A REVIEW PAPER ON REGULATION TECHNIQUE FOR VOLTAGE SAG AND SWELL USING DVR

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***Abstract*: Power quality is one of big concerns in the recent years. It has become very special, mostly, with the introduction of devices, whose function is more sensitive to the quality of power supply. Problem of Power quality is having of the nonstandard current, voltage or frequency that results in a failure of end use devices This paper presents the performance of superconducting magnetic energy storage based dynamic voltage restorers (DVR) on power systems for regulating of voltage sags and swells at critical loads by using super magnetic energy source Simulation results are given to illustrate and understand the function of DVR in supporting load voltages under voltage sags/swells situations.**

***Keywords:* SMES, DVR, voltage sag, power quality, and voltage swell**

Introduction:

Power quality problems consists of a wide range of phenomena. Voltage sag and swell, flicker, harmonics distortion, impulse transients and short and long duration interruptions are very prominent few. These disturbances are responsible for errors to plant shut down and loss of manufacturing capability. Voltage sags and swells can occur more than any other power quality phenomenon. These sags and swells are the mostly occured power quality problems in the power transmission system and distribution system .

In order to overcome these challenges, it needs a device which is capable of injecting minimum energy so as to regulate load voltage at its value. Dynamic Voltage Restorer (DVR) is one of the effective methods for compensating the power quality problems such as voltage sags and swells. SMES based Dynamic voltage restorer (DVR) can give an effective solution to mitigate voltage sag and swell by establishing the appropriate voltage level required by the loads. It is nowadays being used as the active solution for voltage sag and swell mitigation in modern industrial and commercial applications.

Custom power technology is a general term for equipment capable of regulating various power quality problems. Basic functions are fast switching and current or voltage injection for correcting deviation in supply voltage or load current by applying or absorbing reactive and active power, respectively [3].

The power electronic device controllers that are used in the custom power compensation can be a network compensating type or a regulating type. The network reconfiguration devices are usually called switchgears includes current limiting, current transferring and current breaking devices Among compensating devices, a DVR can handle conditions of voltage sags and swells which are considered to have a very bad impact on manufacturing places

3.2 POWER QUALITY PROBLEMS

3.2.1 Voltage sag

A voltage sag as defined by IEEE standard 1159-1995 IEEE recommended practice for monitoring electric power quality which is a reduction in rms voltage at the power frequency for durations from 0.5 cycles to 1 minute mentioned as the remaining voltage.

The IEC (International Electro-technical Commission) terms for voltage sag . The IEC defines voltage dip as a sudden reduction of the voltage at a point in the electrical system followed by recovery of voltage after a short period, from ½ a cycle to a few seconds.

Voltage sag is as a sudden reduction of voltage supply down 90% to 10% of given recovered after a short period of time. A nominal duration of sag is according loss of production in automated processes since voltage sag can cause motor tripping its controller to malfunction. An appearance of r.m.s voltage sag is shown in Figure 2.2

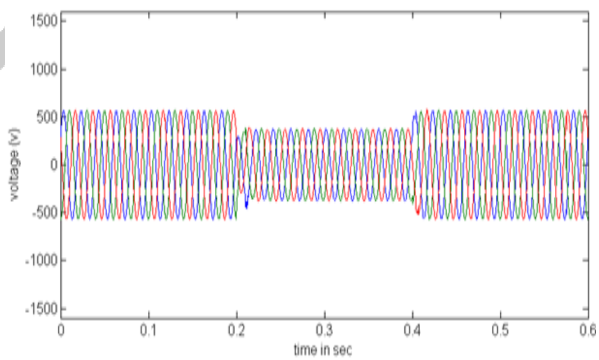


Fig 2.2 voltage sag

3.2.2 Voltage Swells

Voltage Swell is defined by IEEE 1159 as the increase in the rms voltage level to 110%-180% of given, at the power frequency for durations of ½ cycles to one minute. Voltage swell is defined as a sudden increasing of voltage supply from 110% to 180% in rms voltage at the network fundamental frequency with duration from 10 ms to 1 minute. By switching a large inductive load or adding energizing a large capacitor bank causes swells . An appearance of r.m.s voltage swell is shown in Figure 2.3

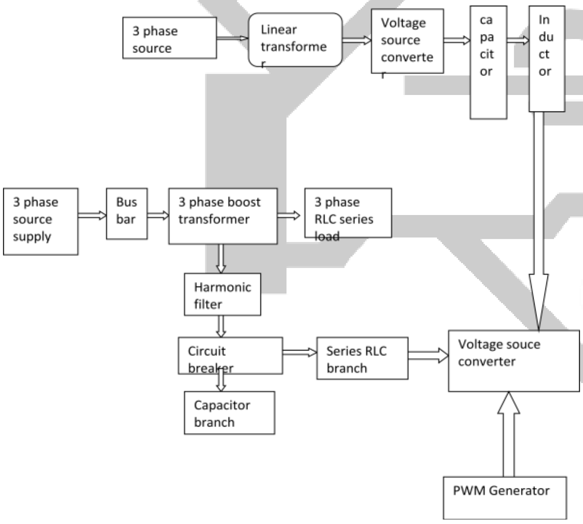
3.6.1 Dynamic Voltage Restorer/ Regulator (DVR)

It is the series voltage controller is connected in series with the protected load as shown in Figure 3.6.1 A DVR is a device that injects a dynamically controlled voltage in series to the bus voltage connecting to booster transformer as depicted in Figure L There are three single phase booster transformers connected to a three phase converter with energy storage system and control circuit . The amplitudes of the three phase injected voltages are controlled such as to remove any detrimental effects of a bus fault to the load voltage V1 The main advantage with this method is that a one DVR can be installed to protect a whole system as well as single loads. Because of the fast switches,voltage regulation can be achieved in less than half a cycle. Main disadvantages is comparetely expensive and it only mitigates voltage The cost of a DVR mainly depends the energy storage capacity.

3.3.3 Pre-sag Compensation Technique

Some voltages are sensitive not only to rms value of the load but also to the phase of load voltage. In this case, illustrated in the Fig.3.8, DVR injects voltage such that the compensated load voltage is in the phase with pre-sag voltage.

BLOCK DIAGRAM FOR REGULATION OF VOLTAGWE SAG AND SWELL USING SMES BASED DVR



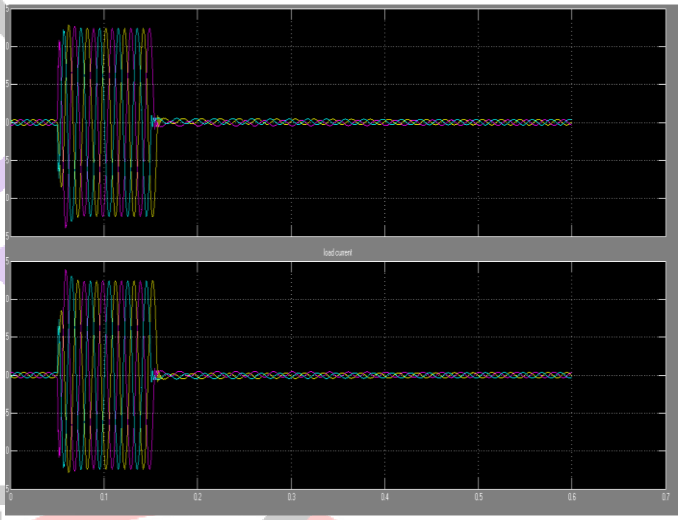
Parameters used for test system are
Power rating (P) =8 KVA
Utility line to line Voltage=400V
Line inductance (L)=4.0 mH
Frequency =50 Hz
Line capacitance (C)=6uF
Switching time =0.05 ms to 0.15 ms Simulation is performed in MATLAB SIMULINK. MATLAB SIMULINK is a very famous effective tool for mathematical analysis

6.1 For voltage sag

Symmetrical sag is simulated by connecting a three-phase inductance in series with resistance to the bus bar In this the 40 % sag is initiated at 50ms and it is kept until 150ms, with total voltage sag duration 100ms. the modulation of dvr is observed the Modulation Timing [Ton Toff]= [0.15 0.25] In this simulation the sag is almost corrected. Here, 99% sag is corrected in each phase. When sag is occurred the DVR automatically comes into the function. The circuit breaker is closed at 50ms and opened at 150ms. It was observed that method which used here simulated THD which is within 1 % limits and maintained voltage at 400 V

6.1.1 For voltage sag with RL load condition

The switching on of power electronic devices produce the harmonics in the system.voltage sag is observed on different conditions of the load, By the result of DVR, the load voltage is kept at constant value throughout the simulation. Observe that during normal operation, the DVR



is doing nothing. Fig 5.5 shows the 3-phase series voltage by DVR, load voltage and source voltage at PCC.

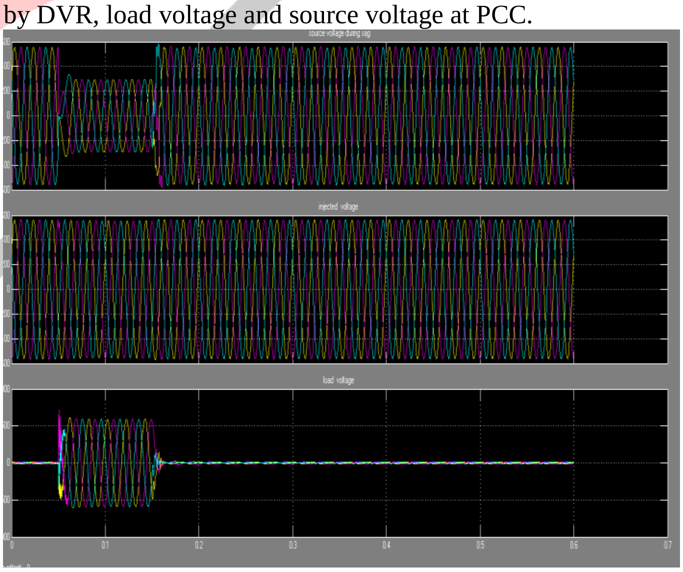
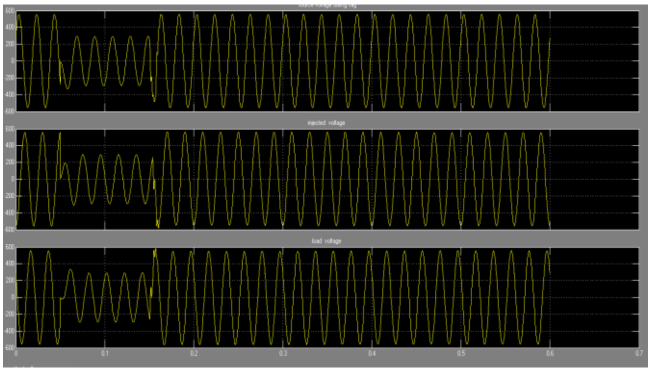


Fig 5.6 (a), (b) are the RMS load voltage with sag and load voltage after sag compensation. It may be observed that the load voltage is almost most constant with sag correction



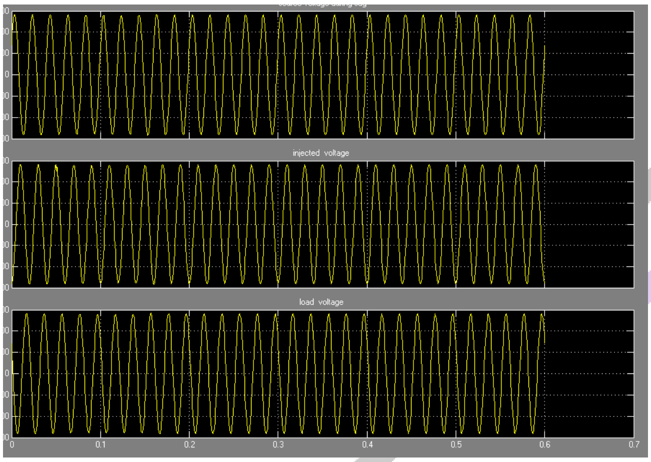
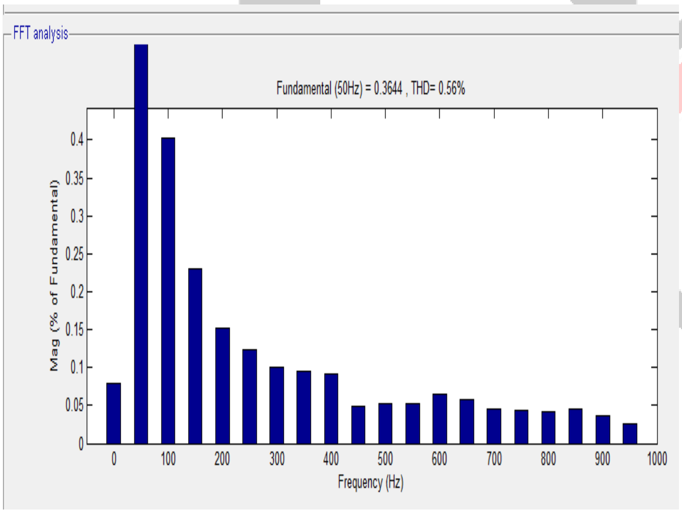


Figure 5.22 and 5.23 shows the three phase load current waveforms. In this simulation the load current is increased when the DVR is connected to the distribution system

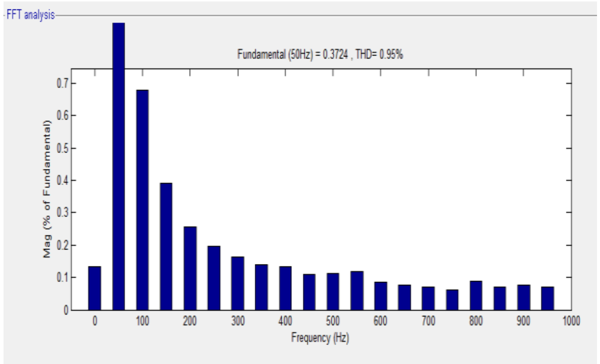
The switching on of power electronic devices produce the harmonics in the system. In this simulation the total harmonic distortion with sag is 0.56%.

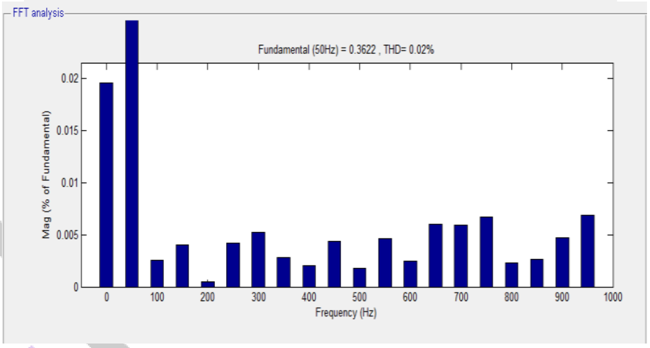


6.1.2 For voltage sag with RC load condition

Simulation results are as shown in fig,It was observed that 50% sag is occurred which was mitigated by using smes based dvr .THD is 0.02%.v In this case particularly inductive power should be kept zero so that sag condition is obtained

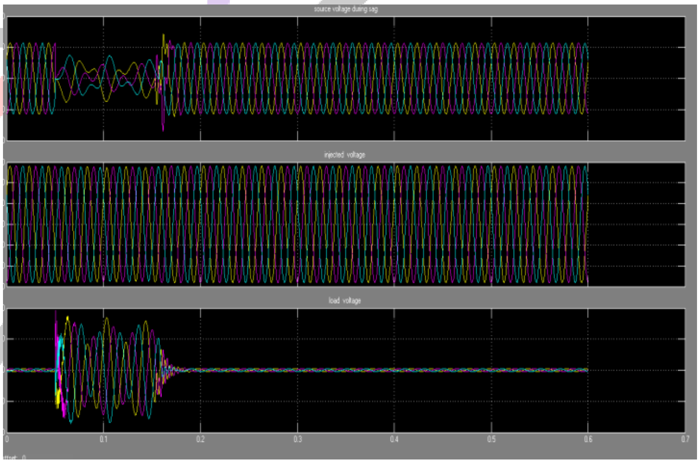
The switching on of power electronic devices produce the harmonics in the system. In this simulation the total harmonic distortion with sag is 0.02%.





6.1.1 For voltage sag with LC load condition

It was observed that in LC Load condition voltage sag is 60 % occurred with irregular transitions active power is very necessary while using DVR as without it irregular transitions .the total harmonic distortion with sag is 0.94%.fig.6 a b c shows sourve voltage ,load voltage and injected voltage



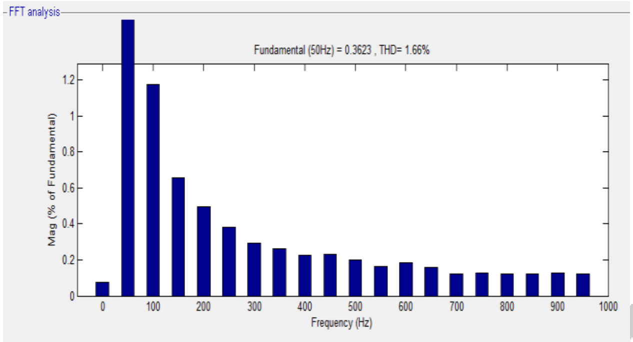
The switching on of power electronic devices produce the harmonics in the system. In this simulation the total harmonic distortion with sag is 0.95%.

6.2 For voltage swell

6.2.1 FOR VOLTAGE SWELL WITH RLC LOAD

The performance of DVR for a voltage swell sitution is investigated.Voltage swell is btained by energizing of a large capacitor bank and the supply voltage is shown in Figure 5.3 (a). The voltage amplitude is increased about l25o/o of nominal voltage. The injected voltage and the load voltage, are shown in Figure 5.3 (b) and (c), respectively. As observed from the results, the load voltage is kept at the given value with the help of the DVR. Similar to the case of

voltage sag, the DVR reacts immediately to inject the accurate voltage component(anti phase with the supply voltage or negative voltage magnitude) to correct the supply voltage In RLC load conditions simulation the total harmonic distortion with swell is 1.66%.
The switching on of power electronic devices produce the harmonics in the system. In this simulation the total harmonic distortion with sag is 1.66%.



Here the voltage is increased to 130% of nominal voltage during swell period. The injected voltage that is obtained by DVR in order to maintain the load voltage. The single phase voltage at PCC and voltage at load is shown in Fig 5.19 and 5.20

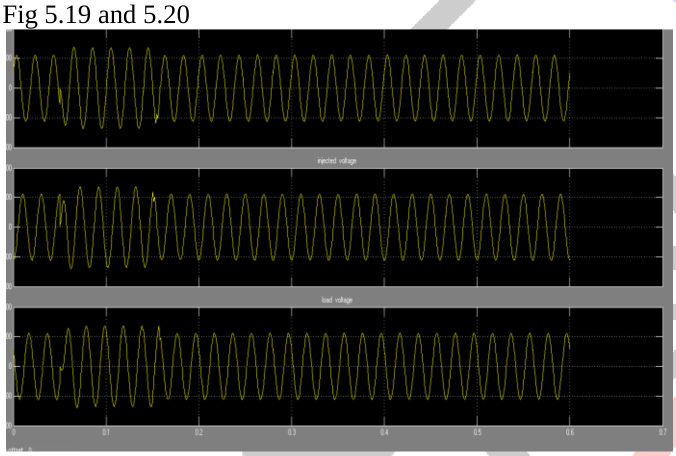


Figure 5.22 and 5.23 shows the three phase load current wave forms and three phase load current wave form. In this simulation the load current is increased when the DVR is connected to the distribution system

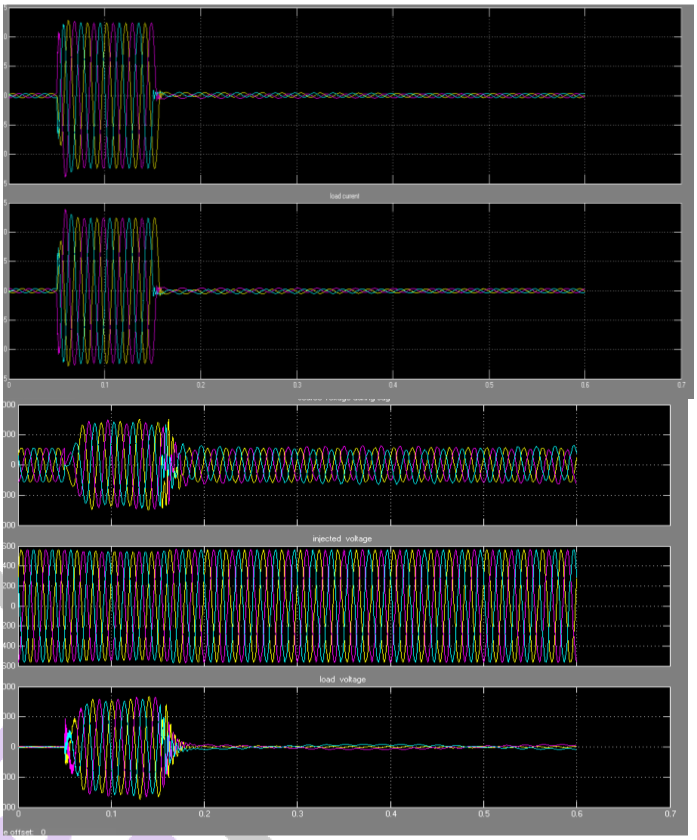
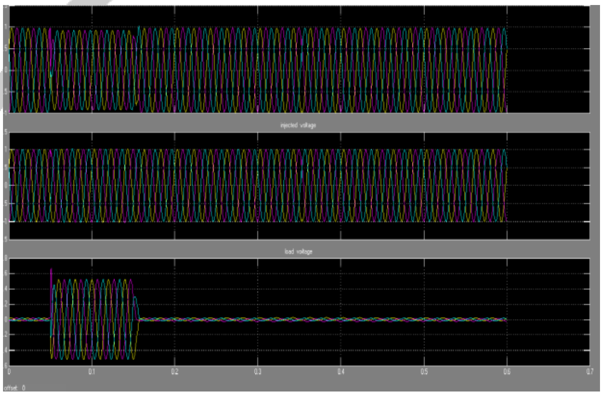


Fig .shows real and reactive power injected by DVR

6.2.2 FOR VOLTAGE SWELL WITH RL LOAD CONDITION

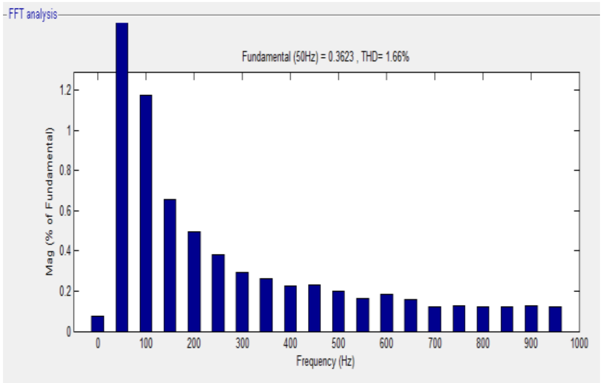
The performance of the DVR with RL LOAD voltage swell is shown in Figure 5.4 In this case inductive power should be kept zero so swell is created.55% voltage rises due to this condition The anti phase unbalanced voltage component injected by the DVR to correct the load voltage is shown in Figure 5.4 (b) and the load voltage is in figure 5.4(c) In LC load conditions simulation the total harmonic distortion with swell is 0.12%.



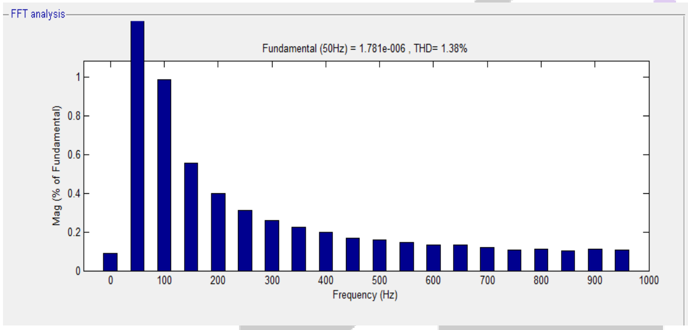
The switching on of power electronic devices produce the harmonics in the system. In this simulation the total harmonic distortion with sag is 1.66%.

6.2.3 FOR VOLTAGE SWELL WITH LC LOAD CONDITION

The performance of the DVR with RL LOAD voltage swell is shown in Figure 5.4 In this case resistive power should be kept zero so swell is created.5% with transitions voltage rises due to this condition The anti phase unbalanced voltage component injected by the DVR to correct the load voltage is shown in Figure 5.4 (b) and the load voltage is in figure 5.4(c) In RC load conditions simulation the total harmonic distortion with swell is 1.38%.



The switching on of power electronic devices produce the harmonics in the system. In this simulation the total harmonic distortion with sag is 1.38%.



Conclusion :
It was observed that is the output voltage of the DVR in series with the system, the harmonic component of is very low and the total harmonic distortion is within 2%.The DC side capacitor voltage can be maintained about 400 V,. The duration of voltage sag is 0.1 s, and the magnet delivers about 781.25 J of energy

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