MITIGATION OF POWER QUALITY PROBLEM DUE TO STARTING OF INDUCTION MOTOR

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Abstract

Power quality problems such as voltage sag which is to be generate effect on industrial distribution system. In this paper analyses the application of custom power devices using dynamic voltage restorer for mitigation of power quality problems voltage sag due to starting of three phase induction motor.contol strategies for DVR is based on dqo transformation feed forward control techniques. DVR to have less THD In distribution system. the propose control scheme simulation results carried out by MATLAB Simulink. The result shows that although period of voltage sag and rating of the load changes even then voltage sags are totally compensated.

Keywords: *Voltage sags, power quality, dynamic voltage restorer, THD, custom power device.*

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1. INDRODUCTION

Now days Power quality is most important issue in all over the world.it must required to mitigate power quality problems for better power output. Power quality is define as maintain the quality between voltage supplied from the electric power system and end use equipment. Now in system uses of power electronics equipment's is increase due to this system is sophisticated about power quality.it must need to improve power quality.

Voltage sag is power quality disturbance in which reduction of voltage for short time. Reduction of the voltage is between 10% and 90% of the normal root mean square voltage at 50Hz.the duration of voltage sag is less than 1 minute but more than 8 milliseconds (0.5 cycles).[2]Voltage sag due to starting of three phase induction motor generated huge impact in industrial distribution system such as unwanted tripping of protective devices, sensitive load. because three phase induction motor consume high current at starting. due to voltage sag results huge economical losses. many researches have been developed different methods to mitigate voltage sags.[1] But use of a custom power device is considered to be most efficient method. the concept of custom power was introduced by N.G.Hingorani in 1995 like flexible AC transmission system for transmission system the term custom power pertains to the use of power electronics controllers in distribution system[4].

Distribution static compensator and dynamic voltage restorer both device are custom power device which is based on voltage source converter principle. The effectiveness of the D- STATCOM is limited because they can only reduce voltage sag duration or increase the remaining voltage level during voltage sag event-STATCOM is compensated voltage sag partially and motor rating is changed compensation effect is also change.[1],[5],[14].DVR is best compensation custom power device which compensate the missing voltage and maintain its compensation effectiveness as motor rating changes.

2. DVR MODEL

Dynamic voltage restorer is series connected compensation device which designed is such that maintain voltage at load side at voltage sag duration and with less total harmonics distortion. following is basic diagram of DVR with main components[9]

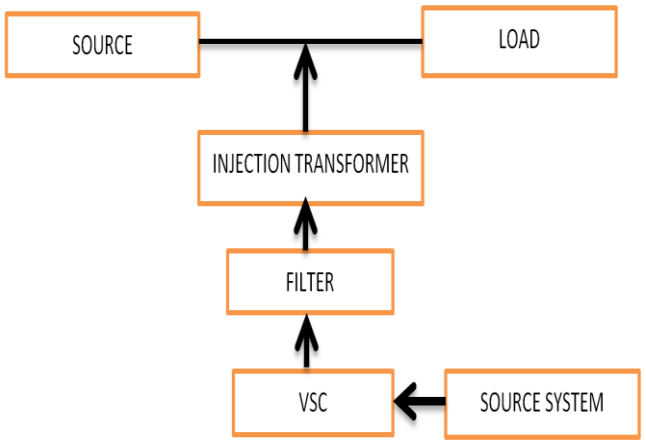

Fig-1 Basic block Diagram of DVR model

1) An injection transformer
2) A harmonic filter
3) A voltage source converter
4) Source system
5) A control system

1. Injection transformer- Injection transformer is connected in series with line which to be compensated. Injection transformer is three phase two winding transformer and it can also called as coupling transformer. Function of the injection transformer injects voltage supplied by voltage source converter. the injection transformer rating is most importance factor for the DVR performance calculation[9].

2. Hormonics filter- In DVR high frequency power electronics switching devices are used due to these devices are generation of harmonics in output voltage which is supplied from VSC.hence it should be necessary eliminate hormonics.filter are used. These are installed at inverter side of injection transformer due to this higher order harmonics are prevented.[9]

3. Voltage source inverter-Voltage source inverter which based on SPWM techniques. IGBT is used as switching device which is firied from sinusoidal pulse width modulation generated pulses. VSC is generated three phase injected voltage by IGBT switching operation[9].

4. Source system The propose is to supply the necessary energy to VSC via a dc link for generation of injected voltages. Energy storage may be use batteries, wind generated power, solar system and flywheels etc. Rectifier is used for AC-DC conversion on the basis of IGBT switching device

5. Control system-Control system is heart of DVR in Control system Sinusoidal Pulse width modulation is used for pulse generation on basis of transformation techniques. The inverter is generated injected voltage by using IGBT switching device

3. CONTROL METHODOLOGY

It is consist of generation pulses by using SPWM techniques based on dqo park transformation feed forward control techniques.in which transform the V_{ref} voltage and V_{s1} voltage from abc to dqo because simple calculation in DC components.futher comparison of both the signal and generate the error signal which used as modulation signal that allows generating a commutation pattern for power switches IGBT's cosistituting the voltage source converter, the commutation pattern is generated by means of the sinusoidal pulse width modulation techniques.[1]

$$\begin{bmatrix} V_d \\ V_q \\ V_o \end{bmatrix} = \begin{bmatrix} \cos(\theta) & \cos\left(\theta - \frac{2\pi}{3}\right) & 1 \\ -\sin(\theta) & -\sin\left(\theta - \frac{2\pi}{3}\right) & 1 \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \end{bmatrix} \begin{bmatrix} Va \\ Vb \\ Vc \end{bmatrix}$$

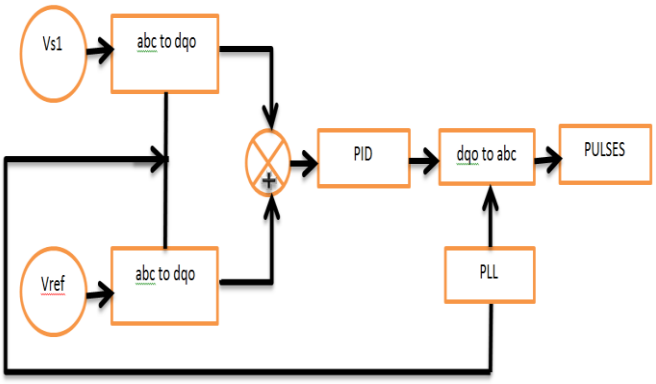

Fig-2 Control Methodology of DVR

Above equation shows the transformation of abc to dqo[5],[6],[8]. DC components calculation is easy as compare to AC components. This transformation which most useful for generation of error signal. Above block diagram shows that control methodology of DVR[1].

4. MODELLING FOR DISTRIBUTION LINE WITH DVR:

Following is proposed model of DVR in MATLAB.in which a one feeder of power distribution is consider and simulated the simulation results are presented on basis of that network for the performance of DVR. The faults is created manually for some period and various results during such condition are carried out.

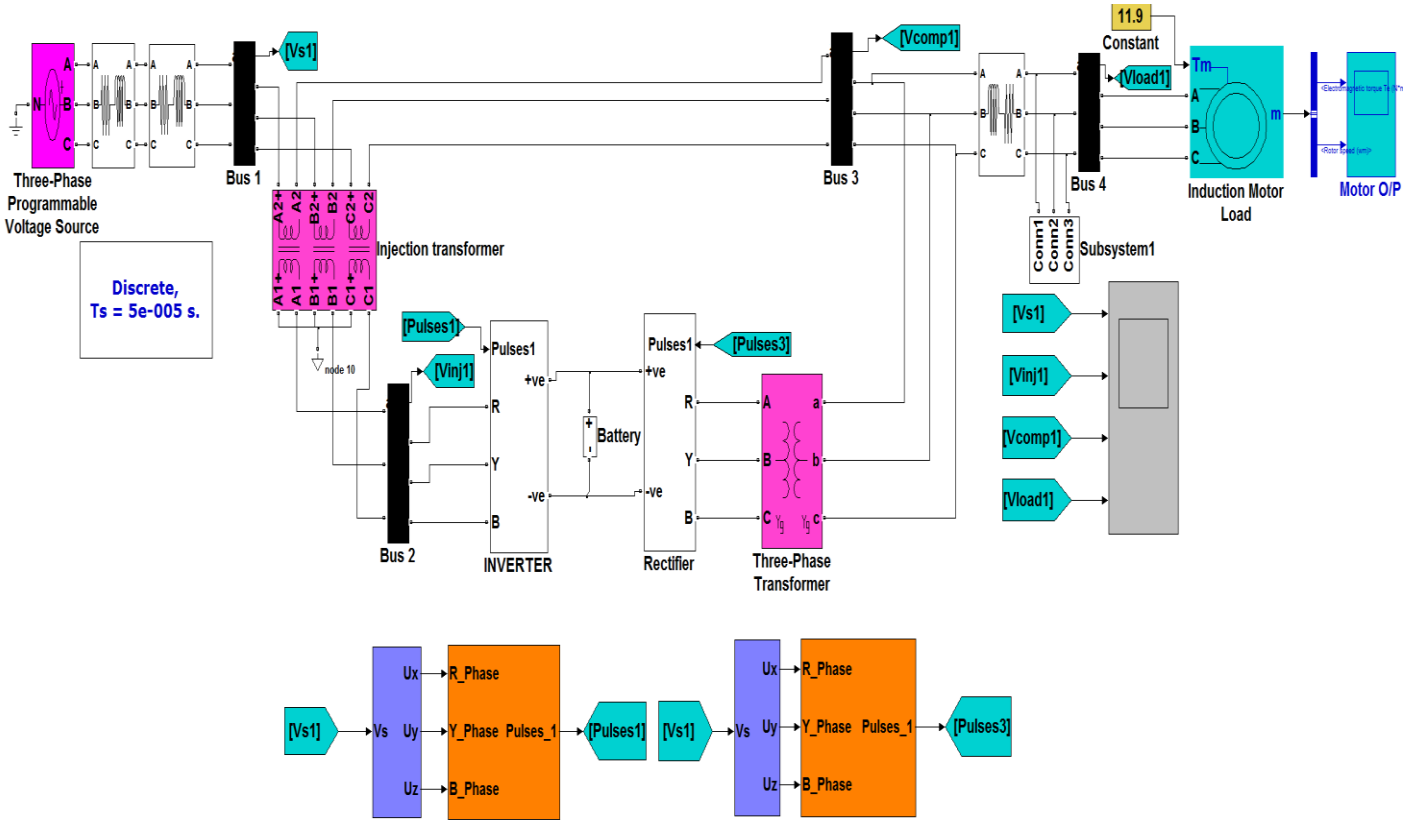

Fig-3 MATLAB simulation model of DVR

5. SIMULATION RESULTS

Following are simulated results with DVR and without DVR.for voltge sag duration from staring time 0.4 to end time 0.6 in sec with 5.4 HP three phase induction motor.

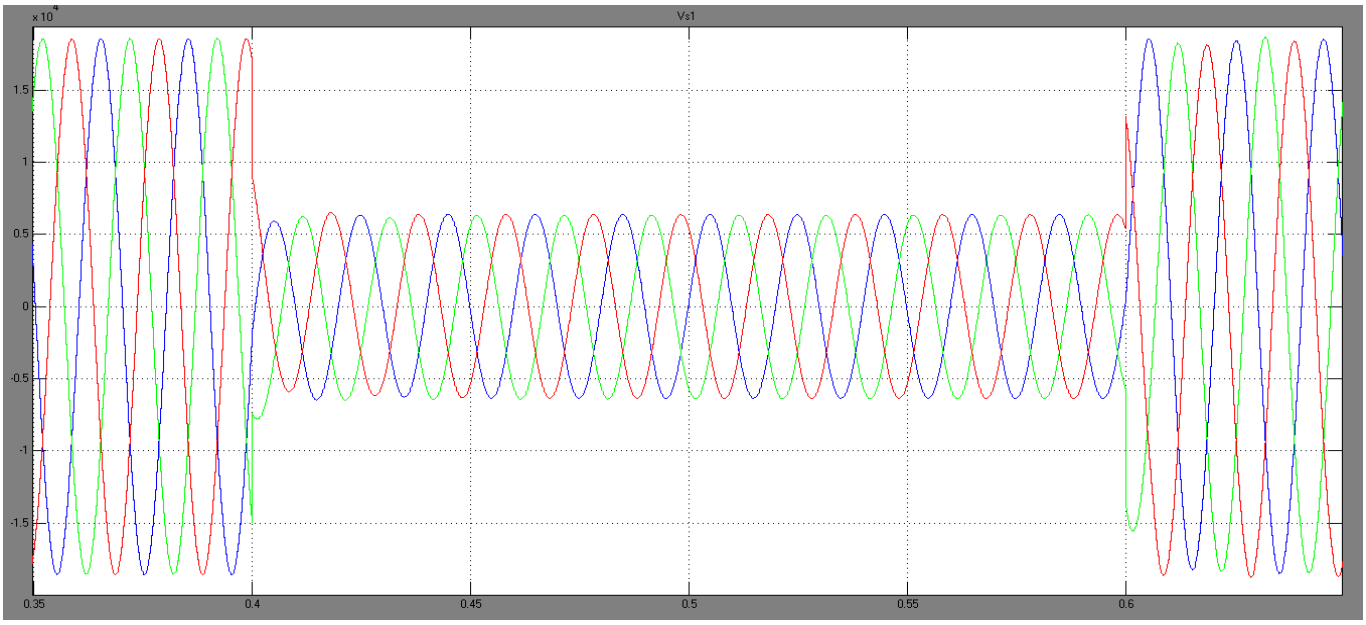

Fig-4. Voltage across source side without DVR

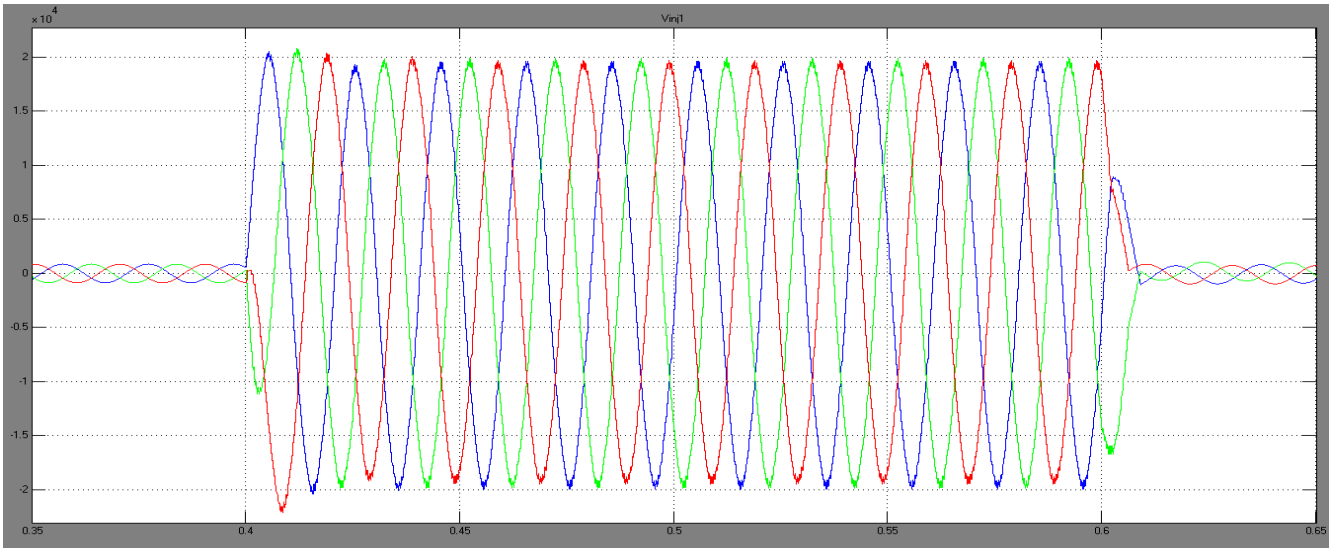

Fig-5. Injected voltage waveform

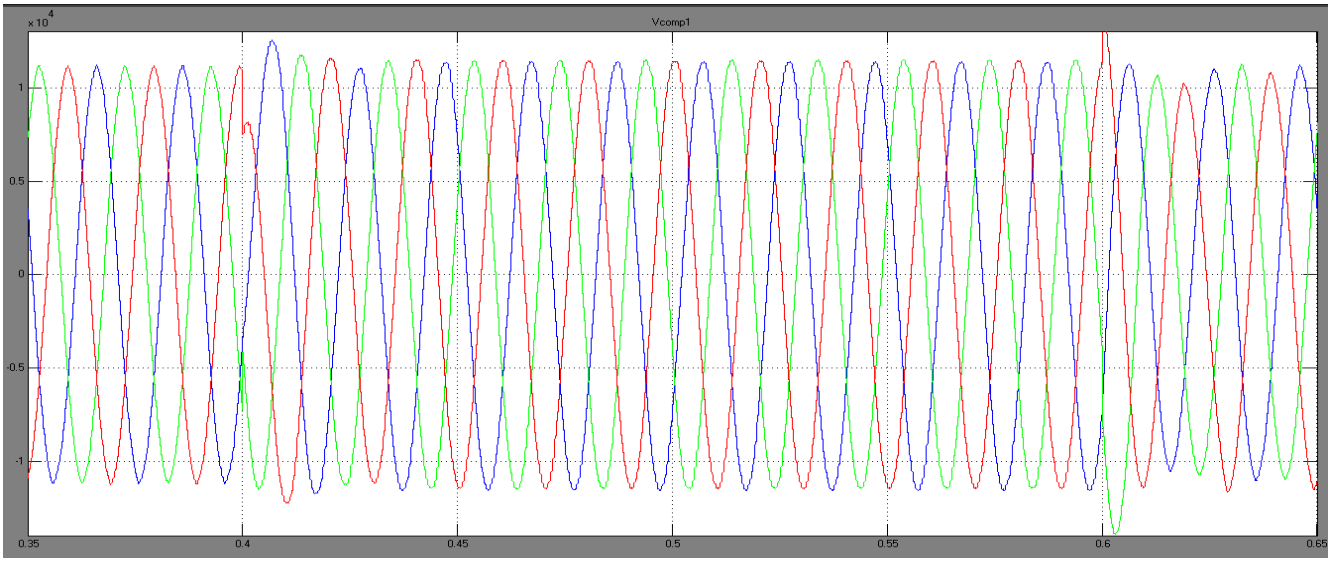

Fig-6. Compensated voltage waveform.

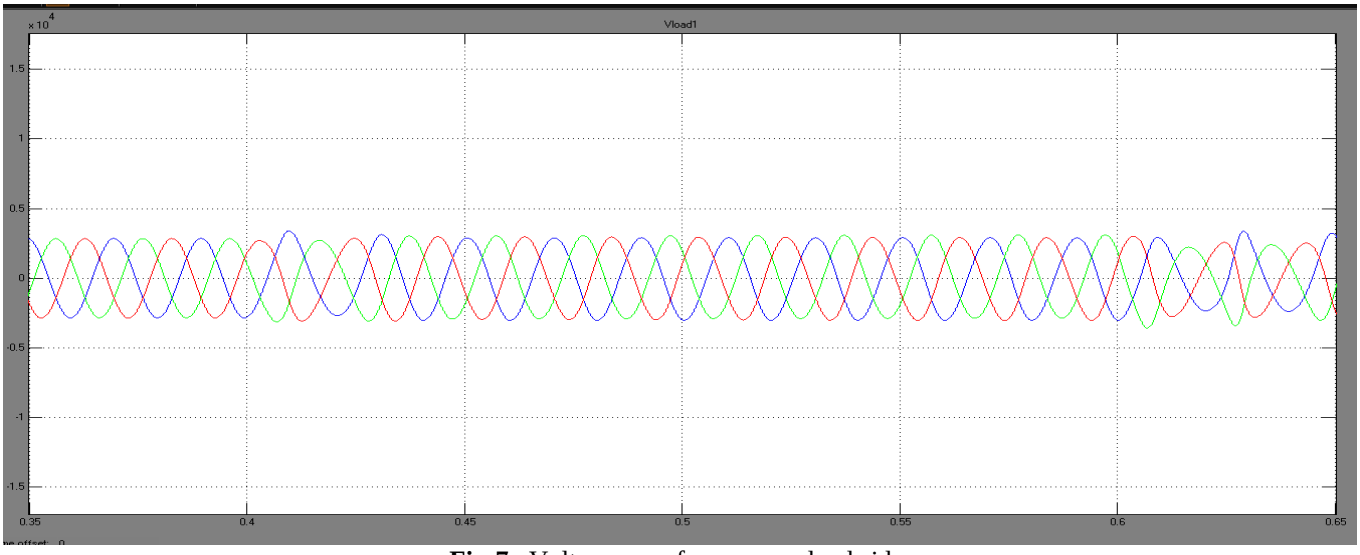

Fig-7. Voltage waveform across load side.

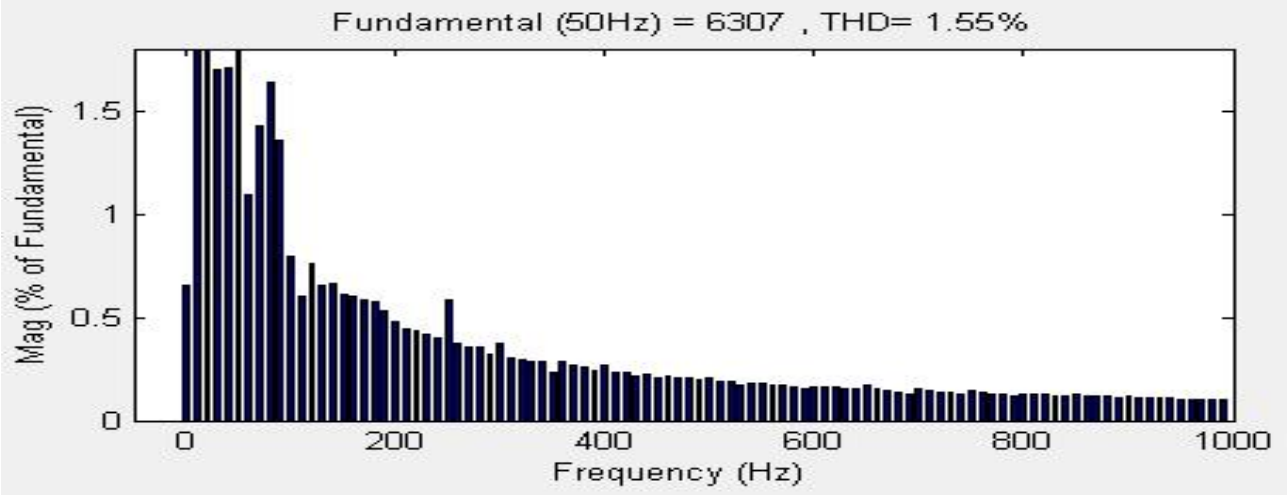

Fig-8. Source side voltage THD

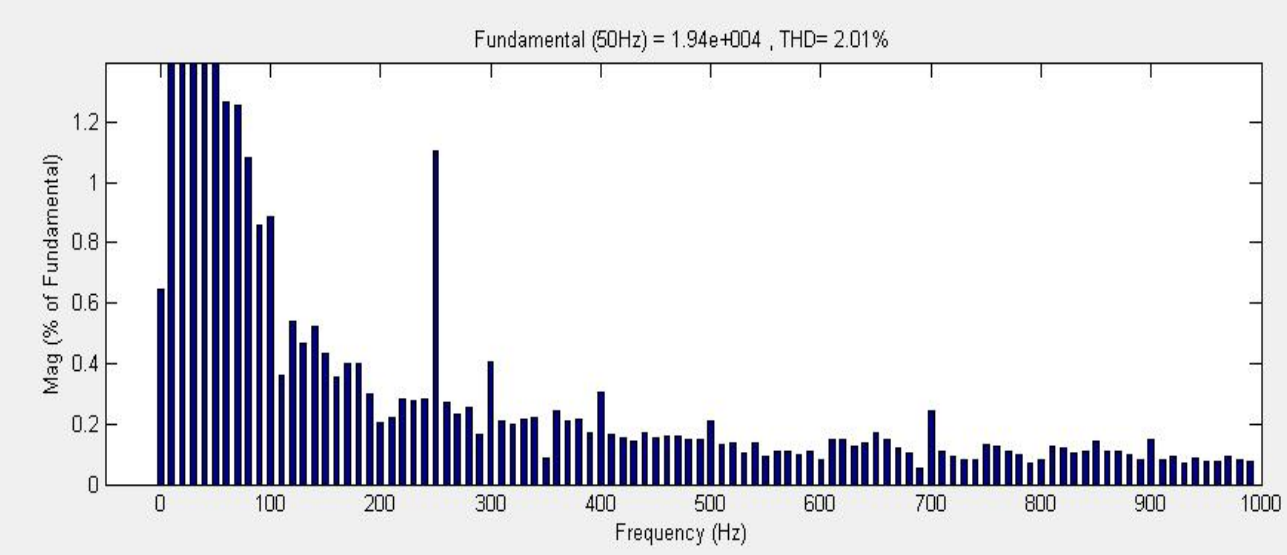

Fig-9. Injected VSC voltage THD

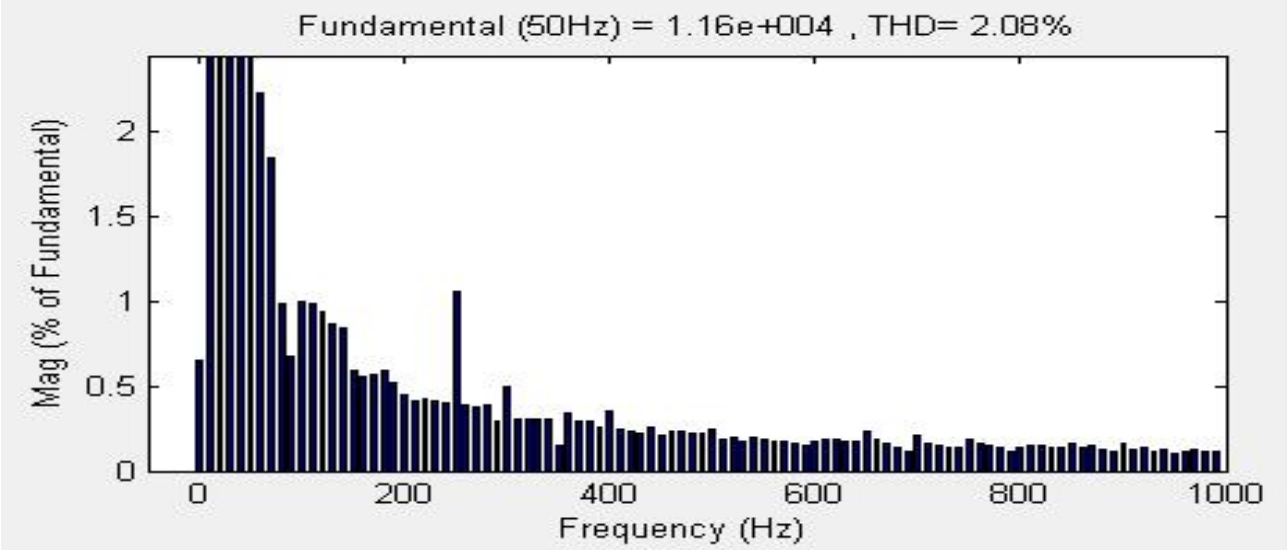

Fig-10. Compensated voltage THD.

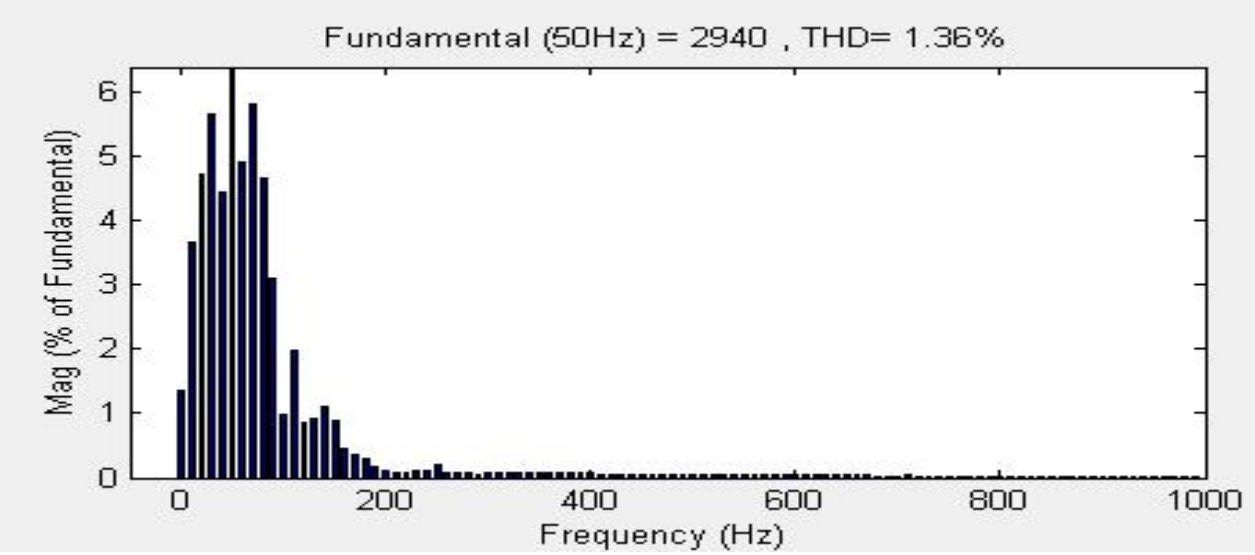

Fig-11. Load side voltage THD

Following are simulated results of DVR.for voltage sag duration from staring time 0.5 to end time 0.8 in sec with 5.4 HP three phase induction motor

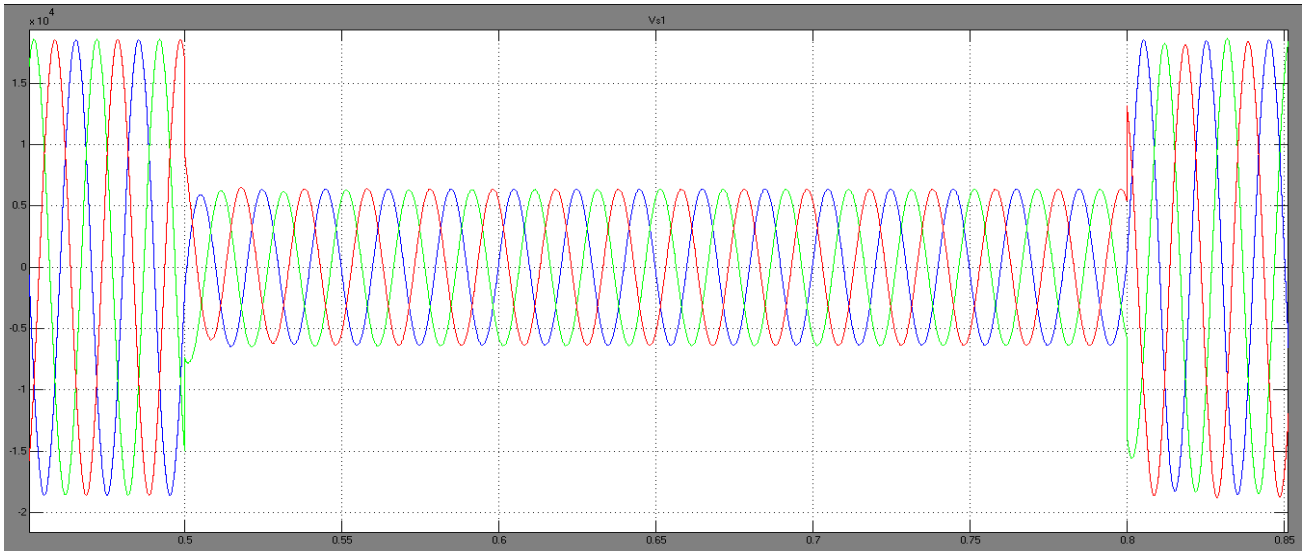

Fig-12. Voltage waveform across source side

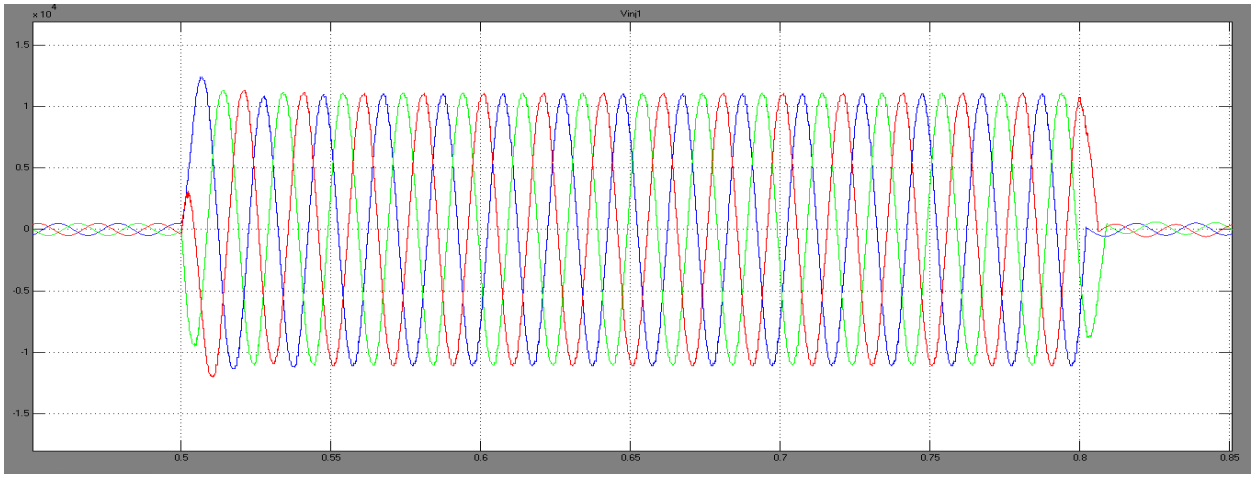

Fig-13. Injected voltage waveform

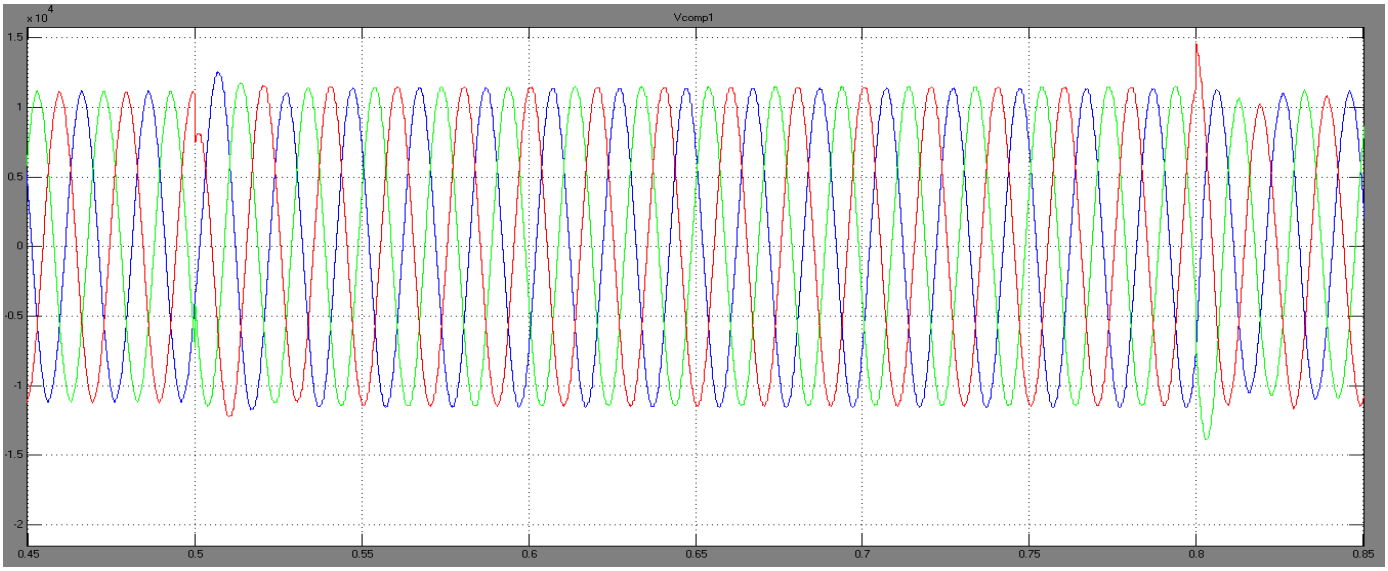

Fig-14. Compensated voltage waveform.

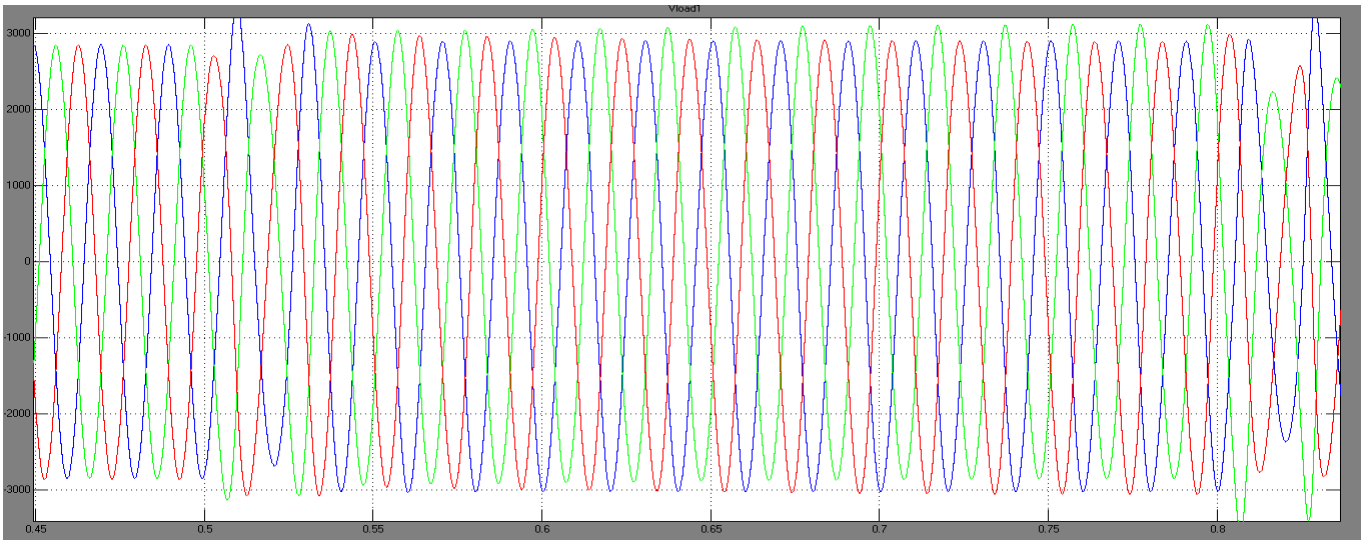

Fig-15. Voltage waveform across load side

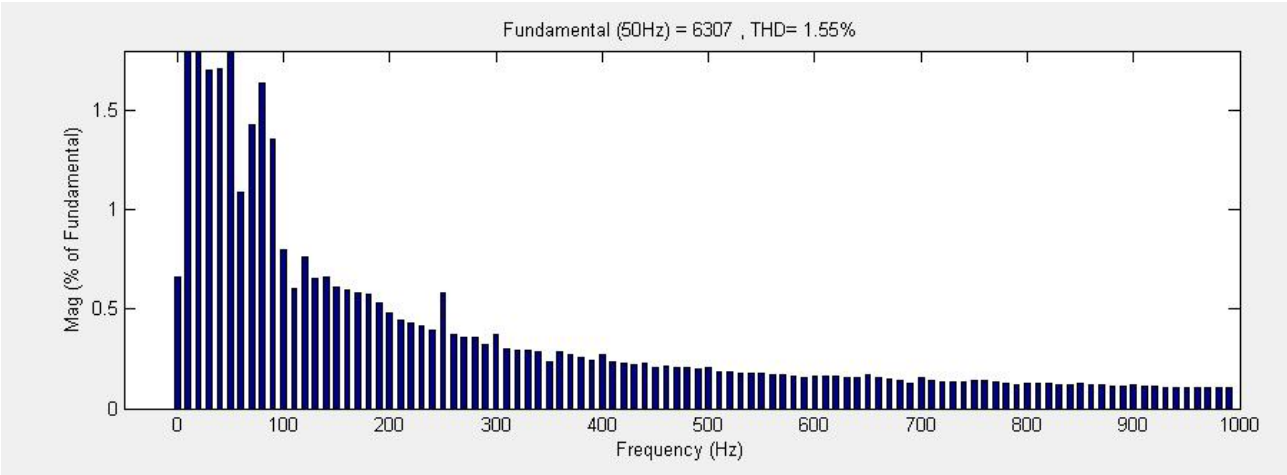

Fig-16. Source side voltage THD.

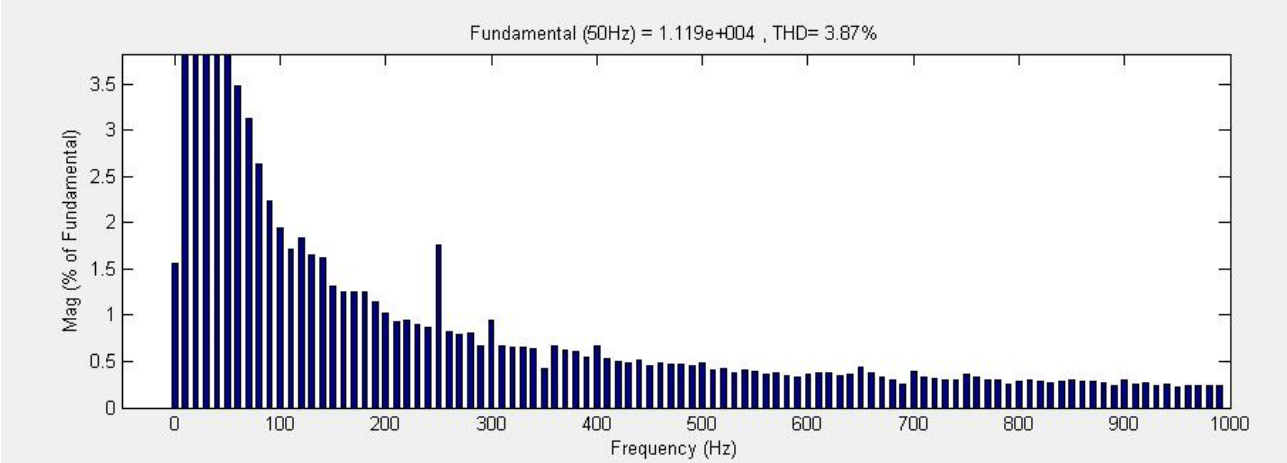

Fig-17. Injected VSC voltage THD.

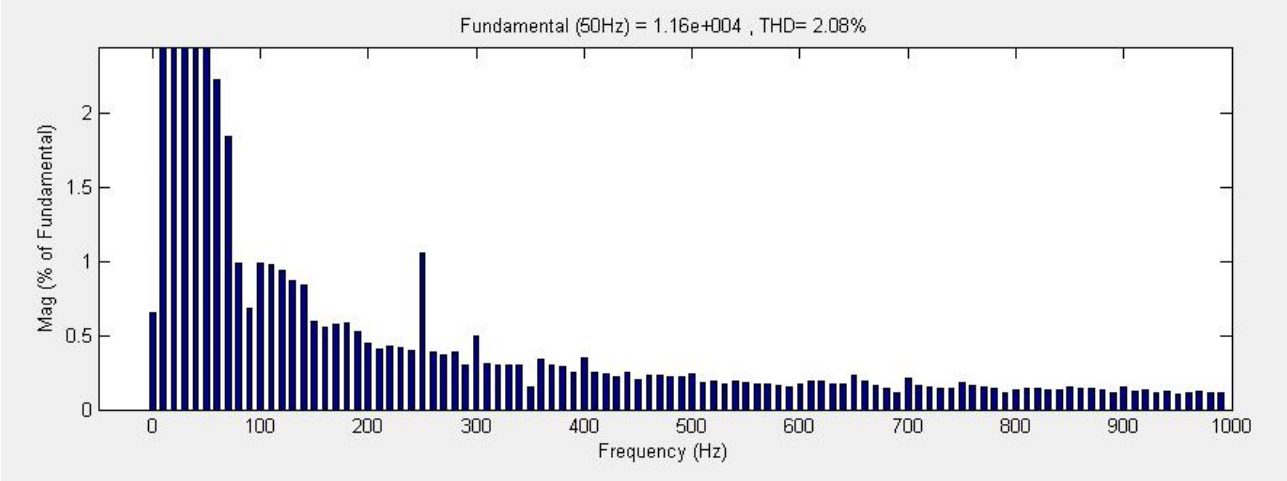

Fig-18. Compensated voltage THD.

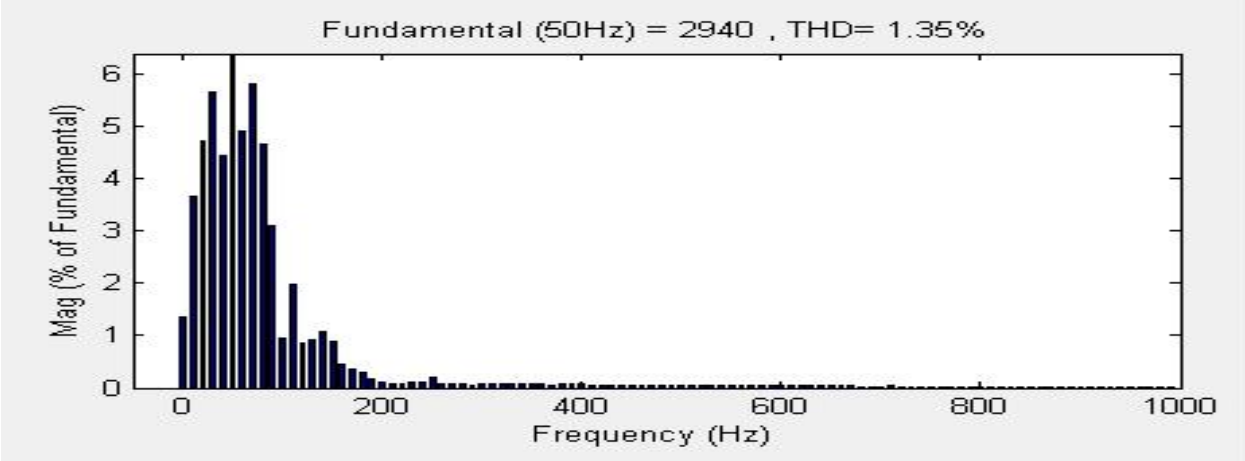

Fig-19. Load side voltage THD

Table-1 Comparison table of system

Motor Rating	Sag duration(sec)	THD(%)for source side(5 cycles)	THD(%)for load side(5 cycles)
5.4 HP,400v,50Hz	0.4 to 0.6	1.55	1.36
	0.5 to 0.8	1.55	1.35

6. CONCLUSION

Power quality problems voltage sag is not new in distribution system when three phase induction motor starting. this paper is present solution for mitigating the voltage sag due to starting of three phase induction motor by using effective custom power device DVR.the simulation is carried out by SPWM techniques. results is clear that the period of voltage sag and rating of the load changes even then DVR is totally compensated with minimum total harmonics distortion.

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