Active Power Filter (SAPF) for Migration of Harmonics Caused by Nonlinear Loads

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***Abstract*— There are different compensating devices whichare generallyused in the casefilteringsystem oftheactivepart, balancing of the load as well as the correction in the caseof the power factor while the regulation of the voltage can alsobe possible. The active power filters are used for the purpose of the elimination of the harmonics system and used for the case of the connection for the series as well as the shunt system. The present work is related to the electrical distribution system where the increasing condition for the single phase is very sudden as well as the loads considered to be linear as well as the non-linear. The voltage stabilizer when used for the case of the overcoming certain drawbacks related to the distribution system then the development of the active power filter has very crucial role to be played. The objectives of the present work consisting evaluation of the performance related to the voltage stabilizer for the different conditions of the active power filter.**

Keywords—active power filter, harmonics, voltage stabilizer and power devices

I. INTRODUCTION

The power quality is a kind of consideration when wave form for the quality of the voltage or the supply voltage, some times in the case of quality of the current or load current which is most of the time varying from the waveform whichis sinusoidal in nature . In this case the amplitude is to be interms of the rated value of RMS in the case of three phase system and also for all the three phases having the frequency just to be rated and have the amplitude. There can be the disturbances in the quality of the power and that includes because of different situations and the variation like transients which can be either impulsive or sometimes oscillatory while there can be sag in voltage there can be interruptions like deviation in the steady-state. Jharkhand the disturbances related sometimes with the supply voltage quality as well sometimes with the current of voltage considered by the load.

That can be reduced in the voltage as well as sometimes interaction can occur and the causes related to it are for the case of false in the system of power. Responses are related with the tracking system when the equipment which is electronic is sensitive and sometimes has consequences particularly with the power plants. The tripping operation sometimes faults in the equipment which are critical and because of which the total production system can be stopped there off of the cost it is also to be borne. Sometimes it is said that that could be the disturbances in the load because of the source. This kind of losses can be avoided the customer want to install some kind of equipment which are the mitigation purpose so that the could be less chances of the disturbance and plant can be protected.

The phenomenon related to the second class is because of the very poor quality in the case of current which is to be considered because of the load. In such cases the load is responsible for the disturbances in the source. The current harmonics the kind of example where there is to be the rectifier of the diode sometimes the currents which are usually not balance and they are drawn by loads that also not balanced. The customers really do not have any problem related to the loss in the production directly when there could be occurrence in the case of power quality.

It is observed that the electrical distribution system have the cases related to the increasing single phase system as well as the load related to the nonlinear available in three phase system. The present study deals with the voltage stabilizer with the help of series active power filters which out to be considered so that the problems related to the disturbances can be overcome. The objective of the present work consists of the summarization related to the problem power quality as well as its solution. Some of the objective also involves evaluation of the performance related to the voltage stabilizer which is to be modeled using the software consideration of the active power filters.

II. LITERATUREREVIEW

The authors studied a combined system related to the passive filter system as well as active filter system which are hand rated with the small intensity and the connection is to be connected with the series. It is observed that the passive filter have considerable removed the load which is obtained because of the harmonics in the similar way like the conventional system works. Wild the active filter produced and improved the characteristics related to the passive filter with proper filtering system.

The work has been carried out related to the different trends in the case of active power line conditioners. This terminology related to the active power line with the conditioners where it is having the similar conservation dislike the active power filter. Search kind of active power line conditioners behaves in the similar way just like the active power filter. Author studied the shunt active power line conditioners where it have observed that it can be expanded from the regulation of the voltage or even in the case of compensation of liquor in the terms of a good improvement for the case of stability of power.

Characteristics of the case of active power filter which is three phase system as well as the performance related to it which is to be operated in the case of frequency which is to be switching type and need to be fixed have been observed and studied by the author. The proposed system consists of pwm inverter source with the voltage and has the importantcharacteristicsintwo numbers.

The active power filter on certain new trend which has been identified in the case of power conditioning and has studied by the author. It is observed that when there is there regulation of the voltage in the case of compensation for the balance of the flicker of the voltage in that case the reactivecurrent which is fluctuating the nature or the compensationof the current which is negative sequence have been studied. The compensation for the case of harmonic and even isolation in the case of harmonic and damping in the case of harmonic have also been studied by the author.

Enquiry of the electric power and its improvement havebeen studied with the help of of series active filter as well as the shunt passive filters. It's observed that to the help of simulation switch off win obtained through the the software of matlab. When there are loads and the variation have been carried out for the case of the impedance in the source. Where is the development for the case of prototype obtained through the analysis on the matlab software. Results obtained through the simulation process of experimentation process have been studied by the author.

The researchers have performed the quality of the powerand improvement related to it with the help of active power filter which is hybrid in nature and it is in series. When there is a white noise which is additive in nature and the losses related to the switching while the distortion is also observed when there is a source current as well as the voltage of theload. It is observed that the method of SRF is very good in the case of generation. The main feature which is observed it is the method of controlling the structure which radiation it is found that the reduction in the distortion error can be tracked, chatting can be surprised as well as noise can be suppressed.

III. POWERQUALITYANDCUSTOMER POWER

Issue related to the quality of power can be defined thatmanifestation for the occurrence in the case of current orvoltage or even frequency with the divisions involved in itand finally the results of third in terms of the failure orsometimes damages and kind of malfunctioning which is thelatest place in the equipment. The power quality issues interms of the field of power electronics and that consists ofapplicationsrelatedtoindustryaswellasdomesticandcommercial. Equipment when used with the effect of powerelectronics and that kills there are appliances like TV andPC, etc. Power electronics is related to the causes in terms ofharmonics the notches as well as in the harmonics and apartfromthatcurrentswhichareneutral.Theharmonicsareusuallyobservedbecauseofrectifiersoftstarterspowersupplieswhichswitchmodecase.

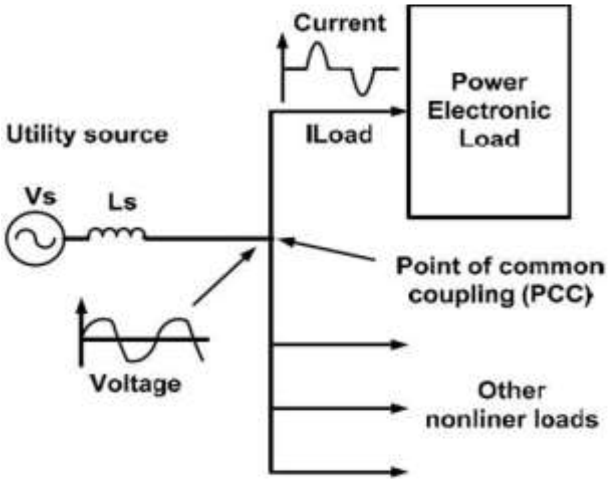

Fig.1.HarmonicproblemsatSourceside

The critical problems related to the harmonics in the case of power system which are electrical in nature are generalized. The distribution system of the power has the harmonics and that are related to the voltage as well as current considered to behave the frequency with the fundamental nature and integer multiplies related to it. It is found that there is no distortion as well as no harmonics in that case the pure voltage or the current is obtained while the wave which is not sinusoidal in that case the distortion as a less harmonics is present.

A. *Modellingofseriesactivepowerfilter*

Reliability is generally used for the case of utilities as well as the customers while when the company which is operating for the competition then this reliability is very important as this is responsible for the profit of the business and considered as the driving energy in the industrial plants. The system of transmission system as well as the distribution system is considered to be having a good reliability while there are a very few disturbances present. Active power filter in series is considered to be the device having the good quality of the power and usually this protect from the disturbances likes ac sin the voltage as well as in the voltage which are related for the faults of are mote system.

B. *Principleofoperation*

The active power filter is considered to be a good story so that the improvement in the quality of the power for the case of distribution network in the electrical system is improved. The series active power filter system how the function related to the protection against the the loads which are coming out from the supplying of harmonics or voltage swell or voltage sag. The schematic diagram of the series active power filter is shown in the figure number2.

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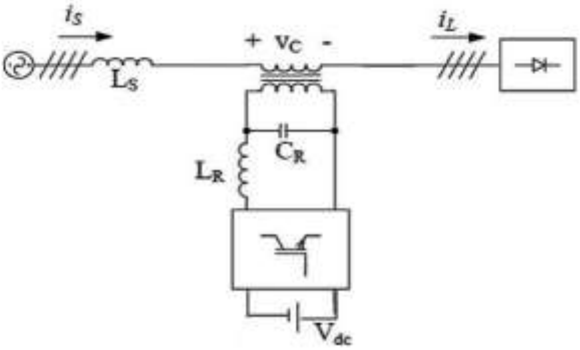

Fig.2.Schematic diagram of series active filter

The control scheme of the series APF for the case of transient stability where the improvement in the power system is obtained and it is shown in the figure number2.

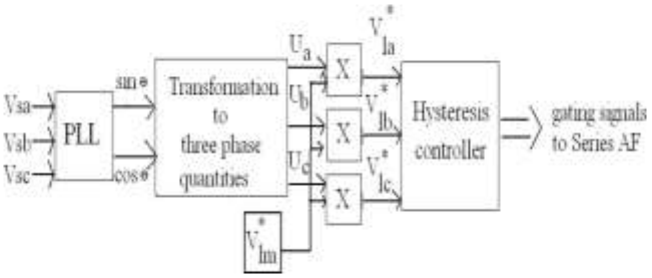

Fig.3.Control Scheme of Series APF for transient stability improvement of power system

IV. Reference Voltage Generation and Hysteresis Voltage Controller

The supply voltage is considered to be not balanced and mostly it is distorted and therefore phase locked loop is very important for achieving the synchronization in related to the supply. This process is related to the conversion of the input voltage which is distorted into the pure supply which is is with the three phase system having sinusoidal nature why the RMS value for the every phase is equivalent to the fundamental value.

$$\begin{bmatrix} u_a \\ u_b \\ u_c \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ -\frac{1}{2} & -\frac{\sqrt{3}}{2} \\ -\frac{1}{2} & \frac{\sqrt{3}}{2} \end{bmatrix} \times \begin{bmatrix} Sin\theta \\ Cos\theta \end{bmatrix} \quad (1)$$

$$\begin{pmatrix} V_{la}^* \\ V_{lb}^* \\ V_{lc}^* \end{pmatrix} = V_{lm}^* \begin{pmatrix} u_a \\ u_b \\ u_c \end{pmatrix} \quad (2)$$

There lay function parameters have been simulated in the mat lab software and it is shown in the figure number 4.

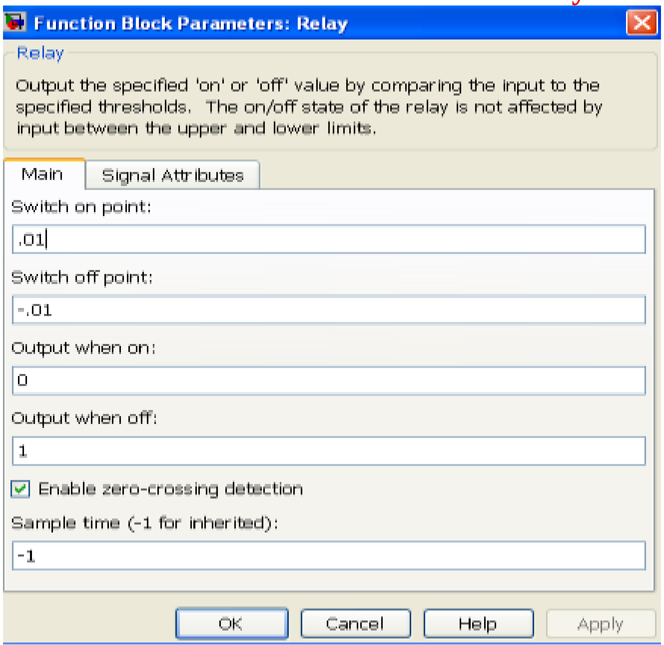

Fig.4.Relay function parameters

The obtained respect to pulses for the case of a upper switch leg1 of SAPF as shown in figure 5.

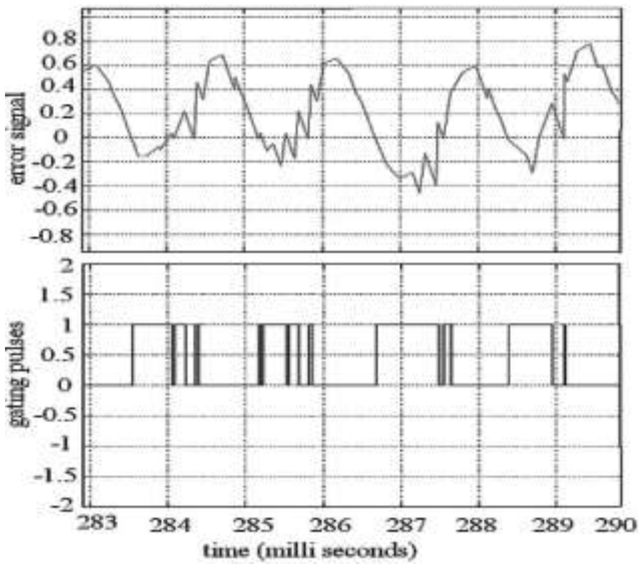

Fig.5.Error signal & PWM pulses generated for the1st top leg of SAPF

V. ProposedMATLAB SimulationModel

The series active power filter generally ne how the configuration and approach is related to the principle based on the injecting voltage which are in series and also in line for the case of transformer injection so that the cancellation of the disturbances in the voltage is obtained so that the voltagesinusoidalbecomesloadside.

The figure number 6 shows the proposed complete matlab simulation model.

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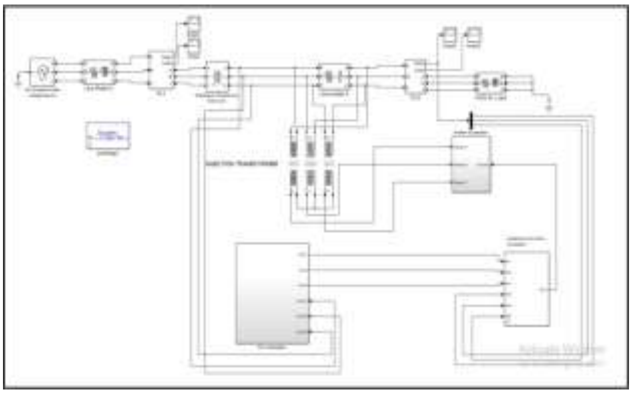

Fig.6.Proposed complete mat lab simulation model

Figure number 7 shows the three phase 6 pulse inverter sub-system with the mat lab simulink model.

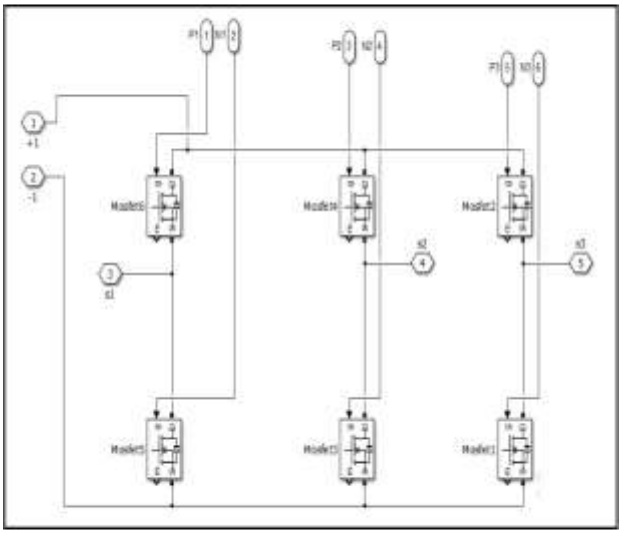

Fig.7.Three phase six pulse inverter sub system matlab simulink model

VI. SIMULATIONRESULTSFORNORMALRLLOAD

A. Case1 voltagesag

Figure 8 shows the three phase transmission line in voltage or source side voltage during voltage sag.

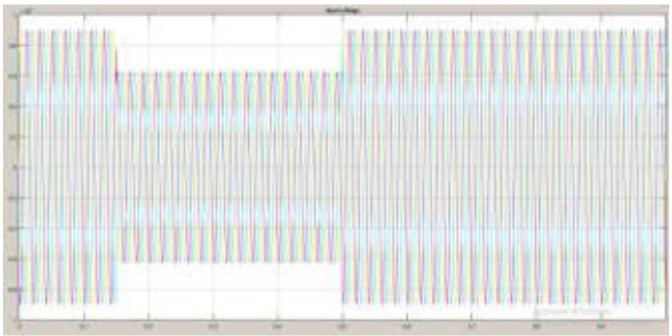

Fig. 8.Three phase transmission line send end voltage or source side voltage during voltage sag

Figure 9 shows three phase transmission line sending end current or source side current during voltage sag.

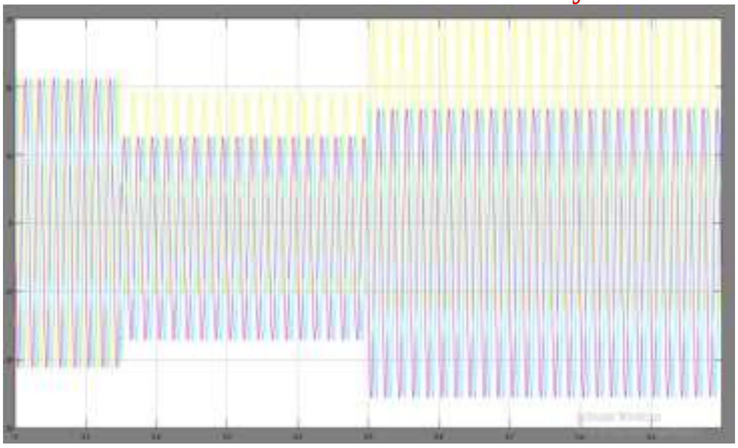

Fig.9.Three phase transmission line sending end current or source side current during voltage sag

Figure 10 shows; three phase transmission line receivingendvoltageorload sidevoltageduringvoltagesag.

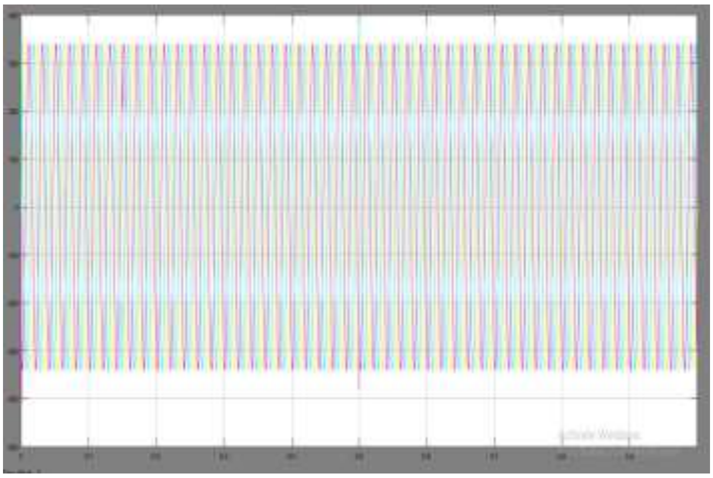

Fig.10.Three phase transmission line receiving end voltage or load side voltage during voltage sag

The figure 11 shows the three phase transmission line receiving any current or load side current during voltage sag.

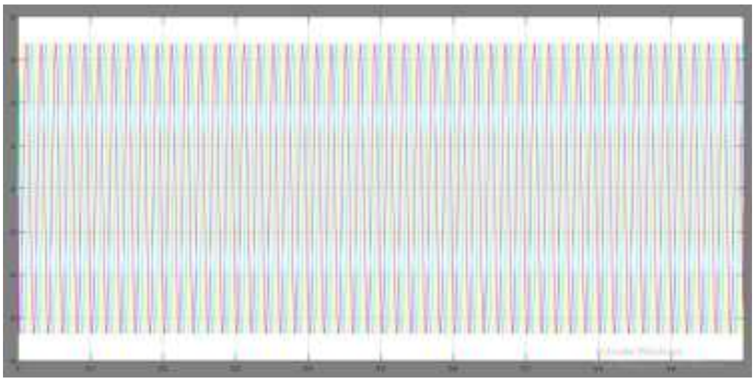

Fig. 11. Three phase transmission line receiving end current or load side current during voltage sag

The following figure 12 shows sending in transmission line voltage FFT analysis for the total harmonic distortion during voltage sag.

Fig.12.Sending end transmission line voltage FFT analysis for Total Harmonics Distortion (THD) during voltage sag

Following figure 13 shows receiving and transmission line voltage FFT analysis for total harmonic distortion during voltage sag.

Fig. 13. Receiving end transmission line voltage FFT analysis for Total Harmonics Distortion (THD) during voltage sag

B. Case 2 voltage swell

Following figure 14 shows three phase transmission line send in voltage or source voltage during voltage swell.

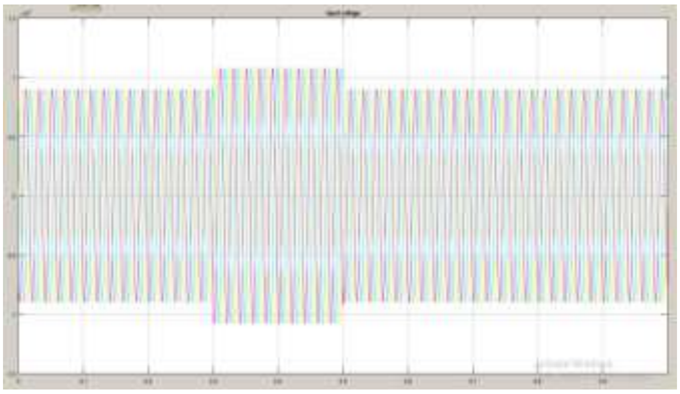

Fig.14.Three phase transmission line send end voltage or source side voltage during voltage swell

The following figure 15 shows three phase transmission line receiving end current or source side current during voltage swell.

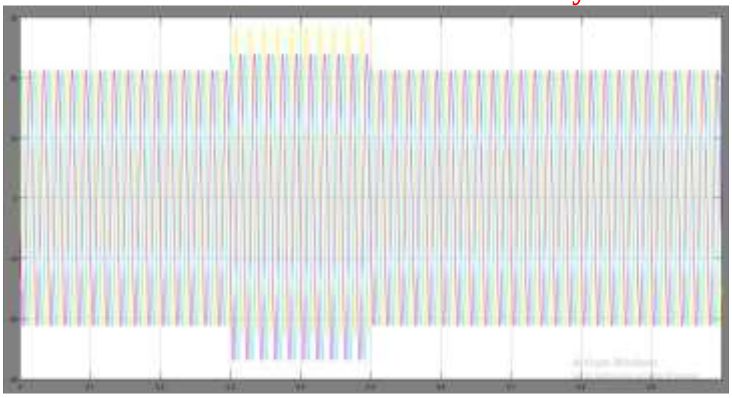

Fig.15.Three phase transmission line receiving end current or source side current during voltage swell

Following figure 16 shows three phase transmission line receiving end voltage or load side voltage during voltage swell.

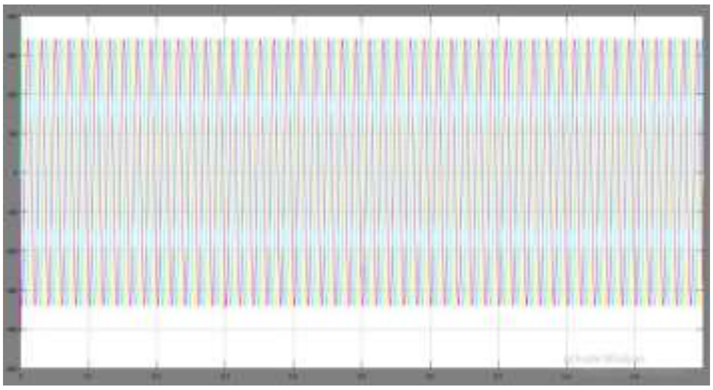

Fig.16.Three phase transmission line receiving end voltage or load side voltage during voltage swell

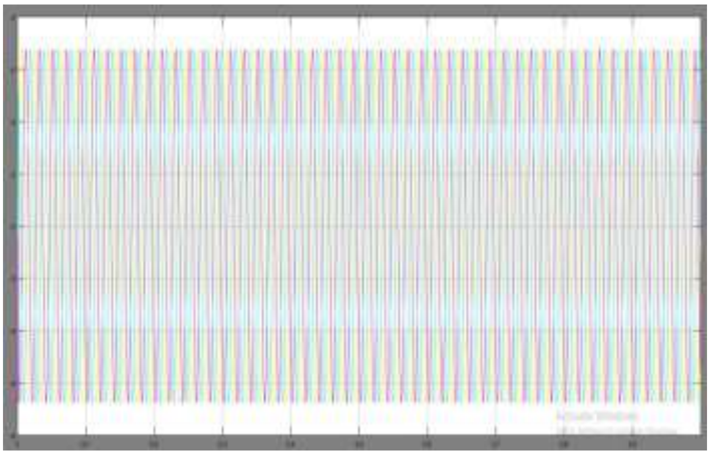

Fig.17.Three phase transmission line receiving end current or load side current during voltage swell

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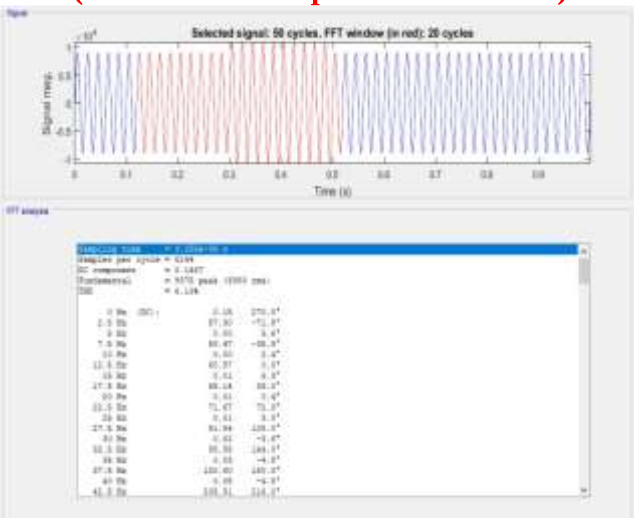

Fig.18.Sending end transmission line voltage FFT analysis for Total Harmonic Distortion (THD) during voltage swell

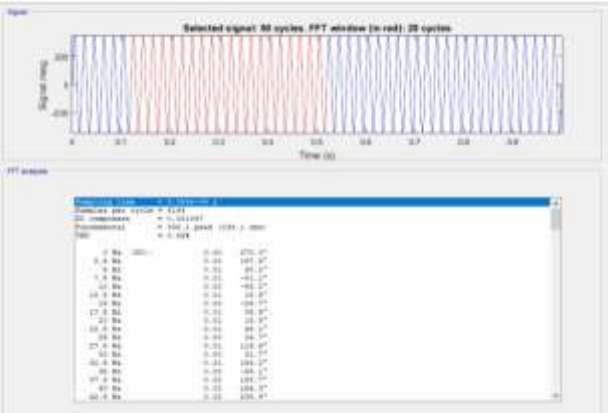

Fig.19.Receiving end transmission line voltage FFT analysis for Total Harmonics Distortion (THD) during voltage swell

C. *Case 3 short duration fault*

The following figure 20 shows three phase transmission line receiving end current or source side current during short duration LG fault.

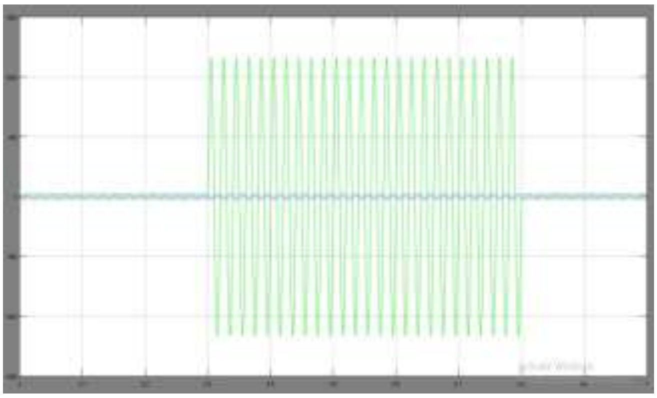

Fig.20.Three phase transmission line receiving end current or source side current during short duration LG fault

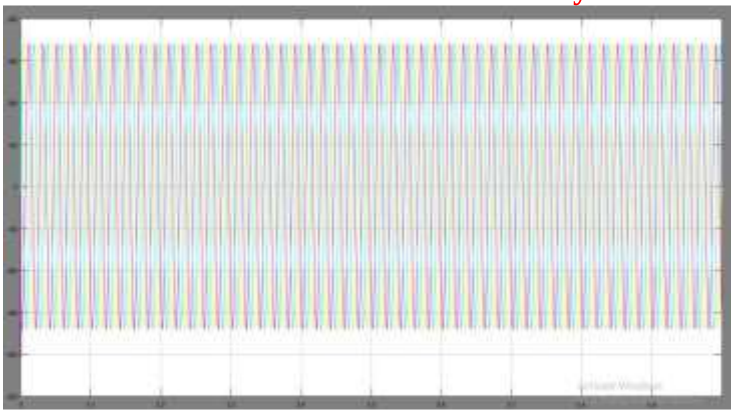

Fig.21.Three phase transmission line receiving end voltage or load side voltage during short duration LG fault

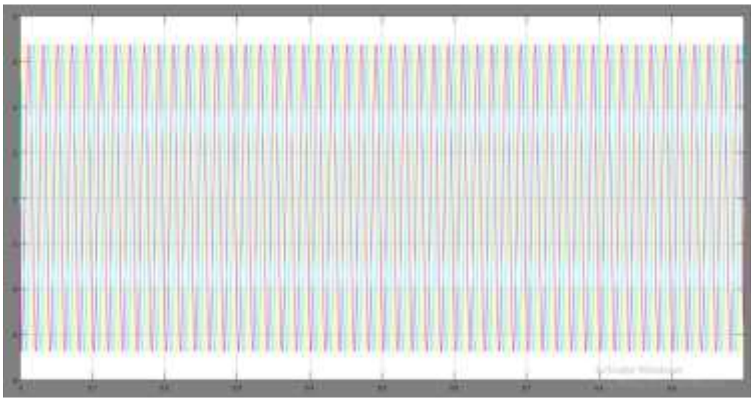

Fig. 22. Three phase transmission line receiving end current or load side current during short duration LG fault

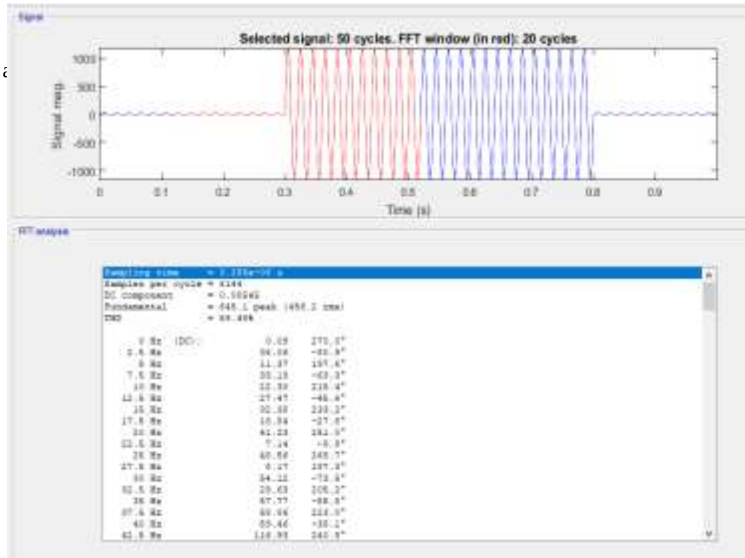

Fig.23. Sending end transmission line Current FFT analysis for Total Harmonics Distortion (THD) during short duration LG fault between phase A and Ground.

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VII. Simulation Results for Rectifier Load

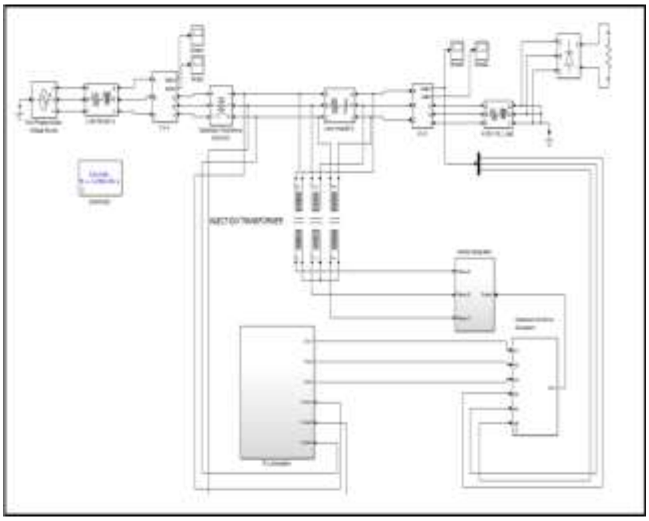

Fig.24.Series active power filter system with rectifier load

TABLE I. PARAMETER SPECIFICATION OF MATLAB SIMULATION MODEL WITH RECTIFIER LOAD

Sr No.	Nameofsimulation block	Specification
1.	Three phase programmable source (Generator)	Phase to phase rms voltage=11KV, Supply frequency=50Hz
2.	Linemodel-1	Lineresistance=0.5Ohm, Line inductance=0.5mH
3.	Three-phase transformer(Two winding)	Primary winding Star connected with ground and Secondary winding Star connected with ground, MVA rating=100MVA;Supply frequency=50Hz;Primary winding voltage V1 =11 KV Secondary winding voltageV2=415V Primary winding inductance L1=0.00030H Secondary winding inductance L2 =4.3857e^{-7}H Primary winding resistance R1=0.00242 Ohm Secondary winding resistance R2=3.4445e^{-6}Ohm Magnetizing resistance Rm=605Ohm Magnetizing inductance Lm= 1.9258H
4.	Ripple capacitor	Resistance=6Ohm, Ripple capacitor=6Micro-Farade
5.	RL Load	Load Resistance=50Ohm, Inductance=10 mili-Ohm
6.	Universal bridge (Rectifierload)	Number of bridge arm=3,Snubber resistance Rs = 1e^{5} Ohm, Contact resistance Ron=1Mili-Ohm

A. *Case-1 Voltage sag*

Table 2 shows source voltage parameter for 3phase with voltage sag condition

TABLE II. SOURCE VOLTAGE PARAMETERS 3-PHASE FOR VOLTAGE SAG CONDITION

Time(second)	Voltage(pu)	Load
0to0.1	1	R =50 Ohm,L=1 mH
0.1to0.4	0.7(Sag)	
0.4to1	1	

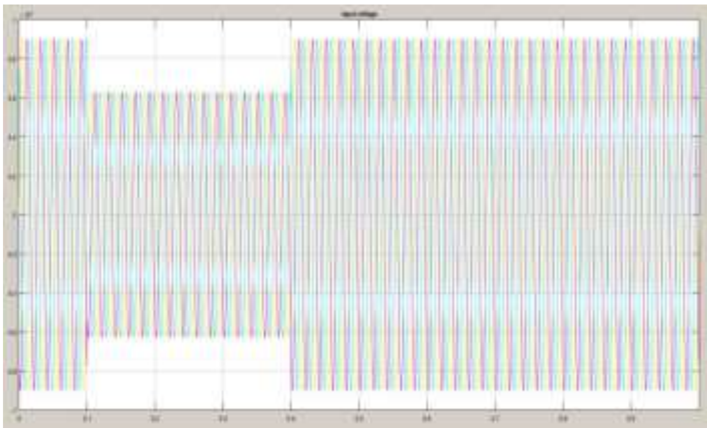

Fig.25.Three phase transmission line sending end side three phase rms voltage during voltage sag (0.7) p.u with rectifier load

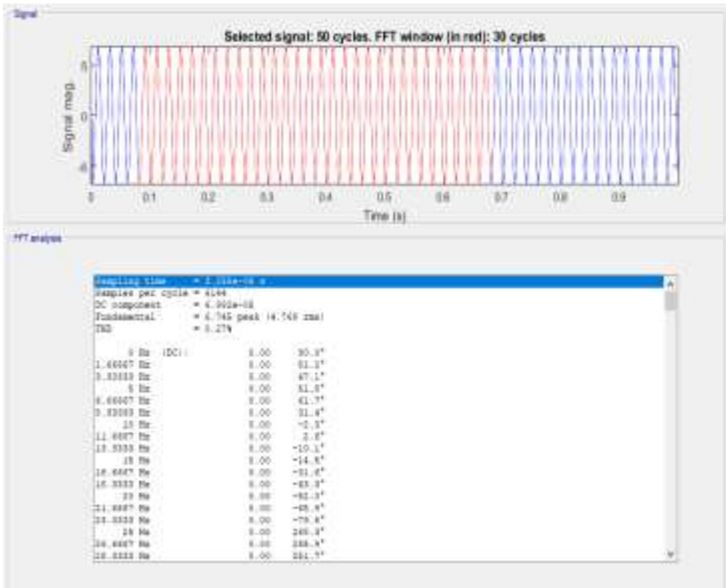

Fig. 26. Receiving end or load side transmission line current of phase BFFT analysis for Total Harmonics Distortion (THD) during sag condition with rectifier load condition.

B. Case-2 Voltage swell

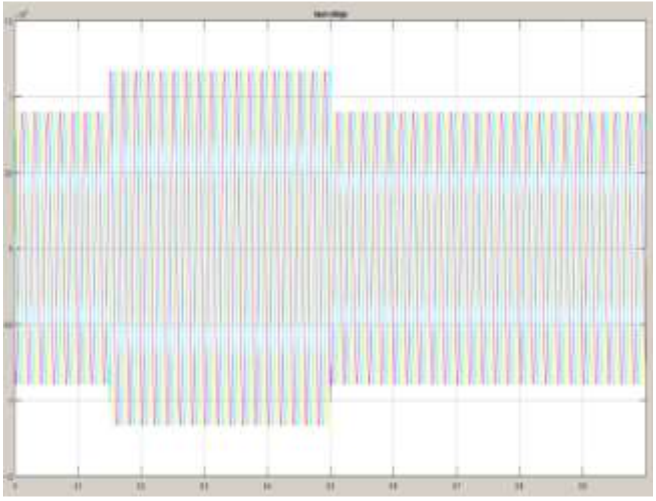

Fig. 27. Three phase transmission line sending end side three phase rms voltage during voltage swell (1.3) pu with rectifier load

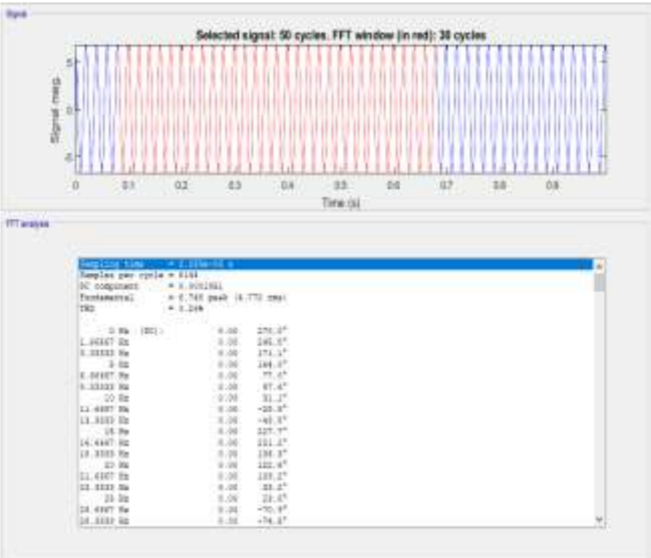

Fig. 28. Receiving end or load side transmission line rms current of phase CFFT analysis for Total Harmonics Distortion (THD) during voltage swell condition (1.3pu) condition with rectifier load condition.

C. Case-3 Short duration of fault

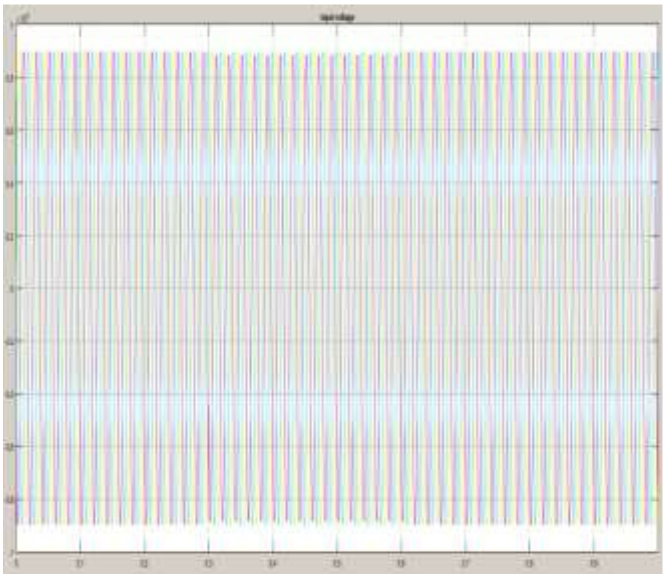

Fig.29.Three phase transmission line sending end three phase rms voltage during short duration of fault (LG-AG)

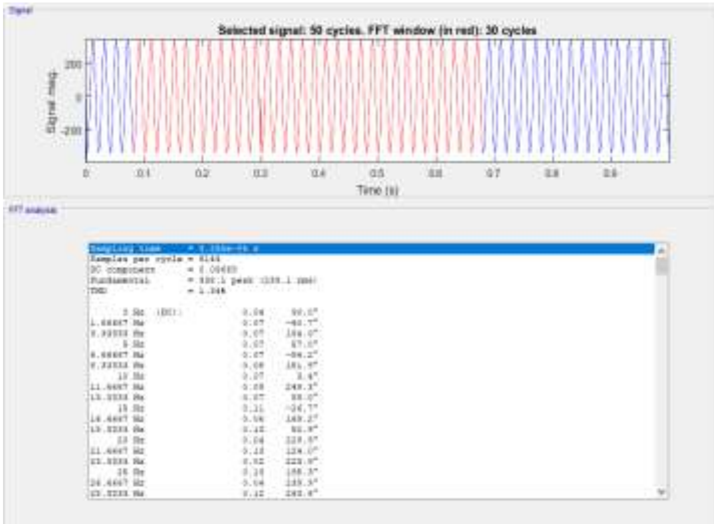

Fig. 30. Figure 31: Receiving end or load side transmission line rms current of phase A FFT analysis for Total Harmonics Distortion (THD) during short duration of fault LG-AG.

VIII. Conclusion

Series active power filter phase lock look system for the reference case of voltage generation system has been designed using the matlab simulation software. Hysteresis PWN best app on the controller for the case of inverter system has also been designed using the matlab simulation software. 3 phase pulse MOSFET which is based upon the inverter system have also been designed using the matlab simulation software. The transmission line sending end as well as receiving end which is also called as load side voltage have also been analysed for the case of voltage sag condition voltages well condition and short duration LG fault. Result analysis of the simulation for the series active power filter can be stated that the there is presence of the compensation related to the voltage sag, voltage swell and harmonics.

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