Compensation of DVR With Supercapacitor Based Energy Storage

A

PROJECT REPORT

Submitted in partial fulfilment of the requirement of the degree of

MASTER OF TECHNOLOGY

By

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Under the Supervision of

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CANDIDATE'S DECLARATION

We hereby certify that Project Report entitled "**Compensation of DVR with Supercapacitor Based Energy Storage**" which is submitted by **Anmol Prashar** in the partial fulfillment of the requirement for the award of degree M.Tech in Department of Electrical Engineering of Delhi Technological University, New Delhi, is an authentic record of the candidates own work carried under the supervision of **Dr.Narendra Kumar**. The matter embodied in this project is original and has not been submitted for the award of any other degree.

We certify that the above statement made by us is correct to the best of my knowledge and belief.

CERTIFICATE

This is to certify that the project report entitle "Compensation of DVR with Supercapacitor Based Energy Storage" by ANMOL PRASHAR (2K19/PSY/03) submitted in the fulfillment in the requirements for the degree of M.Tech in POWER SYSTEM under DR.NARENDRA KUMAR of DELHI TECHNOLOGICAL UNIVERSITY, NEW DELHI during the academic year 2019-2021 is a bonafide record of work carried out under my guidance and supervision.

I further declare that to the best of my knowledge, the project report does not contain any part of work which has been submitted for the award of any degree either in university or in other university.

(Signature of supervisor)

DR. NARENDRA KUMAR

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I express my sincere thanks to all my friends, my well-wishers and classmates for their support and help to complete this project .This acknowledgement will remain incomplete if I fail to express my deep sense of obligation to my parents and God for their consistent blessings and encouragement .This project is by far the most significant accomplishment in my life and it would be impossible without people who supported me and believed in me.

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CHAPTER 1

INTRODUCTION

With the rise in usage of electronic equipment, problems related to power quality are rising on a daily basis. Power quality is the furthermost constraint in current-day period. DVR is known to be a means to recompensate the power insufficiencies for a short-term in insensitive loads. Ability for the compensation of the restorer for the Dynamic-Voltage depends on the extreme voltage of injection as well as the capabilities of power during saggy voltages.

When the continuous voltage drops occur, Dynamic Voltage Restorer (DVR) can pay it off with a very operative approach such as DVR algorithm. The algorithm reduces the real power distributing necessity. Though, the limitations of the same on restoring the load current as well as the load voltage cause fluctuations of the phase angle.

Now-a-days, in spite of the extensive conventional usage of sensitive gear such as computers as well as of the PLCs, rapidity of the procedures of industries is helpless against the disabilities related to the voltages [1-3]. Swell as well as the saggy voltages are some practical instances of the susceptibilities causing improper functioning in system.

Dynamic Voltage Restorer is known to be a source of transformer for the voltage under the control as well as it has been installed among primary source of energy as well as the load so that the voltage levels can be stabilized [4-5]. It is able to sense the rapid disturbance and noise in the voltage of the system. Fig.1 presents the structure that is generally network with simulations in the article.

In this thesis, we are using Thyristor Control Reactor for providing the reactive power. It has been attached to load side of system for removing harmonics by the current that is injected as well as for selecting the firing angles for the Thyristor Control Reactor (TCR).

A duo of thyristors in Thyristor Control Reactor is attached anti-parallelly. Every thyristor is compulsorily enforced into transmission with the help of using of a pulse

to the input of the gate of TCR in one of the two positives as well as of half cycles which is negative of supplied volt. Then current flow will be blocked right next the AC current crosses 0 (zero). The maximum current will flow if thyristors of TCR are fired at the crest voltages.

Supercapacitors SC are proficient of super quick charging as well as discharging, and in fact are also being able to go over a huge no. of cycles for discharging and well as that of charging, without deprivation, in contrary to batteries. Hence, it is proposed to operate the storage system of supercapacitor to store suitable quantity of energy to the system to be released improve its fluctuations. Quantity of energy stored per unit weight in first generation supercapacitor is well-thought-out lesser than that of batteries made of electro chemicals. The voltage differs with the stored energy. In order to capably recover as well as storing energy, classical electronic control as well as switching equipment is mandatory.

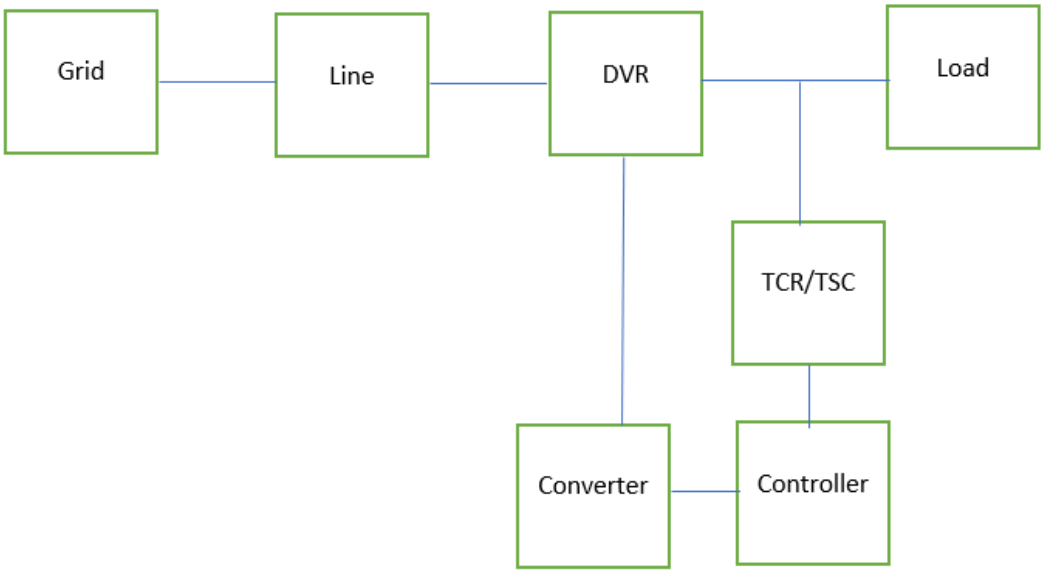

Fig 1: Block Diagram of Complete System

CHAPTER 2

LITERATURE OVERVIEW

- Green P, Fitzer C, James M, "The detection method of the voltage for the dynamic restorer of the voltage" IEEE transactions on industry applications. The paper presents a systematic review and brief description of standards, design as well as the tasks faced in DVR-technology. Brief survey has been conducted on the study that was published to mobilize the various aspects and issues of the DVR system. The arrangement of this literature provides insights about the structure, working fundamentals, compensation techniques, different topologies, control methods and voltage sag detection methods of the DVR under different segments. The part named "Challenges faced by the DVR" discussed in study is useful for the researchers as it can act as a starting point to begin their work in the domain of DVR. The sim-power-system tool of Simulink software /MATLAB are used to provide simulation results which are used for analysis and comparison.

- M.S.El-Koliel, A.H.A. hamza, M.M.Hafez, M.N.Ali and H.El-Eissawi, "improvement in the DVR with the use of PI controller to mitigate the sag of the voltage. One of the common power quality problems is Voltage sag. In nuclear installations, it has a great effect on sensitive as well as the sophisticated equipment of the electronic. For resolving the issue, Flexible Alternating Current Transmission Systems (FACTS) have been used. In power distribution networks, DVR reflects the most efficiency in the FACTS is used for the mitigation of the sag of the voltage. It has been a chain of the connected devices that are based on power electronic which help in rapidly mitigating the sags of the voltage as well as restoring the voltage of the load to pre-fault-value. The study suggests that using Proportional Integral (PI) controller, there can be an improvement in DVR's conventional (d-q-0) transformation which will help mitigating the sag of voltage in the network of distribution. The implementation of the PI controller's is not same as the work that was proposed in study. This led to the reflected improvement in performance. MATLAB/SIMULINK are used to model different types of faults and to

examine the improved proposed technique over the conventional one.

- Zhan, C., A., Ramachandaramurthy, C., Barnes, A., Arularnpalam, and Jenkins, N. V. K., Fitzer, (2001). DVR that is based on the 3D voltage space vector PWM algorithm. In Power Electronics Specialists Conference, 2001. PESC. 2001 IEEE 32nd Annual (Vol. 2, pp. 533–538). IEEE. Based on a 3-dimensional /spl alpha//spl beta/0 voltage space, a voltage space vector PWM algorithm for a dynamic voltage restorer (DVR) is described. The switching strategy is applicable to the control of 3-phase 4-wire inverter systems like the 4-leg PWM inverter and the split-capacitor PWM inverter. When done comparison with the conventional method, the voltage space vector PWM method instantaneously controls /spl alpha//spl beta/0 components of the terminal voltages. The control algorithm was confirmed by simulation. The results of the 3 kW DVR system experiment using a split-capacitor PWM inverter are given to validate the results of simulation

- Woodley, N. H. (2000), Field experience with the DVR system. In the Power Engineering Society Winter Meeting, 2000. IEEE (Vol. 4, pp. 2864–2871). IEEE. The issues related with PQ problems in industries are damage of equipment, deprivation of the quality of product as well as the temporary shutdowns. There are huge monetary losses incurred if any damage or mal-operation of the industrial sensitive loads happens and the resultant losses are disproportionately higher when compared to the severity of the PQ issues. The power quality traditional to the technique of mitigation, with the evolution of the power electronics technology, are replaced with introduction of the Custom Power System devices (CUPS). DSTATCOM, DVR and UPQC are some of the electronic controller of major power which is based on the CUPS. The DVR is the solution for losses in the economy that is caused due to the PQ issues in industries. One of the most cost-effective CUPS is DVR. In the published literature, there are limited papers which are related to review of the DVR technology. In the study, systematic review of the literature has been conducted as well as brief details are given on the standards, designs as well as the tasks in DVR technology. A brief survey has been conducted on published.

- A.Kiani Haft lang, Atefe Kiani Haft lang, M.Baledi, Ehsan Gharibreza, "The algorithm for the new compensation for the DVR in the Level of voltage of the medium level", International Journal of Engineering and Innovative Technology (IJEIT). According to this study, the restorer's compensation ability depends on its power capabilities and maximum injection voltage during sag voltages. DVR can compensate reoccurring voltage drops with efficient strategy like minimum energy algorithm. With the help of algorithm with the minimum energy, the DVRs delivering needs of real power is minimized. This technique will not be of as much concern on the capacity of the storage of energy of the Dynamic Voltage Restorer. Nevertheless, the method has its restrictions on current cause fluctuations of the phase angle and restoring the load voltage. In the paper, the TCR is used to provide the reactive power. TCR has been fixed on network's load side and helps for the elimination of the harmonics with the use of injecting current and then choose the best firing angles for the electronic device.

- Priyanka kumara and Vijay kumar Garg," The quality of the Power enhancement using the DVR: an overview, IJSRP volume-3, issue-8. The issues revolving around voltage unbalance and the impact of the voltage unbalance on loads that are sensitive are well known. For mobilizing these issues, power devices which are custom have been put into place like DVR, that is effective as well as efficient modern device. The paper illustrates the point of view of researches on DVR for the quality of power; Improvement in the distribution networks of power. Sensitivity-industrial-loads, critical commercial-operations, Utility-distribution-networks influenced from different kinds of outages and the interruptions of the service as well as the outcomes of the financial loss. This report explains the primary substance of DVR, fundamental of the operation, kinds of the strategies of control for the DVR, DVRs topologies system; in the system of distribution as well as the methods of compensation.

- M.S.El-Koliel, M.M.Hafez' and H.El-Eissawi, "improvement of the DVR with the usage of the proportional Integral(PI) controller to mitigate the voltage sag. One of the common power quality problems is Voltage sag. In nuclear installations, it has a great influence on sensitive as well as sophisticated

equipment of electronics. For resolving this issue, Flexible Alternating Current Transmission Systems (FACTS) have been used. In power distribution networks, Dynamic Voltage Restorer (DVR) which is one of the most efficient FACTS, is used for mitigation of the sag of the voltage. It is a series of connected power electronic based devices which help in quickly mitigating the voltage sags and restoring the load voltage to the pre-fault-value. This study proposes that using Proportional Integral (PI) controller, there can be an improvement in DVR's conventional (d-q-0) transformation which will help for the mitigation of the sag of voltage in the network of distribution. PI controller's application is different than planned work of study. This reflected improvement in the performance. MATLAB/SIMULINK are used to model different types of faults and to examine the improved proposed technique over the conventional one.

- Johan Morren who is a Student Member of the IEEE along with Sjoerd W. H. de Haan had published "Ride through turbine of the wind with the DFIG during dip of voltage" in IEEE TRANSACTIONS ON ENERGY CONVERSION, VOL. 20, NO. 2, JUNE 2005. A solution is defined in the following paper, making it probable for the turbines of the wind using DFIG generators to remain in touch with the grid in the grid faults. Aim of the solution is restriction of high current of rotor for the protection of converter and for providing a sidestep for this current through many resistors connected with the rotor windings. Using such resistors, it's made probable to ride via grid-faults without any disconnections in the turbine from grid. Due to the connection of the generator and converter, the simultaneous operation is established during as well as after the fault. Also, the operation that is normal could be sustained instantly after clearing of the fault. Another important characteristic is the reactive power to be supplied to the grid during the long dips for the facilitation of the restoration of the voltage. A strategy for the control has been developed which helps to make the transition again to the normal operation. Without any special action for the control, large transients would be there.

- Xunwei Yu and Zhenhua Jiang [6] advised an alike scheme except that the SC has been exchanged by a system of storage of the battery energy. The main aim of the system for the battery conversion is for having a regular DC link voltage,

so undulation of voltage of the capacitor remains low. Also, converter of the side stator could be taken in use for ordering the constant amount of real as well as the reactive power for grid.

CHAPTER 3

DYNAMIC VOLTAGE RESTORER

DVR shields the load in contrast to the swell as well as the saggy voltages using another voltage of 3-Phase with the same frequency as of system coupled in the chain with voltage of the load. On basis of sensitivity of the load, pre-fault, in-phase, as well as strategies with the minimum energy are established for scheming the restorer DVR. If injected voltage, V_d is in phase along with voltage of the source, the system of in-phase monitoring is attained.

DVR is a solid-state device which is put in series connection b/w the supply side and the sensitive load via injection transformer.

The load voltage is being regulated using the DVR device by inserting the voltage deviation into the system at any magnitude as well as the phase angle. In [3], four variations of DVR topologies are being used along with the scenarios of energy storage as well as without energy storage.

There are various kind of devices for storing the energy applied in the DVR like super capacitors, batteries, flywheels as well as super magnetic coils. These diverse varieties of storages of energy are essential to supply reactive power as well as active power to DVR.

An advanced DVR topology presented that by paralleling with a TSC/ TCR compensator at the load side, it overcomes the phase jumped issue which it brings by traditional control [6]. Implemented at medium voltage level, the Dynamic Voltage Restorer is being used to shield a group of low voltage consumers as well as medium consumers of the voltage [7].

Outcome of Dynamic Voltage Restorer on network has been by experimentation studied under the system that is faulted for a nonlinear load. In [9] calculated schemes for control, it includes the popularly-used single voltage loop control, an inner current loop, double-loop control with an outer voltage loop as well as the voltage feedback plus reference feed forward control.

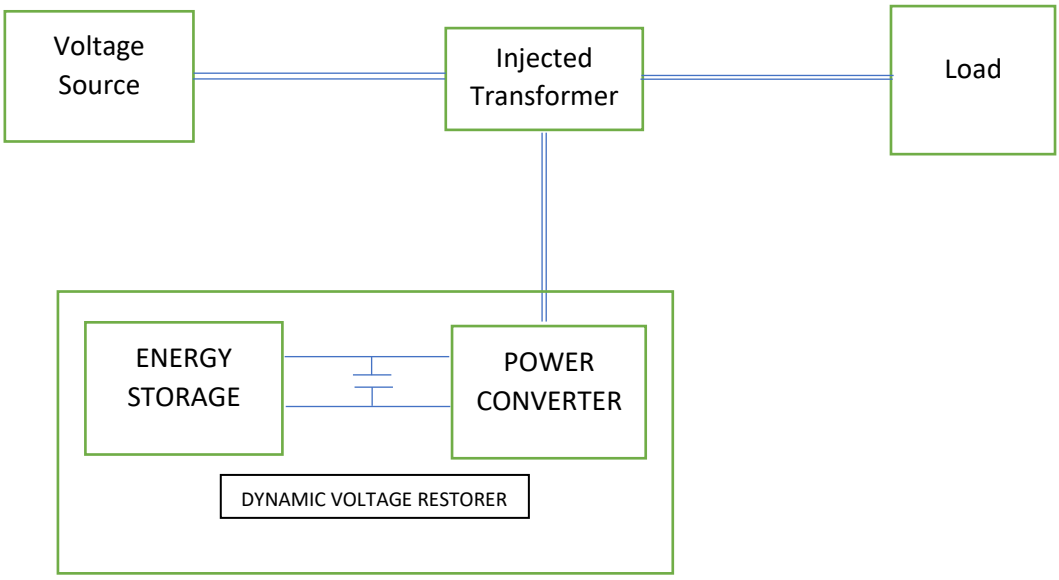

Fig 2: Block Diagram for Understanding the DVR

(DVR has been a means for recompensing short-term insufficiencies of the power in the insensitive loads. The ability of DVR to compensate varies with extreme injection voltage as well as the capabilities of power during saggy voltages.

When the continuous voltage drops occur, Dynamic Voltage Restorer (DVR) can pay it off with a very operative approach such as DVR algorithm. The algorithm reduces the real power distributing necessity. Though, the limitations of the same on restoring the load current as well as the load voltage causes fluctuations in the angle of the phase.

In the thesis, the usage of the TCR has provided the reactive power. It has been fixed on side of the load of network for the elimination of injecting current harmonics and by selecting the firing angles which are best for power of the electronic device.

Components of the Dynamic Voltage Restorer

A DVR consists of the following components:

(i) Main transformer;
(ii) Passive filter;
(iii) DC Voltage Source; and

(iv) Controllable voltage source converter.

Almost all of the significant structural block for the Dynamic Voltage Restorer is the source converter of the voltage that can be controlled. It is incharge for the detection of the bugs (error) signal as well as of designing the suitable signals for controlling in very short-period.

There are mainly two-parts: the strategy for the control as well as the section for estimation to determine the method for injection of the voltage as well as also response time for the Dynamic Voltage Restorer have been decided respectively.

Mostly the sensitive loads are used to be placed on the low voltage side of the system, the most suitable position for placing the Dynamic Voltage Restorer is less than the low voltage of the bus bar as well as also should be closure to the source of the system.

As mentioned earlier in introduction, Dynamic Voltage Restorers are usually operated to shield sensitive loads in contrast to disturbances as well as the noise that is used to place in source of the power. In the Fig.2, different controllers can be taken in usage generate 3 asymmetric voltage components for compensation of saggy voltage.

Conventional Configuration of DVR:

The general configuration of the DVR consists of:

i. An Injection transformer
ii. DC charging circuit
iii. Device for Storage (Supercapacitor)
iv. A Voltage Source Converter (VSC)
v. A Harmonic filter
vi. A Controlling as well as Protection system

Operations of Dynamic Voltage Restorer

The dynamic voltage restorer usually in standard conditions used to operate in the mode of standby. During noise as well as disturbances or faulty conditions, nominal

voltage of the system can be will be contrasted to the variations in the voltage. Through this we got the value of the differential voltage which the restorer has to inject in the resultant output to sustain voltage of the supply to the load within limits.

The amplitude as well as the phase angle of the injected voltages are adjustable which consents control of real as well as reactive power exchange b/w DVR as well as system of the distribution. The input of the DVR's terminal (DC Voltage) has been connected to a proper device for storing energy. As cited, the transfer of reactive power among the distribution system as well as the Dynamic Voltage Restorer is generated using Dynamic Voltage Restorer without the reactive components of AC passive internally. The real power using Dynamic Voltage Restorer input DC terminal has been provided which is interchanged at outcome of DVR AC terminals by an exterior source of energy or we can say the storage system for energy.

CHAPTER 4

SUPERCAPACITOR MODELLING

Supercapacitors are able to have of quick charges as well as discharges. They are also able to check through many discharging and charging cycles without deprivation, in contrast to the batteries. So, it uses SC storage system in order to store necessary energy to release into the system for the improvement of the performance of the system during the transient periods.

The system contains a converter that the storage of energy of the SC has been considered as the application of storage of wind energy in the sector because of the various merits over the system of storage for energy of battery.

- SCs are suitable for the application needing ruptures of power repeatedly from less than a second to even a few minutes. It is efficient as they are able to store as well as to release the energy that is electrical in its physical form.
- It is able to get discharged in fraction of a second or even several minutes. It also has the ability to get charged from seconds to several minutes.
- It has high cycle life when compared to the batteries, which makes it suitable for various charge/discharge cycles.
- When the system is completely charged the charging is quit by the SC. So, it has no risk for overcharging.
- It has a good reversibility power making it little degradable over several cycles.
- It has internal resistance which is very low as compared to the batteries.
- Wide operating range of temperature from the very low temperature around -40o C and high around +40o C.

- There is a concentration of the extreme power because of the high discharge of the current.
- The range of efficiency of the DC-DC round trip is 90-95%.
- They are environmentally friendly because they do not have any kind of chemical action in SCs neither any dangerous component that can damage the environment.

Though there are several advantages, it has disadvantages which are related to the SCs. One will be able take its care during control designing.

The energy stored with respect to its weight in the SC of first generation is lower when compared to the electrochemical batteries. The amount of energy stored brings variations in the voltage. To make sure that the energy is stored and recovered efficiently, switching equipment and the electronic control is essential.

There are various models developed for description of the Double-Layer SC. The most widespread model known as the two branches model is used in our study, that is well-known. (As represented in figure 5).

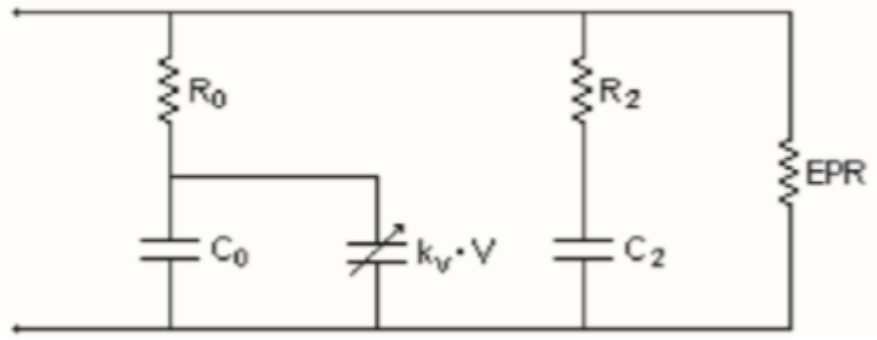

Fig 3. Equivalent Model fo Two Branches Supercapacitor Model

CHAPTER 5

CONTROL OF A DYNAMIC VOLTAGE RESTORER

Using the equation written below, the instantaneous values of the 3-phase voltages V_a, V_B and V_C are being transformed into the system of αβ coordinates. The resultant vector consists of Vsα as well as Vsβ.

$$\begin{bmatrix} V_{s\alpha} \\ V_{s\beta} \end{bmatrix} = \sqrt{\frac{2}{3}} \begin{bmatrix} 1 & -\frac{1}{2} & -\frac{1}{2} \\ 0 & \frac{\sqrt{3}}{2} & \frac{\sqrt{3}}{2} \end{bmatrix} \begin{bmatrix} V_{sa} \\ V_{sb} \\ V_{sc} \end{bmatrix} \quad (1)$$

Also, the reference voltages V_{qRef} as well as V_{dRef} are achieved with the help of quantified controlling strategy. The error voltages V_{dError} and also the V_{qError} are attained by comparison of the 'd' as well as the 'q' voltage components with their corresponding reference voltages V_{qRef} as well as V_{dRef}.

The resulting difference voltages $V_{dInjected}$ as well as $V_{qinjected}$ are formerly injected to the system using the help of Dynamic Voltage Restorer. In order to create the injected voltages, $V_{dInjected}$ as well as $V_{qinjected}$ are shifted back to the designed system of $\alpha\beta$ coordinates using a suitable opposite transfer matrix.

So, the vector of the resultant in coordinate system of αβ is further transformed again into coordinate system which was original with the use of following equation:

.

$$\begin{bmatrix} V_{sd} \\ V_{sq} \end{bmatrix} = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} V_{s\alpha} \\ V_{s\beta} \end{bmatrix} \quad (2)$$

Finally, the resulting instantaneous voltages which are V_{a0}, V_{b0} as well as V_{C0} are being fed into the block of the voltage source convertor (VSC). The voltages created with the help of the VSC are being fed into the 3-Phase-series-connected converter.

So, the appropriate voltages of serial in the unity to presently available errors of the voltage are now fed into system to re-establish swell as well as sag voltages returned back to their pre-fault conditions.

ANALYSIS OF TCR

The Reactor which is controlled by the Thyristor is known to be self-controller which is handled with the help of many thyristors. The reactance that is operative is attainable with taking the control of firing angles of thyristors in a firm limit. One pair of the thyristors which are present in the TCR has been applied anti-parallelly.

Both of the thyristors have to undergo the conduction due to the pulse application to the input of the gate in any one of the positive as well as the negative half cycles of voltage which is supplied to it. Thus, flowing of the current will be blocked once the current of ac exceeds the zero limit.

In the case when the thyristors are fired at the voltages of the crest, then flow of the current in the thyristors is the most.

The current which flowing in reactor could be transformed from the extreme to zero by having variations in the angle of the firing delay with respect of peak for voltage which is applied in each of the half-cycle. Principally, the flow of current has been reactive and it lags approx. 90^o of voltage.

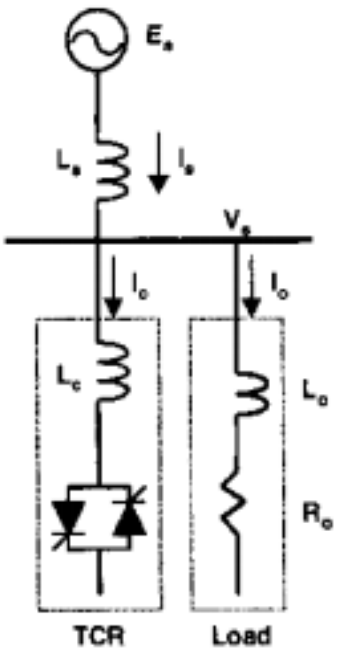

Fig 5: Thyristor Control Reactor

The Reactor of the controlled for the thyristor (Fig.1) presents the composed TCR that is conventional of a constant reactor of the inductance, and the thyristor which is bi-directional. The current which is passing through reactor could be measured from the extreme to the zero level with the help of the angle control of the delay in the firing.

Basically, the turning-ON of thyristor is overdue because of peak of the voltage which is applied in each of half-cycle. So, period of conduction of the current has been controlled in the form as it has been presented in the Fig.2.

In case of any delay in the thyristor of an angle a (0 5 a 5 n12) with concern to voltage crest, the reactor current is presented with v(t) = $V\ cos\ \omega$ as follows;

$$i_c(t) = \frac{1}{L_c}\int_0^{\omega t} v(t)dt = \frac{V_s}{\omega L_c}(\sin \omega t - \sin \alpha) \qquad (3)$$

It's obvious that the current magnitude in reactor can be variable incessantly by the delay angle in the controlling from the extreme (d) to the zero level (a = n/2), as presented in Fig.5.

Principle as well as the substance of harmonic flowing of the current in the reactor i(t) can be expressed in the form of a function of the angle a, respectively:

$$i_{cf}(\alpha) = \frac{V_s}{\omega L_c}(1 - \frac{2}{\pi}\alpha - \frac{1}{\pi}\alpha - \frac{1}{\pi}\sin 2\alpha) \qquad (4)$$

$$i_{cn}(\alpha) = \frac{V_s}{\omega L_c}\frac{4}{\pi}\left\{\frac{\sin\alpha\cos(n\alpha) - n\ cos\alpha\ \sin(n\alpha)}{n(n^2-1)}\right\} \qquad (5)$$

In which the value of n $=$ $2\mathrm{k} + \mathrm{l}, \mathrm{k} = 1,2,3$ ...

It is obvious from the (2) that TCR is able to control the principles of the current from the zero level to the extreme level because it is variable reactor that is controlled with the help of the delay angle a.

If there is any unbalanced 3-phase system, then triple-n harmonic currents (3'd, 9Ih, 15", etc.) start circulating in the delta which is applied to the TCRs and is restricted

from entering the system of power. The value of the else harmonics can be produced with the help of the TCR.

From Fig. 5, bus voltage V can be expressed:

$$V_s = \frac{Y_s E_s}{Y_s + Y_c + Y_o} \tag{6}$$

With the value of Y, = l/jwL,, Y, = lJdc, Yo = U(R0 + jwLo).

Y can be varied if delay angle a is controlled. What it implies is that, V can be varied and the generation of the sag of voltage by thyristor switch firing of TCR, as well as the extreme drop of voltage has been decided with the help of the purpose of the ratio among the L and the L, under the provided conditions of load.

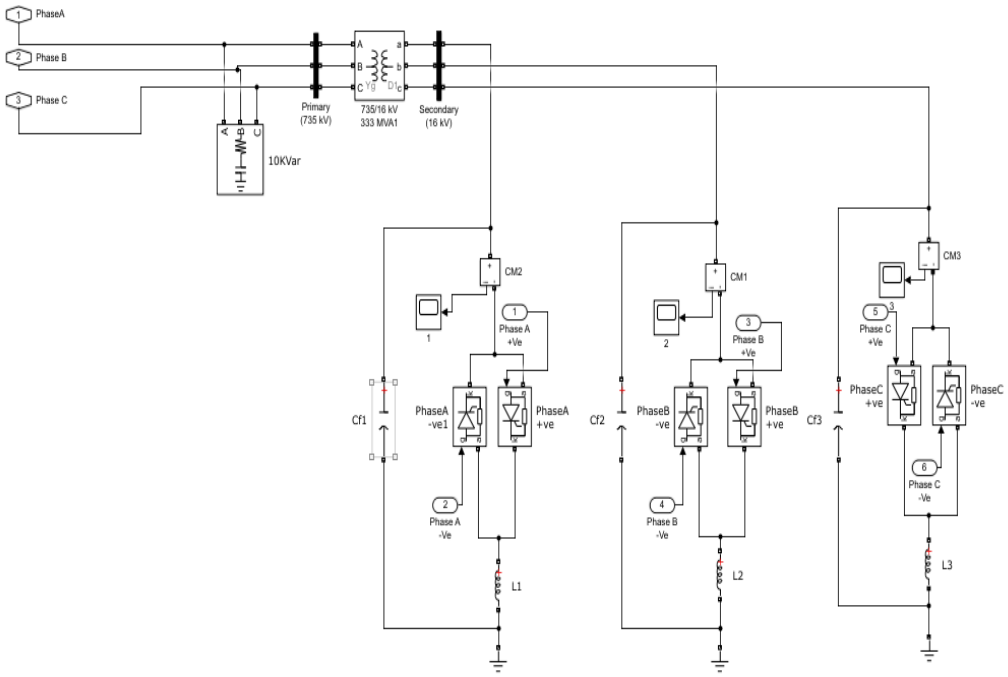

Fig 6: Simulink Model of TCR

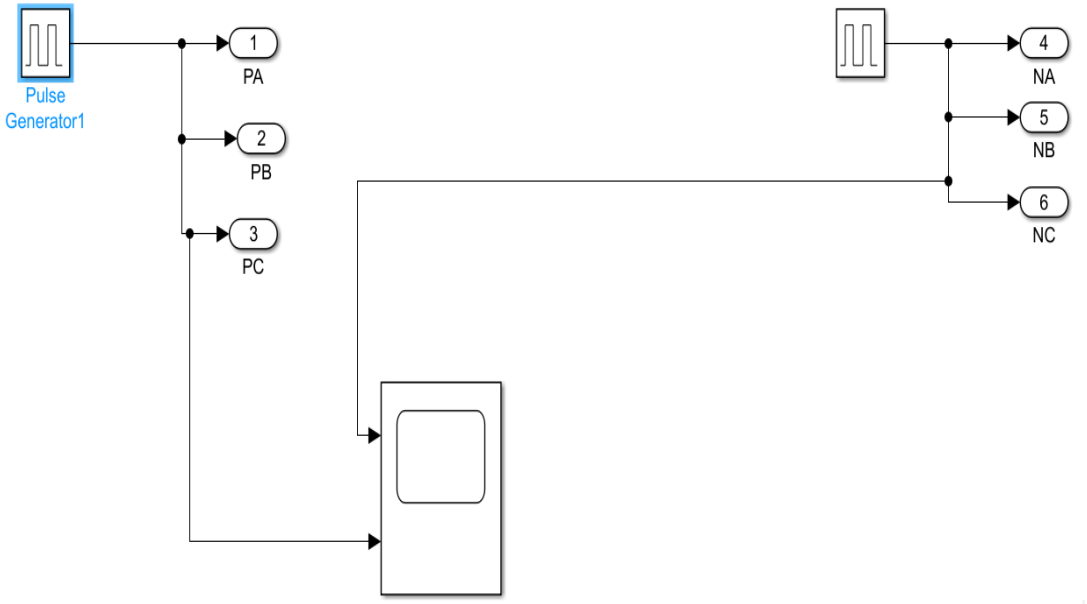

Fig 7: Simulink Model for Firing Control Of TCR

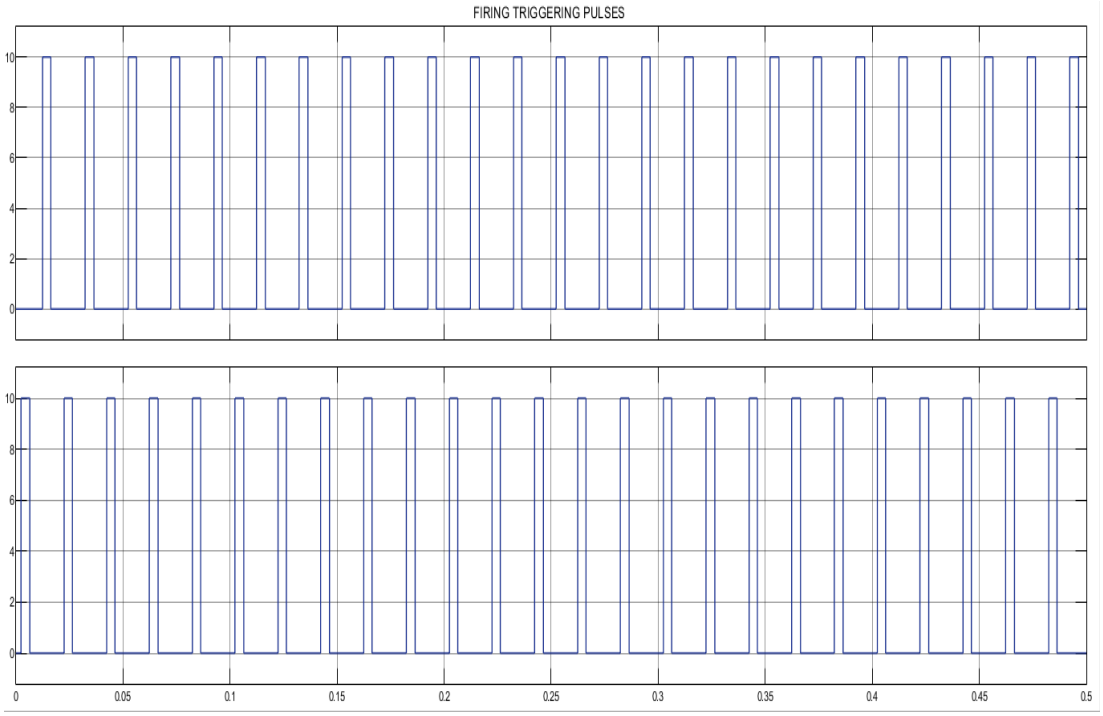

Fig 8: Firing Pulses for FC-TCR

CHAPTER 6

SYSTEM SIMULATION & RESULTS

On the basis of the discussion of the Chapter 3, the Simulink model of DVR is presented in fig 9.

The Model consists of:

i. An Injection/ Booster transformer.
ii. DC charging circuit.
iii. Storage Devices (Super Capacitor).
iv. Bi-directional DC-DC Voltage Converter.

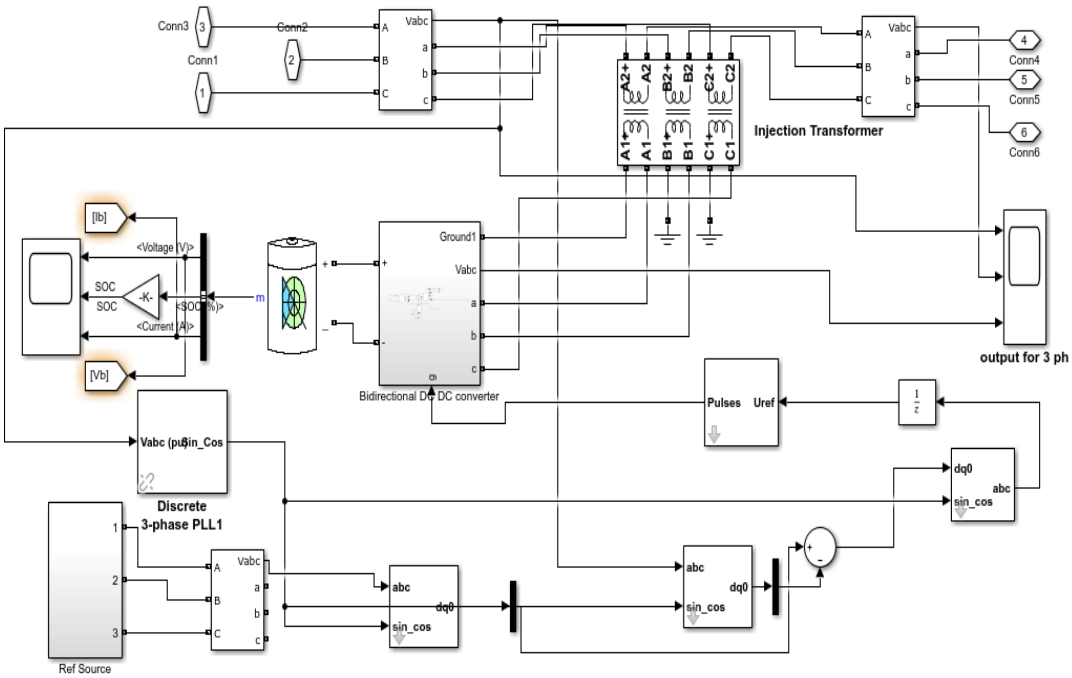

Fig 9: Simulink Model of DVR

Bidirectional DC to DC Converter for Super Capacitor

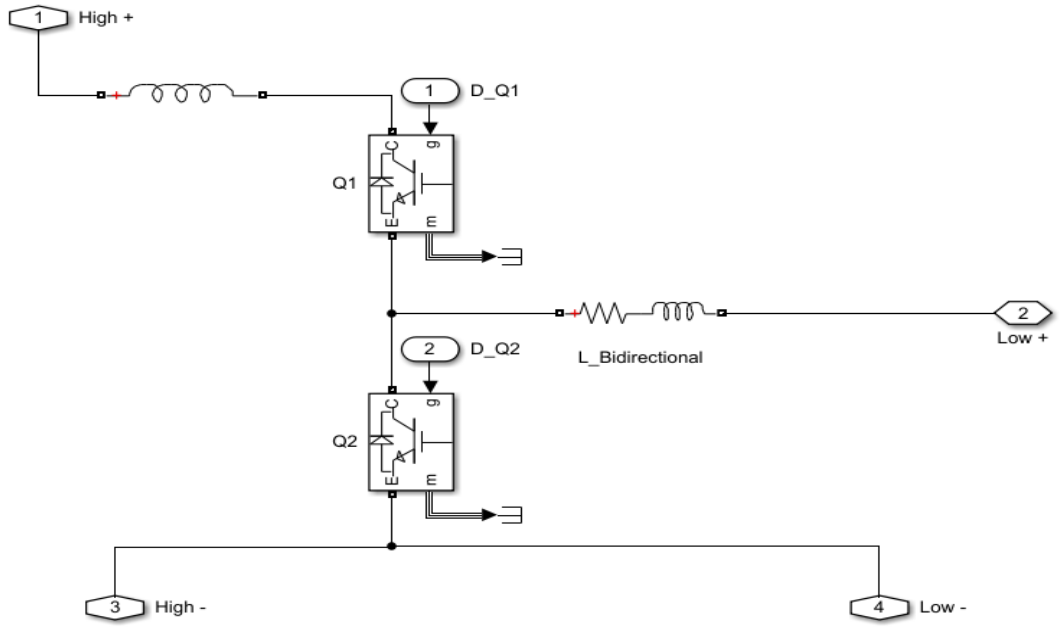

Fig 10- Bidirectional DC to DC Converter for Supercapacitors

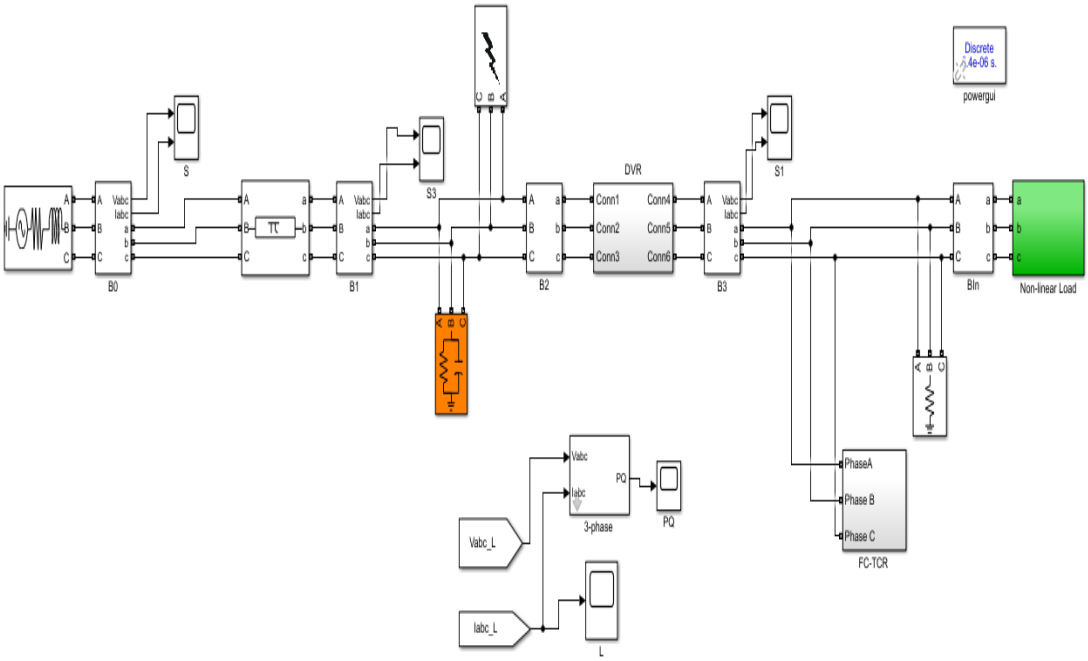

Fig 11- Simulink Model of the Complete System

OUTPUTS

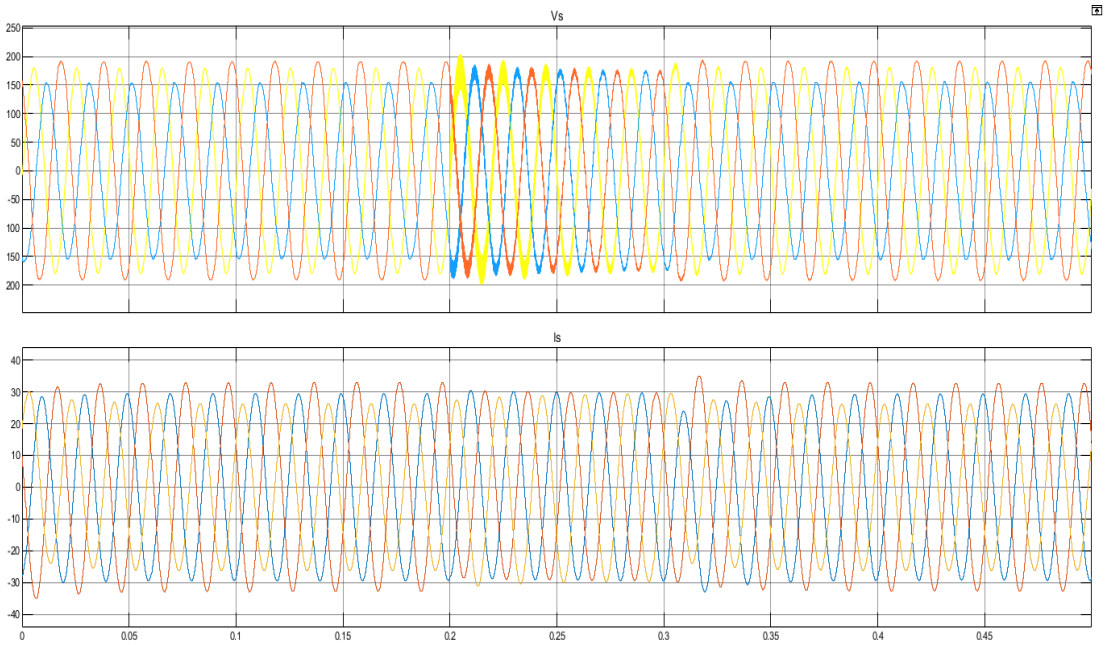

Fig 12: Output showing the Source Voltage (V_s) and Source Current (I_s)

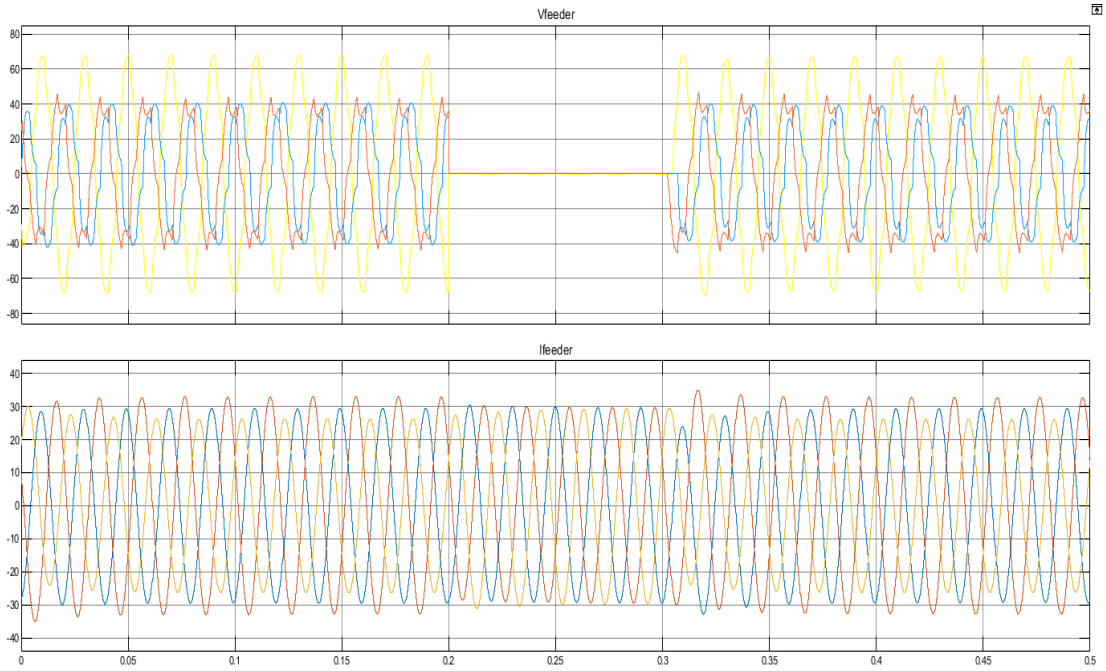

Fig 13: Output of feeder Voltage (V_{feeder}) and Feeder Current (I_{feeder})

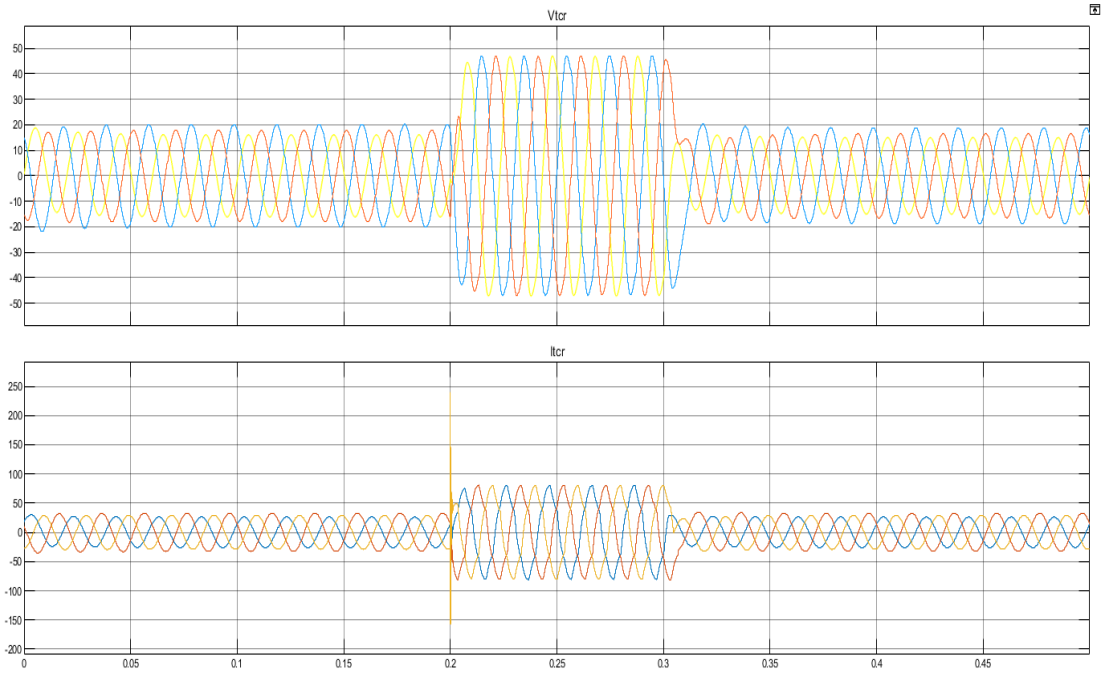

Fig 14: Output showing the DVR Voltage (V_{DVR}) and DVR Current (I_{DVR})

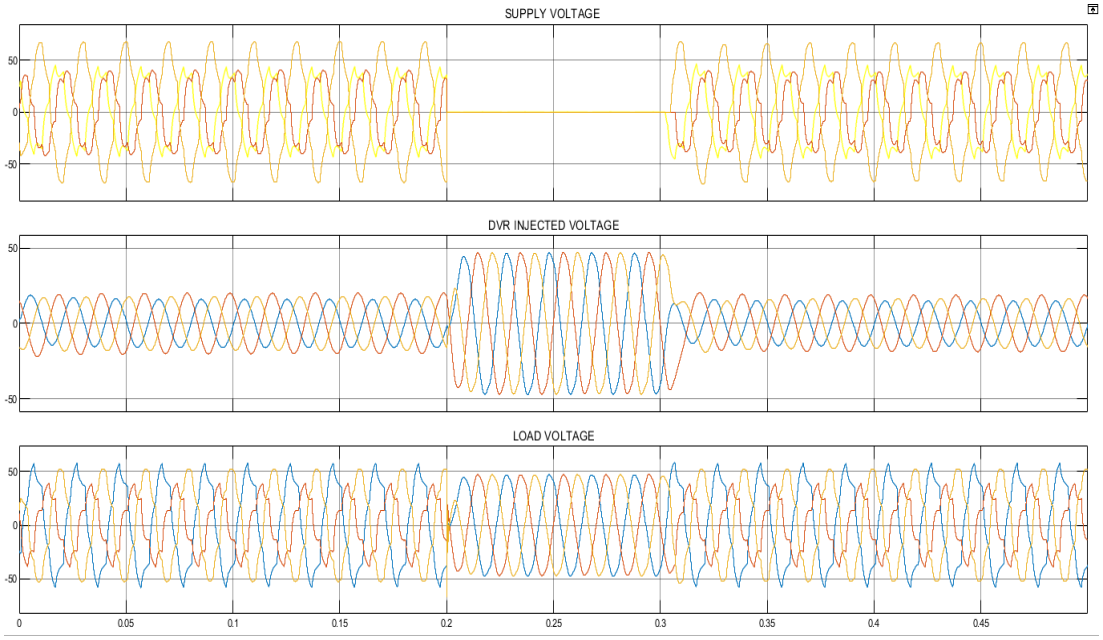

Fig 15: Output showing the overall Source Voltage (V_s) after feeder, DVR Injected Voltage and Load Voltage

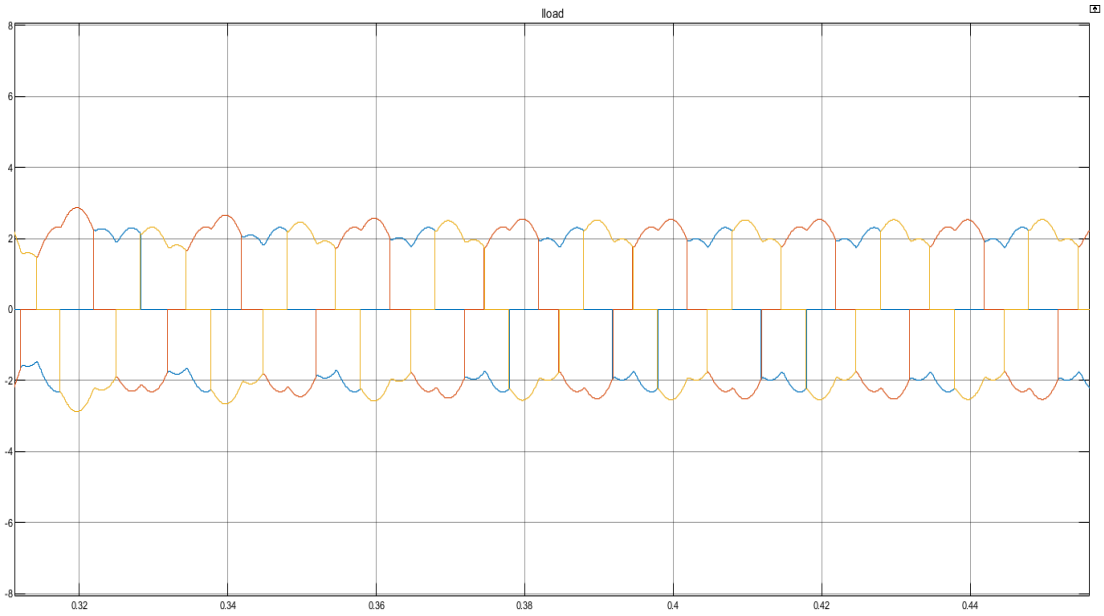

Fig 16: Output showing Continuous Current Passing to the Load after TCR (I_{LOAD})

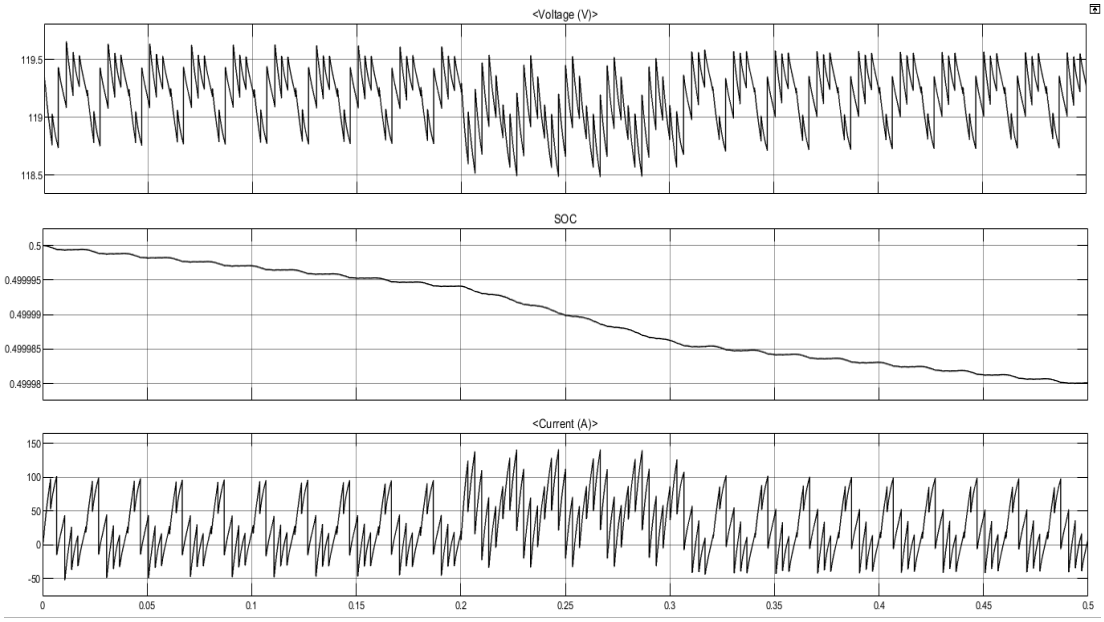

Fig 17: Output showing the Supercapacitor Voltage and Supercapacitor Current

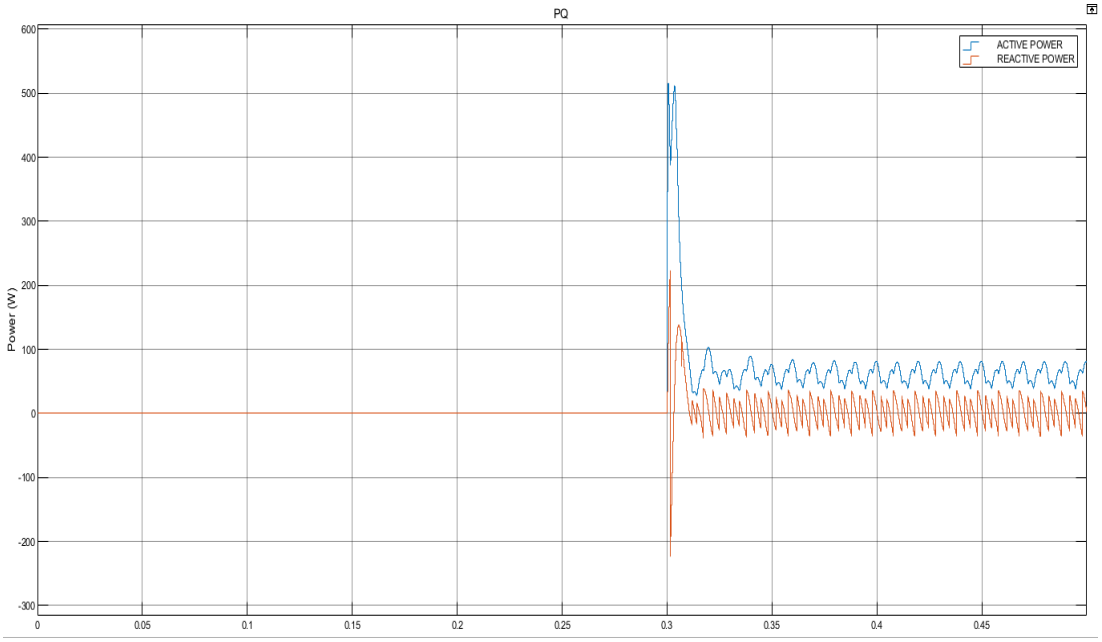

Fig 18: Outputs of the Active Power (Blue) and Reactive Power (RED)

CHAPTER 7

CONCLUSION and FUTURE WORK

CONCLUSION

- The primary aim of the work is for explaining quality of power; the issues with the voltage of the medium level network as well as the negative impact on the loads with critical system as well as demonstrate the devices of the custom power used for justification in its details.
- In the above study, we have discussed about DVR for the improvement of quality of power known to be one of the devices with custom power as well as the having great efficiency and also have the efficiency in the solution for the improvement in the quality of the power.
- The basic concept of the operation, the components of the power circuit, the structure, the techniques of compensation, modes of operation along with the several methods for the control of DVR explained in the detail.
- The effectiveness as well as the performance of provided DVR which has been connected with the testing system.
- For showing purpose of the DVR for the justification of quality of power; issues with DVR, connected to the system having the load which is non-linear and the faults which are applied.
- The graph of the power has been calculated. Also, the current of the load graph of the outcome attained presents few ripples as well as the continuous flow.

FUTURE WORK

- The impacts of the quality of power issues on loads which are sensitive if the two distributors are feeding the load will be discussed in the future work.
- For justification of the quality issues in the power as well as the examination of the stability of the system of power with new device named as the IDVRs is going to be conversed. The device contains two Dynamic Voltage Restorer which have been connected in the two unlike distribution feeders as well as the DC-link.

- The IDVR which is the proposed device in the following project as well as the new strategy of control is going to be modelled as well as for the simulation by the EMTDC/ PSCAD.

CHAPTER 8

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