fault without DVR

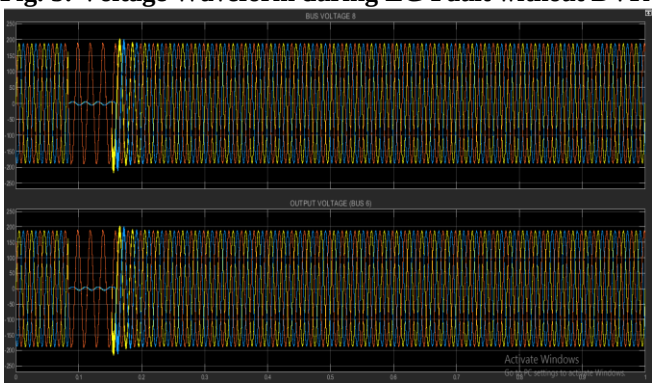

Fig. 6: Voltage Waveform during LL Fault without DVR

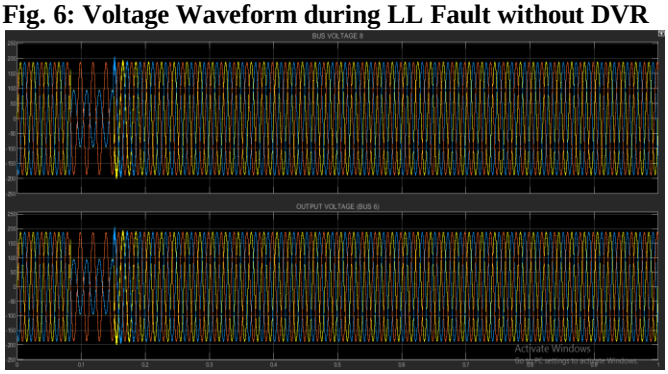

Fig. 7 Voltage Waveform during LLG Fault without DVR

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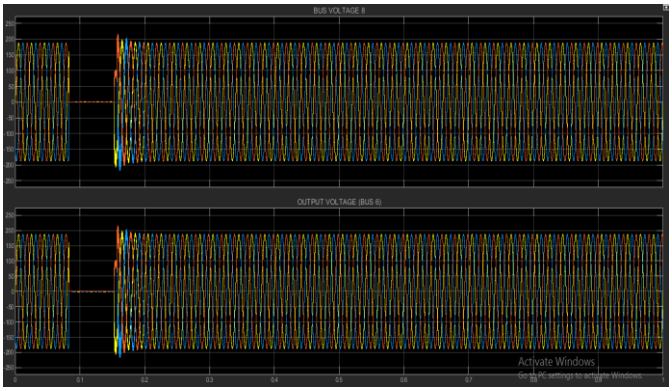

Fig. 8: Voltage Waveform during LLL Fault without DVR

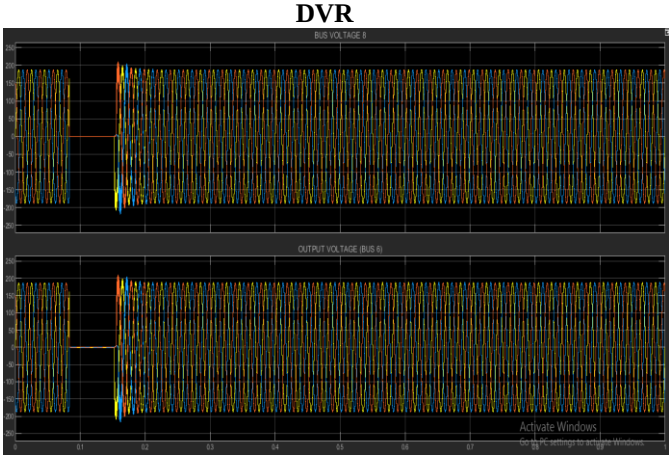

Fig. 9: Voltage Waveform during LLLG Fault without DVR

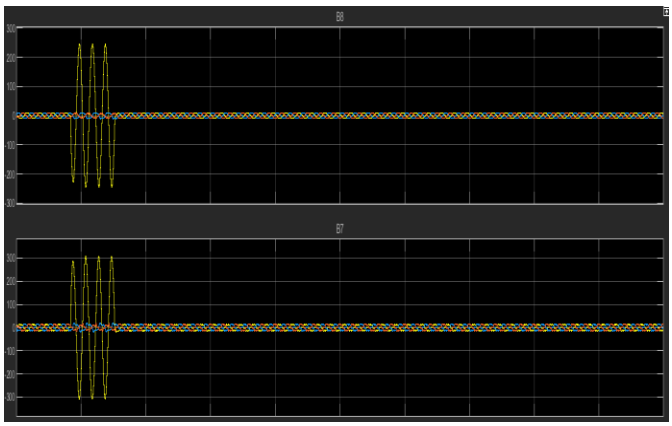

Fig. 10: Current Waveform during LG Fault without DVR

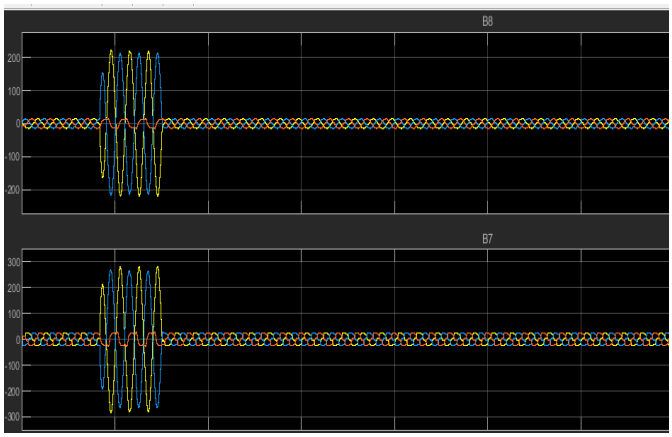

Fig. 11 Current Waveform during LL Fault without DVR

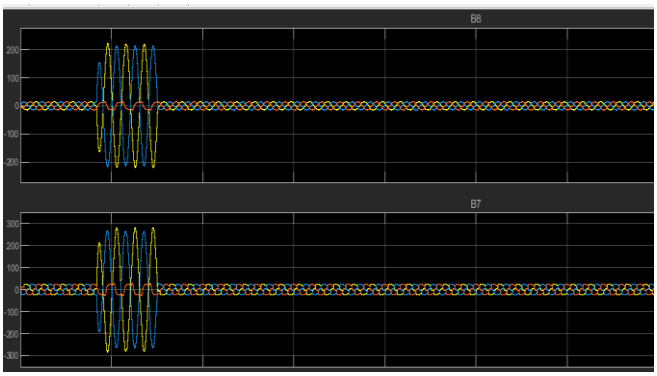

Fig. 12: Current Waveform during LLG Fault without DVR

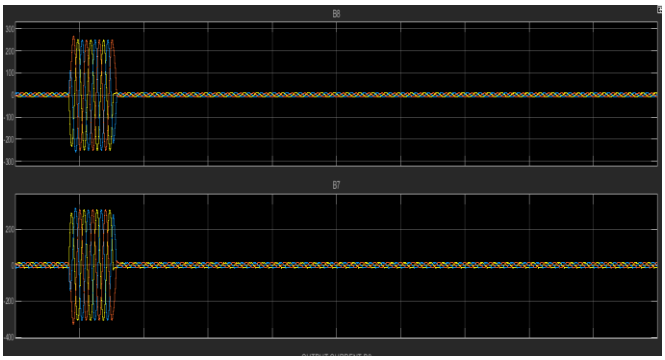

Fig. 13: Current Waveform during LLL Fault without DVR

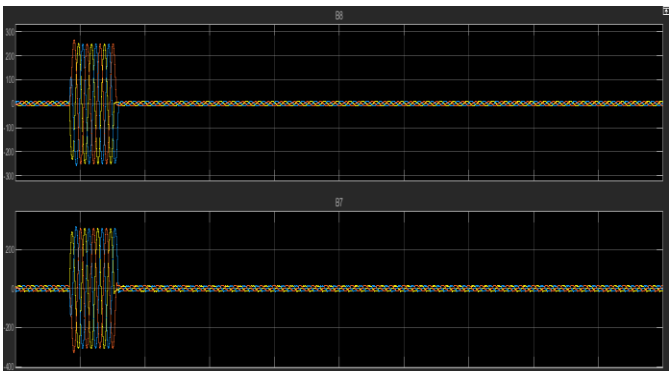

Fig. 14: Current Waveform during LLLG Fault without DVR

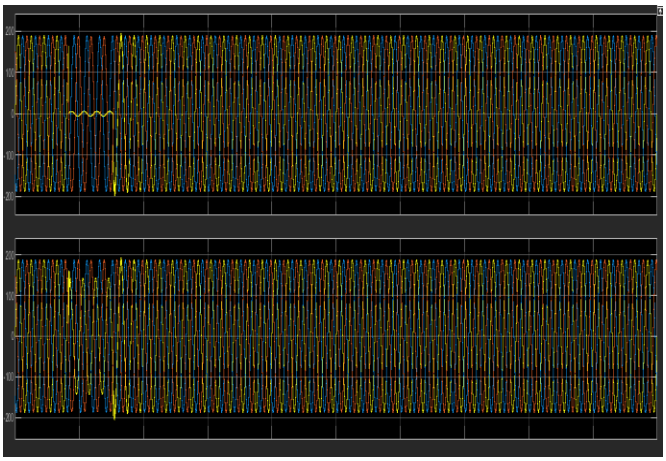

Fig. 15: Voltage Waveform during LG Fault with DVR

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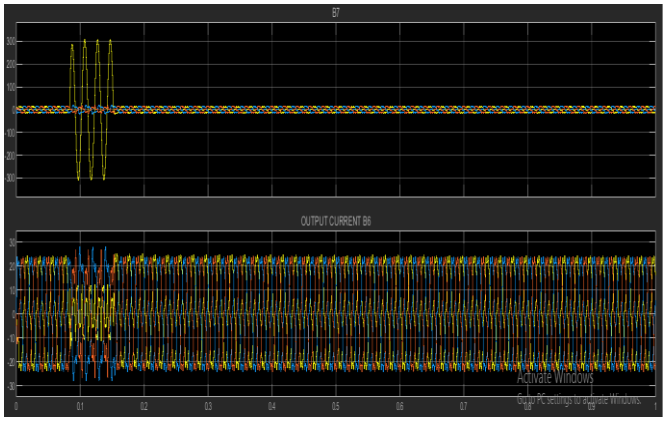

Fig. 16: Voltage Waveform during LL Fault with DVR

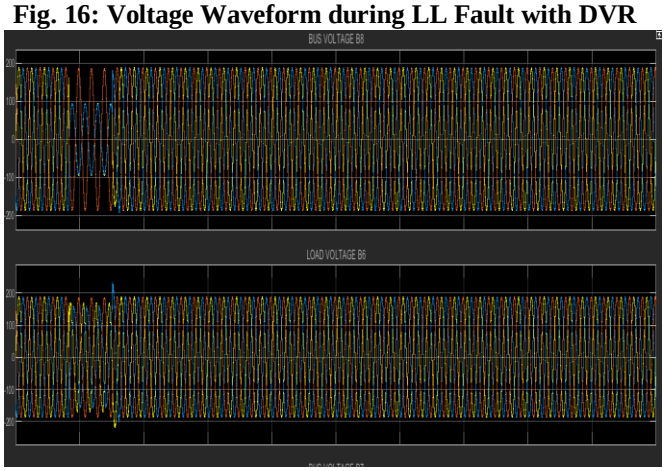

Fig. 17: Voltage Waveform during LLG Fault with DVR

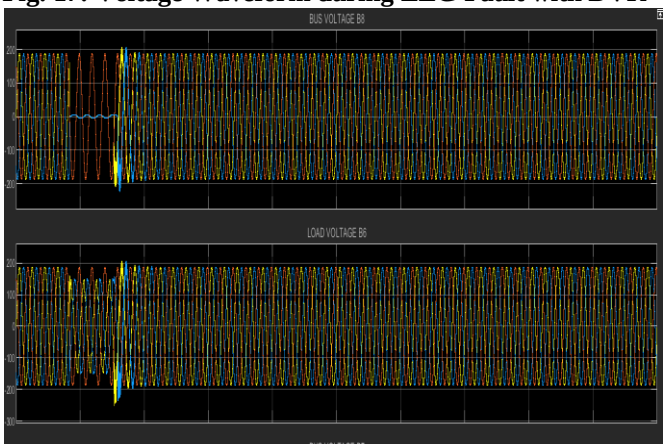

Fig. 18 Current Waveform during LG Fault with DVR

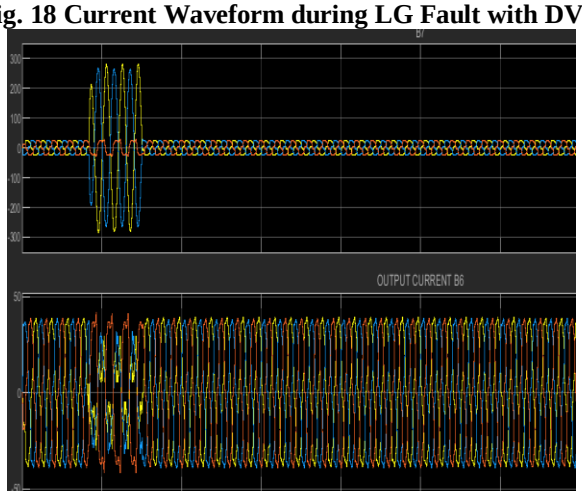

Fig. 19: Current Waveform during LL Fault with DVR

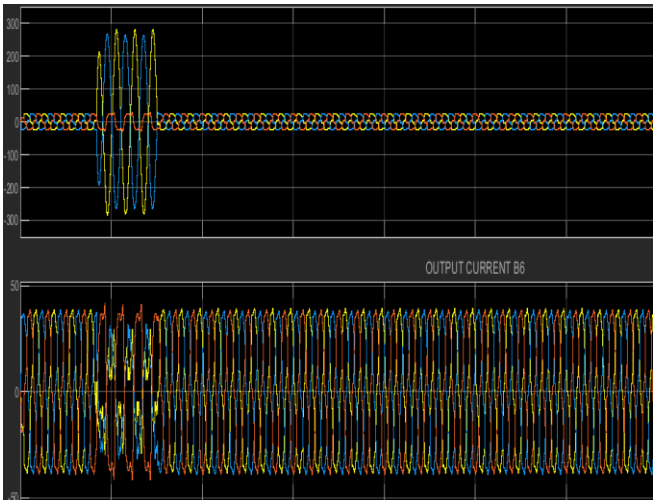

Fig. 20: Current Waveform during LLG Fault with DVR

IV. CONCLUSION

This paper is a thorough study about the Power system, where different types of fault are formed in a transmission line. In order to improve the power quality in the transmission line due to the fault, DVR is used, whose main function is to compensate the voltage, so there will be consistent voltage throughout the power system. Thereafter if fault is occurred then due to DVR, the load voltage and the load current will not be affected. As a result the load side will be protected against the fault.

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