REAL AND REACTIVE POWER MANAGEMENT IN DISTRIBUTION SYSTEM FOR UNBALANCED CONDITIONS

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Abstract: The lattice and enhancing its unwavering quality have as of late turned out to be significant necessities for extensive circulated age units. Under most lattice blames, the precision of the conventional voltage bolster plans (VSSs) is significantly influenced because of the presence of the zero-succession voltage. Additionally, the conventional VSSs have been utilized just in the STATCOM applications where the dynamic power is zero. This undertaking proposes a progressed VSS in the converter-interfaced units, called zero-grouping remunerated voltage support (ZCVS), to precisely manage the three-stage voltages of the association point inside the pre-set security limits. The proposed plan remunerates the zero-succession segment as well as thinks about the dynamic and receptive power infusion. In contrast to the conventional strategies, the proposed VSS is adjusted even in resistive conveyance frameworks. The commitment of this paper is, be that as it may, ternary. As the second commitment, the constrained dynamic power swaying is proposed to be enlarged to the ZCVS.

Index Terms **– STATCOM, ZCVS, VSS and MATLAB**

I. *INTRODUCTION*

In the upcoming years, usage of electrical vitality expanded exponentially and client necessity and quality meanings of intensity were changed immensely. As the electric vitality turned into a basic piece of the everyday life, its ideal utilization and unwavering quality wound up essential. Constant system view and dynamic choices have turned out to be instrumental for upgrading assets and overseeing requests, along these lines making dispersion the executives framework which could deal with appropriate work processes, very critical a Dissemination The board Framework is a gathering of utilizations intended to screen and control the whole circulation organize productively and dependably. It goes about as a choice emotionally supportive network to help the control room and field working faculty with the observing and control of the electric dissemination framework. Enhancing the dependability and nature of administration regarding decreasing blackouts, limiting blackout time, keeping up satisfactory recurrence and voltage levels are the key expectations [1]. A blackout the board framework has a system segment/network model of the appropriation framework. By joining the areas of blackout calls from clients with information of the areas of the assurance gadgets, (for example, circuit breakers) on the system, a standard motor is utilized to anticipate the areas of blackouts. In view of this, reclamation exercises are graphed and the group is dispatched for the same.[2]

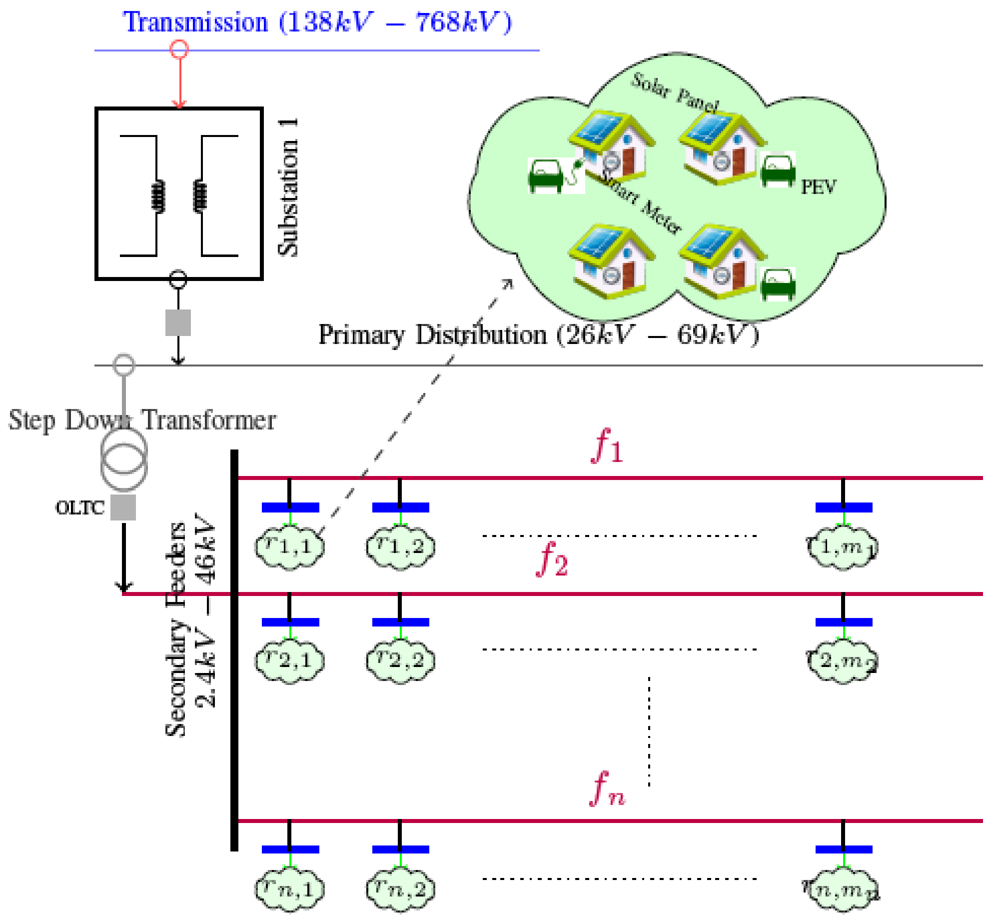
In parallel with this, circulation utilities started to take off Supervisory Control and Data Acquisition (SCADA) frameworks, at first just at their higher voltage substations. After some time, utilization of SCADA has logically stretched out downwards to destinations at lower voltage levels.

DMS(Distribution Management System) is to get constant information and give all data on a solitary comfort at the control focus in an incorporated way. Their advancement fluctuated crosswise over various geographic domains. In the USA, for instance, DMS is normally developed by taking Blackout The board Frameworks to the following dimension, mechanizing the total groupings and giving a start to finish, coordinated perspective of the whole circulation range. In the UK, on the other hand, the a lot denser and progressively coincided system topologies, joined with more grounded Wellbeing and Security control, had prompted early centralization of high-voltage exchanging tasks, at first utilizing paper records and schematic graphs imprinted onto extensive wallboards which were 'dressed' with attractive images to demonstrate the present running states. There, DMS is developed at first from SCADA frameworks as these were extended to permit these brought together control and wellbeing the executives strategies to be overseen electronically. These DMS is required significantly increasingly itemized part/availability models and schematics than those required by early OMSs as each conceivable detachment and earthing point on the systems must be incorporated. In domains, for example, the UK, along these lines, the system part/availability models were normally created in the DMS first, while in the USA these were commonly worked in the GIS.The run of the mill information stream in a DMS has the SCADA framework, the Data Stockpiling and Recovery (ISR) framework, Correspondence (COM) Servers, Front-End Processors (FEPs) and Field Remote Terminal Units (FRTUs)..These ideas are influenced by an assortment of components all through the dissemination arrange including: substation transport voltages; length of feeders; transmitter estimating; type, size, and area of various burdens (resistive, capacitive, inductive, or a mix of these); and the sort, size, and area of circulated vitality assets (photograph voltaic, dispersed breeze, different capacity innovations, and so on.); among others.The multifaceted nature and dynamic nature of these attributes make the assignment of overseeing electrical appropriation systems testing. While voltage control and VAR direction are frequently referenced in blend (for example Volt/VAR control)[5-7]. Feeder voltage direction alludes to the administration of voltages on a feeder with changing burden conditions. Notwithstanding ostensible working voltage, an utility dissemination framework is intended to convey capacity to customers inside a predefined voltage run. Under typical conditions, the administration and usage voltages must stay inside ANSI standard C84.1-2011 points of confinement, characterized as Range A. On a 120V base, this administration run is characterized as 114– 126V and use run is 110-126V. Amid high burden conditions, the source voltage at the substation is at the higher end of this range and the administration voltages toward the finish of the feeder are at the lower end of the range.Nearly all power framework loads require a mix of genuine power (watts) and responsive power (VARs). Genuine power must be provided by a remote generator while receptive power can be provided either by a remote generator or a nearby VAR supply, for example, a capacitor. Conveyance of responsive power from a remote VAR supply results in extra feeder voltage drop and misfortunes because of expanded current stream, so utilities like to convey receptive influence from a nearby source. Since interest for receptive power is higher amid overwhelming burden conditions than light burden conditions, VAR supply on an appropriation feeder is managed or constrained by exchanging capacitors on amid times of intense interest and off amid times of low interest. Likewise with voltage control, there are both feeder plan contemplations (to limit capital expenses) and working contemplations[8-10].

Providing VARs when and where requested is inborn to working an electric power framework. In any case, the stream of receptive power influences control framework voltages similarly as the stream of genuine power does. The impacts of genuine power stream about dependably affect voltage while the impacts of responsive power streams are now and then positive and here and there negative. Experience has demonstrated that general expenses and execution of working a power framework can be best overseen if voltage control and responsive power control are very much coordinated. Various advances have been utilized by service organizations to screen and modify voltage and additionally VAR levels on their electrical systems. In substations, these incorporate capacitor banks, voltage controllers and power transformers with On-Load Tap Changers (OLTC). Obviously by being situated in the substation, these gadgets control electrical parameters at the substation transport level. While they consider down line feeder conditions, they are used basically for gross alterations and were planned at first for outspread dispersion systems. Down-line feeder advances including settled and exchanged capacitor banks and voltage controllers are likewise used to help modify framework parameters along the length of a feeder. With the improvement of chip based controls and processing stages, inescapable, elite correspondences advances, generally conveyed sensor innovation including AMI frameworks and propelled programming calculations, it is presently conceivable to facilitate these gadgets to upgrade the more extensive electrical framework at the feeder, substation or utility dimension with frameworks. With these incorporated frameworks set up, utilities can streamline voltage profiles and VAR stream to accomplish an assortment of goals, including: decreasing pinnacle request, focusing on power factor levels to limit vitality misfortunes, or actualizing Protection Voltage Decrease. CVR controls feeder and substation gear to lower Circulation line voltage inside endorsed standard reaches. The outcome is a huge decrease of misfortunes and vitality request. They can likewise change target destinations at various occasions of the day/week/month/year to meet execution objectives

II. EXISTING SYSTEM

Electric transmission and distribution networks are considered as a critical and essential infrastructure for modern societies, any failure on any transmission or distribution line can cause major power outages. Volt-VAR optimization (VVO) works by adjusting the feeders and substation components in response to the operator's demand to reduce losses and demand along the distribution lines. VVO make problems are (i) Micro-level DR model, (ii) Energy efficiency of the equipment, (iii) Roof-top solar or locally installed energy sources, and (iv) G2V and the V2G control modes of the electrical vehicles.



. **Figure 1. Electricity Transmission and Distribution System**

A distribution network which is shown in Fig. 1, having n feeders: f1; f2; _ _ _; fn. Each of the feeders, i.e., fi ($1 \le i \le n$) supplies electricity to a set of neighborhood1 micro grids $r_{i,j}(\{r_{i,j}/1 \le j \le m_i\})$and mi is the number of communities attached to a feeder fi. A service drop transformer connects the neighborhood to the feeder. Each of these transformers serves 120=240V with a maximum apparent power rating from 10KV A to 200KV A. Customers are assumed to have roof-top solar panels to serve a fraction of the electricity needed by the neighborhood.

The HEMS is capable of identifying appliances and controlling the consumption of the equipment with the control information received from the CEMS. On the other hand, the CEMS (one for each $r_{i,j}$) takes the terminal voltage of the community, adjusts the voltage regulator or OLTC and sends the demand to the substation Energy Management System (EMS). Let t and τ be the time (hour) and total hours of a day, where $\in \tau$. The EMS at the substation regulates the generation, fixes the OLTC transformer TAP, adjusts the capacitor bank switches and calculates the electricity cost $\mu(E^{t}{}_{g})$ (total generation at t is$\mu(E^{t}{}_{g})$) and reduces the distribution losses. Next, the EMS sends the electricity cost $\mu(E^{t}{}_{g})$to the CEMS. Upon obtaining the electricity cost, each of the community improves the consumption pattern and transfer the control to the HEMS.

We assume that HEMS connects the appliances of a customer through an HAN (Home Area Network), and a NAN (Neighborhood Area Networks) connects the HEMS to the CEMS. Also, CEMSs are connected to the substation EMS using a WAN (Wide Area Network) to transfer control and measurements between them. Besides, all other components of the grid (PMU, PDC, etc.) are dedicated to monitoring and reporting measurements for the stability and the fault free operation of the electrical network according to the decision made by the EMS. Based on the mentioned system architecture, our proposed system is composed of two major energy management schemes: (i) VVCO and (ii) OECM which are shown in Fig. 3 which interact to achieve the minimum energy generation cost and billing of the customer while satisfying the demand.

III. RESEARCH METHODALOGY

This proposed technique a propelled voltage bolster plot tending to these three issues. To begin with, it completely remunerates the zero-grouping segment and precisely manages the stage voltages inside the pre-set security constrain under lopsided blame conditions. The wellbeing voltage limits are commonly forced by lattice codes for continuous activity of GCCs. Second, the proposed plan is material to resistive frameworks, for example run of the mill circulation frameworks. Third, the dynamic power exchanged by the GCC is additionally considered in the proposed VSS. The conveyed dynamic power is, notwithstanding, very oscillatory under extreme unequal conditions. This paper likewise proposes an explanatory procedure to confine the dynamic power motions and upgrade dc-transport voltage adjustment, called constrained dynamic power wavering (LAPO). As the third commitment, the most extreme dynamic power conveyance is likewise detailed

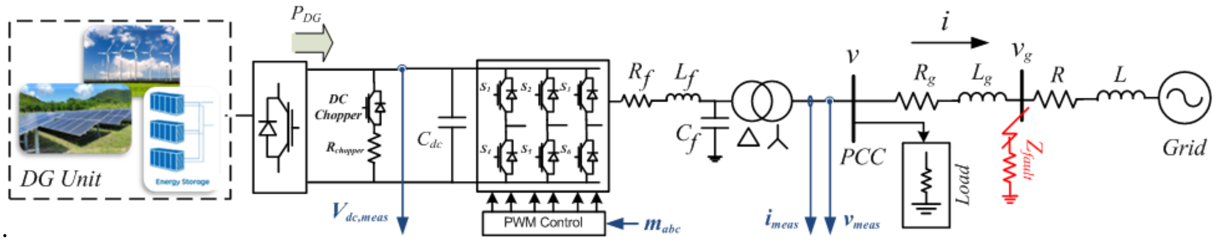


Figure 2. Circuit topology of the grid-connected converter

A. OPERATING PRINCIPLE

Fig. 2 illustrates the schematic of a GCC-based DG unit along with its different control parameters. A grid fault or unbalanced loading can cause unbalanced voltage condition at the PCC of a GCC. For any unbalanced condition, the positive and negative sequence voltage vectors can be written in the $\alpha\beta$ frame as

$$v^{+}=\begin{bmatrix} v_{\alpha}^{+} \\ v_{\beta}^{+} \end{bmatrix}=\begin{bmatrix} V^{+}\cos(\omega t+\delta^{+}) \\ V^{+}\sin(\omega t+\delta^{+}) \end{bmatrix},$$

$$v^{-}=\begin{bmatrix} v_{\alpha}^{-} \\ v_{\beta}^{-} \end{bmatrix}=\begin{bmatrix} V^{-}\cos(\omega t+\delta^{-}) \\ -V^{-}\sin(\omega t+\delta^{-}) \end{bmatrix} \qquad \text{----- (1)}$$

To exploit a flexible supportive performance from a GCC, its injected current vector, *i*, can be divided into four vectors of positive and negative sequences and active and reactive components as

$$i=i_{p}^{+}+i_{p}^{-}+i_{q}^{+}+i_{q}^{-}$$

$$i=\begin{bmatrix} i_{\alpha} \\ i_{\beta} \end{bmatrix}=\begin{bmatrix} I_{p}^{+}\cos(\omega t+\delta^{+})+I_{p}^{-}\cos(\omega t+\delta^{-}) \\ I_{p}^{+}\sin(\omega t+\delta^{+})-I_{p}^{-}\sin(\omega t+\delta^{-}) \end{bmatrix}$$

$$+\begin{bmatrix} I_{q}^{+}\sin(\omega t+\delta^{+})-I_{q}^{-}\sin(\omega t+\delta^{-}) \\ -I_{q}^{+}\cos(\omega t+\delta^{+})-I_{q}^{-}\cos(\omega t+\delta^{-}) \end{bmatrix} \qquad \text{---- (2)}$$

where the superscripts "+"/"-" and subscripts "*p*"/"*q*" denote the positive/negative and active/reactive components, respectively. These current components should be found in a way that they can provide the required voltage support with any grid condition. The mathematical expressions of the AC-side voltages in terms of the injected active/reactive currents are as

$$v=v^{+}+v^{-}=\begin{bmatrix} v_{\alpha}^{+}+v_{\alpha}^{-} \\ v_{\beta}^{+}+v_{\beta}^{-} \end{bmatrix}=\begin{bmatrix} v_{g\alpha}^{+}+v_{g\alpha}^{-}+L_{g}\dfrac{di_{\alpha}}{dt}+R_{g}i_{\alpha} \\ v_{g\beta}^{+}+v_{g\beta}^{-}+L_{g}\dfrac{di_{\beta}}{dt}+R_{g}i_{\beta} \end{bmatrix} \qquad \text{----- (3)}$$

where the subscript "*g*" represents the grid components according to Fig 2. Eq (3) can be expanded as (4).

$$\begin{bmatrix} V^{+}\cos(\omega t+\delta^{+})+V^{-}\cos(\omega t+\delta^{-}) \\ V^{+}\sin(\omega t+\delta^{+})-V^{-}\sin(\omega t+\delta^{-}) \end{bmatrix}=\begin{bmatrix} V_{g}^{+}\cos(\omega t+\delta_{g}^{+})+V_{g}^{-}\cos(\omega t+\delta_{g}^{-}) \\ V_{g}^{+}\sin(\omega t+\delta_{g}^{+})-V_{g}^{-}\sin(\omega t+\delta_{g}^{-}) \end{bmatrix}+L_{g}\omega\begin{bmatrix} I_{q}^{+}\cos(\omega t+\delta^{+})-I_{q}^{-}\cos(\omega t+\delta^{-}) \\ I_{q}^{+}\sin(\omega t+\delta^{+})+I_{q}^{-}\sin(\omega t+\delta^{-}) \end{bmatrix}$$

$$+L_{g}\omega\begin{bmatrix} -I_{p}^{+}\sin(\omega t+\delta^{+})-I_{p}^{-}\sin(\omega t+\delta^{-}) \\ I_{p}^{+}\cos(\omega t+\delta^{+})-I_{p}^{-}\cos(\omega t+\delta^{-}) \end{bmatrix}+R_{g}\begin{bmatrix} I_{p}^{+}\cos(\omega t+\delta^{+})+I_{p}^{-}\cos(\omega t+\delta^{-}) \\ I_{p}^{+}\sin(\omega t+\delta^{+})-I_{p}^{-}\sin(\omega t+\delta^{-}) \end{bmatrix}+R_{g}\begin{bmatrix} I_{q}^{+}\sin(\omega t+\delta^{+})-I_{q}^{-}\sin(\omega t+\delta^{-}) \\ -I_{q}^{+}\cos(\omega t+\delta^{+})-I_{q}^{-}\cos(\omega t+\delta^{-}) \end{bmatrix} \qquad \text{--- (4)}$$

In general, the difference between δ^{+} and δ_{g}^{+} is negligible. Therefore, the analytical solution of the problem can be simplified by assuming δ^{+} and δ_{g}^{+} to be equal. Equation (4) can be represented as

$$\begin{bmatrix} \left(V^{+}-V_{g}^{+}\right)\cos(\omega t+\delta^{+})+\left(V^{-}-V_{g}^{-}\right)\cos(\omega t+\delta^{-}) \\ \left(V^{+}-V_{g}^{+}\right)\sin(\omega t+\delta^{+})-\left(V^{-}-V_{g}^{-}\right)\sin(\omega t+\delta^{-}) \end{bmatrix}$$

$$=\begin{bmatrix} \left(L_{g}\omega I_{q}^{+}+R_{g}I_{p}^{+}\right)\cos(\omega t+\delta^{+}) \\ \left(L_{g}\omega I_{q}^{+}+R_{g}I_{p}^{+}\right)\sin(\omega t+\delta^{+}) \end{bmatrix}$$

$$+\begin{bmatrix} \left(R_{g}I_{p}^{-}-L_{g}\omega I_{q}^{-}\right)\cos(\omega t+\delta^{-}) \\ -\left(R_{g}I_{p}^{-}-L_{g}\omega I_{q}^{-}\right)\sin(\omega t+\delta^{-}) \end{bmatrix}$$

----- (5)

if the following expressions are satisfied:

$$\frac{I_{p}^{+}}{I_{q}^{+}}=\frac{R_{g}}{L_{g}\omega}, \quad \frac{I_{p}^{-}}{I_{q}^{-}}=-\frac{R_{g}}{L_{g}\omega}$$

----- (6)

Then, the positive and negative components of (5) result in

$$\begin{cases} V^{+}-V_{g}^{+}=L_{g}\omega I_{q}^{+}+R_{g}I_{p}^{+} \\ V^{-}-V_{g}^{-}=R_{g}I_{p}^{-}-L_{g}\omega I_{q}^{-} \end{cases}$$

----- (7)

B. ZERO-SEQUENCE COMPENSATED VOLTAGE SUPPORT (ZCVS) SCHEME

The basic requirement in the voltage support is to avoid the over-voltage and under-voltage at the PCC whenever possible. If the rated power of the GCC and the connecting line impedance are not small, the three-phase voltages can be regulated at the pre-set safety limits, i.e., V_{min}^{set} and V_{max}^{set}. The proposed scheme was only applied to the STATCOM application where the reference current only consists of the reactive components. However, the effect of the active power in regulating the voltage should not be ignored at the distribution level since: (1) the resistance of the lines in the distribution system is not negligible; and, (2) DGs inherently generate and inject the active power to the system. Therefore, the active components of the current are also taken into account in this paper as presented in the next section. Complying with voltage limits during unbalanced grid faults, the maximum and minimum phase voltages should respect

$$V_{\max}=\max\{V_{a},V_{b},V_{c}\}\leq V_{\max}^{set}$$
$$V_{\min}=\min\{V_{a},V_{b},V_{c}\}\geq V_{\min}^{set}$$

----- (8)

where V_a, V_b, and V_c are the magnitude of the three-phase voltages at the PCC of the GCC. The value of - are set to 0.9-1.1 pu and 0.8-1.2 pu, respectively, in the simulation and experimental tests in this paper. To meet these limits, a combination of positive/negative and active/reactive currents (i.e., I_p^+, I_p^-, I_q^+, and I_q^-) should be injected into an inductive or resistive grid to support the grid voltage. These four reference values should be properly found such that the maximum phase voltage does not overpass V_{max}^{set}, and the minimum phase voltage is kept at (or above) V_{min}^{set}. The ac-side voltage support scheme can be extracted as a function of the grid voltage and the injected positive/negative currents. The magnitudes of the phase voltages can be obtained in terms of the magnitudes of positive and negative sequence voltages by the following expressions:

$$\begin{cases} V_{a}=\sqrt{(V^{+})^{2}+(V^{-})^{2}+2(V^{+})(V^{-})\cos(\gamma)}+(V^{0})\cos(\gamma^{0}) \\ V_{b}=\sqrt{(V^{+})^{2}+(V^{-})^{2}+2(V^{+})(V^{-})\cos(\gamma-\frac{2\pi}{3})}+(V^{0})\cos(\gamma^{0}-\frac{2\pi}{3}) \\ V_{c}=\sqrt{(V^{+})^{2}+(V^{-})^{2}+2(V^{+})(V^{-})\cos(\gamma+\frac{2\pi}{3})}+(V^{0})\cos(\gamma^{0}+\frac{2\pi}{3}) \end{cases}$$

----- (9)

where $\gamma=\delta^{+}-\delta^{-}$ and $\gamma^{0}=\delta^{0}-\delta^{+}$. From (9), the maximum and minimum phase voltages can be determined by

$$V_{\min} = \min(V_a, V_b, V_c) = \sqrt{(V^+)^2 + (V^-)^2 + 2(V^+)(V^-)\lambda_{\min}} + (V^0)\lambda^0_{\min}$$
$$V_{\max} = \max(V_a, V_b, V_c) = \sqrt{(V^+)^2 + (V^-)^2 + 2(V^+)(V^-)\lambda_{\max}} + (V^0)\lambda^0_{\max} \quad \text{----- (10)}$$

Where $\lambda_{\min}$, $\lambda_{\max}$, $\lambda^0_{\min}$, and $\lambda^0_{\max}$ and can be found as follows.

$$\begin{cases} \lambda_a = \cos(\gamma) \\ \lambda_b = \cos(\gamma - \frac{2\pi}{3}) \\ \lambda_c = \cos(\gamma + \frac{2\pi}{3}) \end{cases} \rightarrow \begin{cases} \lambda_{\min} = \min(\lambda_a, \lambda_b, \lambda_c) \\ \lambda_{\max} = \max(\lambda_a, \lambda_b, \lambda_c) \end{cases}$$
$$\begin{cases} if \quad \lambda_{\min} = \lambda_a \rightarrow \lambda^0_{\min} = \cos(\gamma^0) \\ if \quad \lambda_{\min} = \lambda_b \rightarrow \lambda^0_{\min} = \cos(\gamma^0 - \frac{2\pi}{3}) \\ if \quad \lambda_{\min} = \lambda_c \rightarrow \lambda^0_{\min} = \cos(\gamma^0 + \frac{2\pi}{3}) \end{cases}$$
$$and \begin{cases} if \quad \lambda_{\max} = \lambda_a \rightarrow \lambda^0_{\max} = \cos(\gamma^0) \\ if \quad \lambda_{\max} = \lambda_b \rightarrow \lambda^0_{\max} = \cos(\gamma^0 - \frac{2\pi}{3}) \\ if \quad \lambda_{\max} = \lambda_c \rightarrow \lambda^0_{\max} = \cos(\gamma^0 + \frac{2\pi}{3}) \end{cases} \quad \text{----- (11)}$$

The reference values for the maximum and minimum phase voltages of (10) can be determined such that the phase voltages are regulated within the explained thresholds of (8). This can be accomplished by setting the reference values as

$$V^{ref}_{\min} = V^{set}_{\min}$$
$$V^{ref}_{\max} = \min(V^{set}_{\max}, (V_{\max} - V_{\min})) \quad \text{----- (12)}$$

After finding the proper V^{ref}_{min} and V^{ref}_{max} by (12) and applying them in (10), the reference values for the V^+_{ref} and V^-_{ref} can be solved as

$$(V^+_{ref})^2 = \frac{-B + \sqrt{B^2 - 4A^2}}{2} \quad \text{----- (13)}$$
$$V^-_{ref} = \frac{A}{V^+_{ref}}$$

where

$$\begin{cases} A = \dfrac{V_H - V_L}{2(\lambda_{\max} - \lambda_{\min})} \\ B = 2A \times \lambda_{\max} - V_H \end{cases}$$
$$V_L = (V^{ref}_{\min} - V^0\lambda^0_{\min})^2$$
$$V_H = (V^{ref}_{\max} - V^0\lambda^0_{\max})^2 \quad \text{----- (14)}$$

Using (13)-(14), the reference values for the desired positive and negative sequences of the voltage are obtained. Then, V^+ and V^- in (7) are replaced with the reference values obtained by (13)-(14). Moreover, V_g^+ and V_g^- can be estimated by using the PCC measurements. Therefore, (7) can be rewritten as

$$\begin{bmatrix} \Delta V^+_{ref} \\ \Delta V^-_{ref} \end{bmatrix} = \begin{bmatrix} \omega L_g I^+_q \\ -\omega L_g I^-_q \end{bmatrix} + \begin{bmatrix} R_g I^+_p \\ R_g I^-_p \end{bmatrix} \quad \text{----- (15)}$$

Now, the solution of (15) exists in the determination of four current components (I^+_p ,I^-_p,I^+_q , and I^-_q). A general solution for (15), which is applicable in grids with any *X/R* ratio, can be obtained as

$$I_p^+ = \frac{R_g}{X_g^2 + R_g^2} \times \Delta V_{ref}^+, \quad I_p^- = \frac{R_g}{X_g^2 + R_g^2} \times \Delta V_{ref}^-$$

$$I_q^+ = \frac{X_g}{X_g^2 + R_g^2} \times \Delta V_{ref}^+, \quad I_q^- = \frac{-X_g}{X_g^2 + R_g^2} \times \Delta V_{ref}^- \qquad \text{----- (16)}$$

where expressions of (6) are also satisfied. In inductive and resistive grids, the effective current components in providing voltage support can be conducted from (16), respectively, as (17) and (18)

$$I_q^+ = \frac{\Delta V_{ref}^+}{X}, \quad I_q^- = \frac{-\Delta V_{ref}^-}{X} \qquad \text{----- (17)}$$

$$I_p^+ = \frac{\Delta V_{ref}^+}{R}, \quad I_p^- = \frac{\Delta V_{ref}^-}{R} \qquad \text{----- (18)}$$

According to (16), the active components do not contribute in supporting the voltage in an inductive grid. In this case, they can be utilized to fulfill complementary objectives discussed in the next section (i.e. MAPD strategy).

C. PROPOSED HARDWARE SYSTEM

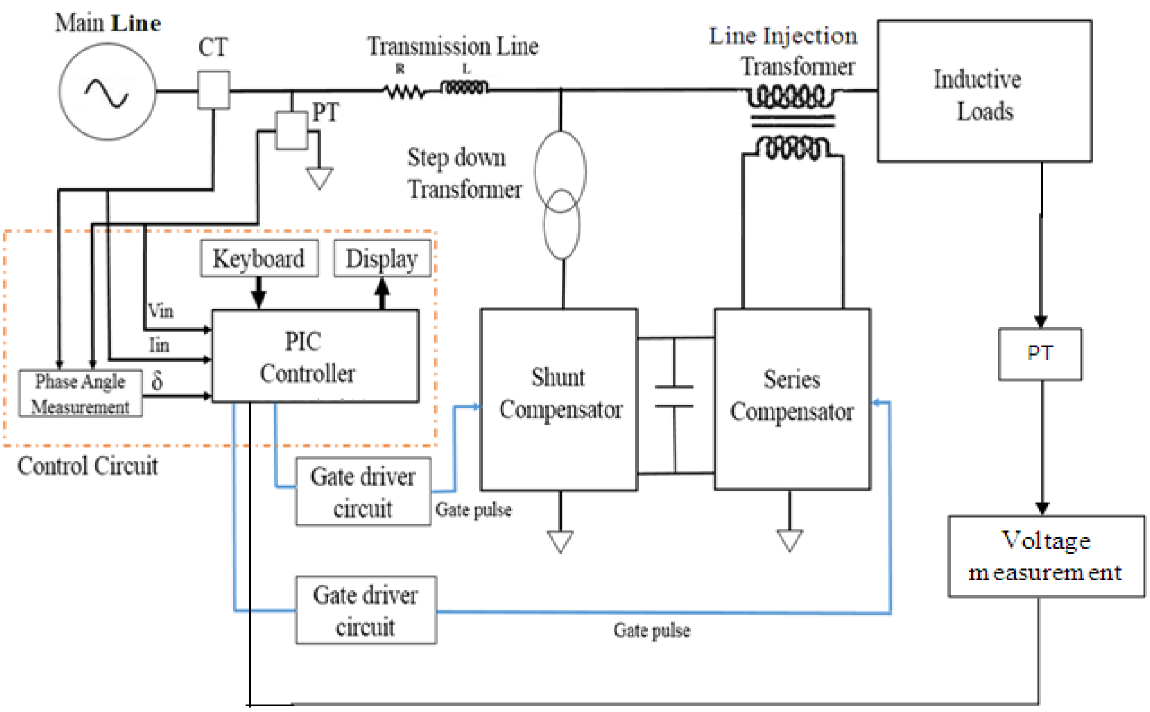


Figure 3. Proposed block Diagram

Power supply gives supply to all components. it is used to convert AC voltage into DC voltage. Transformer used to convert 230V into 12V AC.12V AC is given to diode. Diode range is 1N4007, which is used to convert AC voltage into DC voltage. AC capacitor used to charge AC components and discharge on ground. LM 7805 regulator is used to maintain voltage as constant. Then signal will be given to next capacitor, which is used to filter unwanted AC component. Load will be LED and resister.LED voltage is 1.75V.if voltage is above level beyond the limit, then it will be dropped on resister.

Voltage measurement unit used for read the line voltage for monitoring voltage level through controller unit. Current value read from the current measurement unit for analyzing the power factor value. Phase angle unit helps to derive the phase angle value through the current and voltage value.

Microcontroller analyzes the Voltage level for sag and swell value to trigger the gate driver units for switching the shunt and series compensators. Step down transformers used for given the dc supply for shunt and series compensators

D. Series converter:

In series resonant converters, the load is connected in series with the series L-C circuit through a transformer. The transformer ac output is then rectified to get the desired dc voltage.

E.Shunt (Parallel) inverter:

Parallel inverter used to convert DC voltage into AC voltage and given over the transmission line. Then load will be operated through shunt inverter.

IV. RESULTS & DISCUSSION

A. SIMULATION PLATFORM

Simulink is a software package for modeling, simulating, and analyzing dynamical systems. It supports linear and nonlinear systems, modeled in continuous time, sampled time, or a hybrid of the two. Systems can also be multi rate, i.e., have different parts that are sampled or updated at different rates . For modeling, Simulink provides a graphical user interface (GUI) for building models as block diagrams, using click-and-drag mouse operations. With this interface, you can draw the models just as you would with pencil and paper. Simulink includes a comprehensive block library of sinks, sources, linear and nonlinear components, and connectors. Models are hierarchical, the models are built using both top-down and bottom up approaches the system can viewed at a high level, then double-click on blocks to go 5 down through the levels to see increasing levels of model detail. This approach provides insight into how a model is organized and how its parts interact.After a model is defined, it can simulate, using a choice of integration methods, either from the Simulink menus or by entering commands in MATLAB's command window. The menus are particularly convenient for interactive work, while the command-line approach is very useful for running a batch of simulations. Using scopes and other display blocks, the simulation results can see while the simulation is running. In addition, the parameters can be changed and immediately see what happens, for "what if" exploration. The simulation results can be put in the MATLAB workspace for post processing and visualization .Model analysis tools include linearization and trimming tools, which can be accessed from the MATLAB command line, plus the many tools in MATLAB and its application toolboxes. And because MATLAB and Simulink are integrated, you can simulate, analyze, and revise your models in either environment at any point.

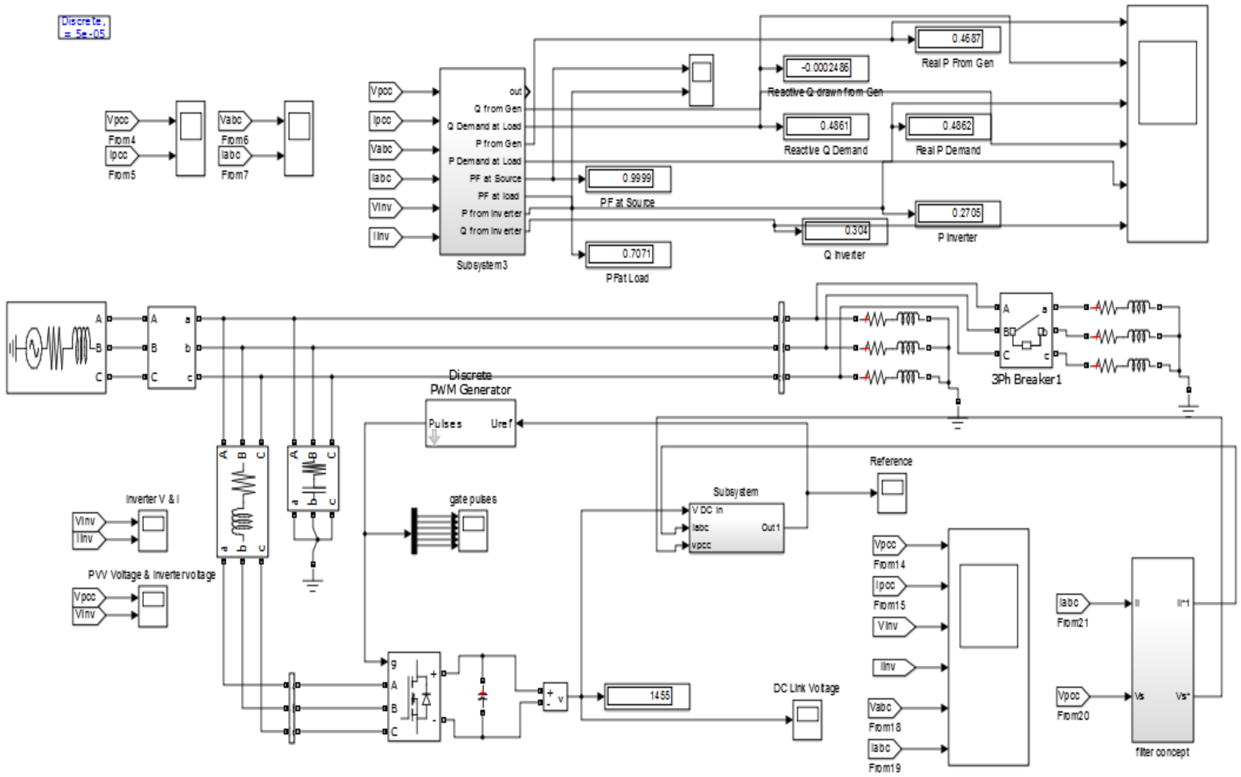


Figure 4. Simulink Model of Volt/VARManagement of DG System

The power factor, real and reactive power measurement are the indeed one in this work. The reactive power and real power measurements block has to be designed separately in MATLAB. The figures 5 & 6 shows the power measurement blocks in this work.

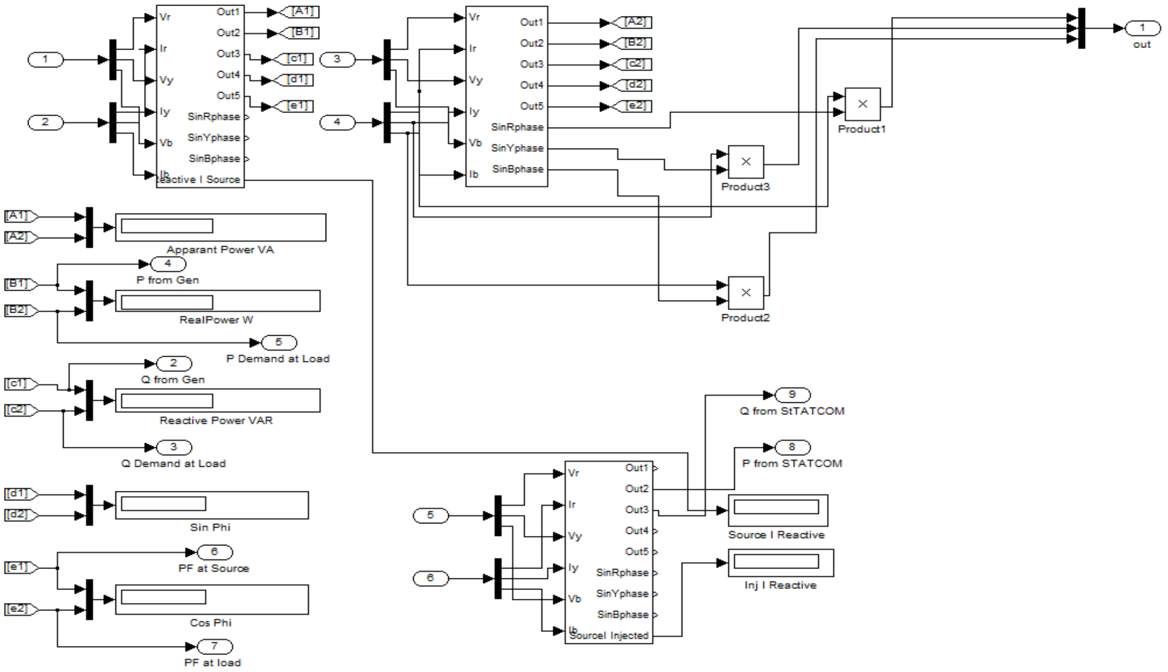


Figure 5. Simulink model of Power Factor, Real power and Reactive Power Measurement

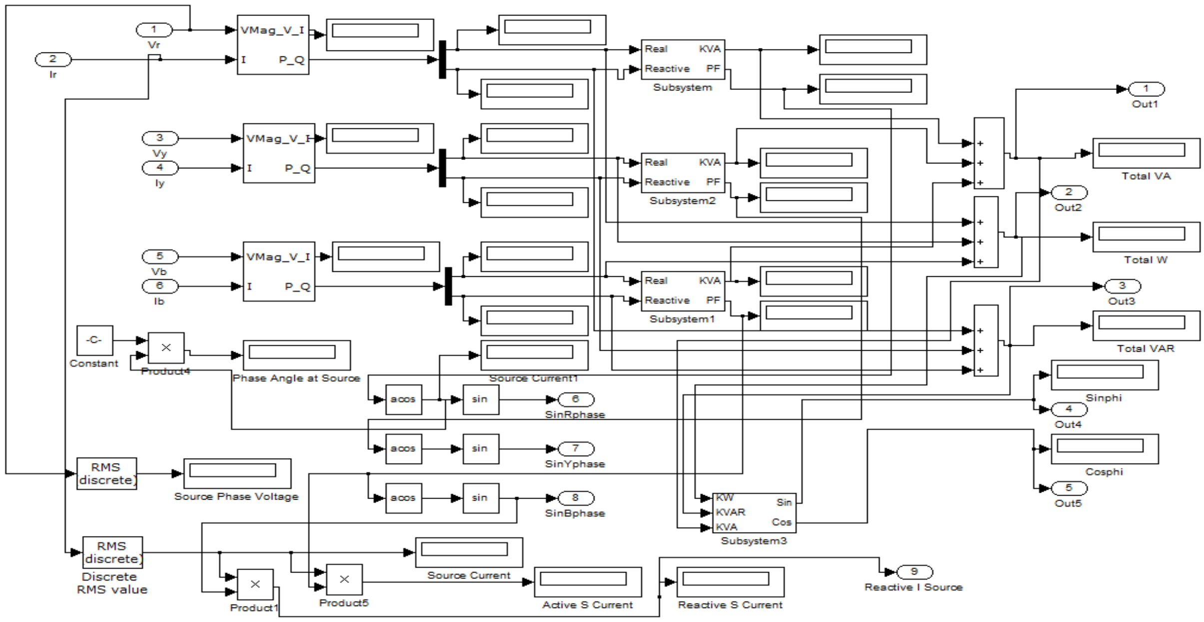


Figure 6. Simulink model of Real power and Reactive Power

The main control bloc in the proposed system is designed with the PI controller as a main controller it is displayed in the following figure 7.

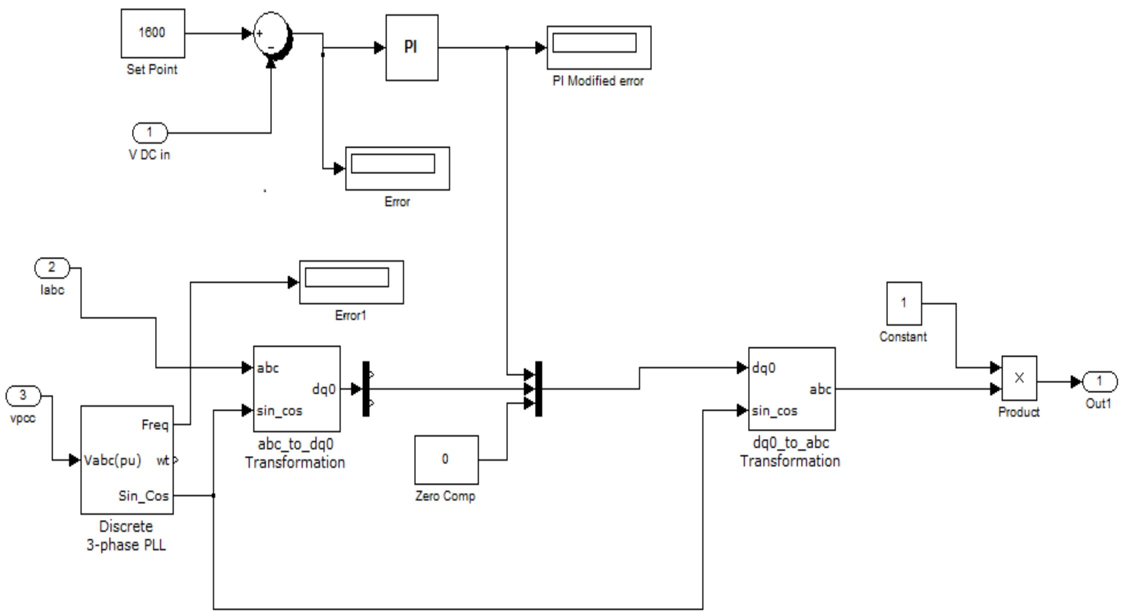


Figure 7. Simulink model of STATCOM tuning with PI Controller

V. RESULTS AND DISCUSSION

The effectiveness of the proposed system is depicted in this section and the reactive loads are gradually added for a specific time interval in this simulation work. The three phase circuit breaker is added at two intervals ie(, 0.1s-0.3s & 0.5s-0.7s.)

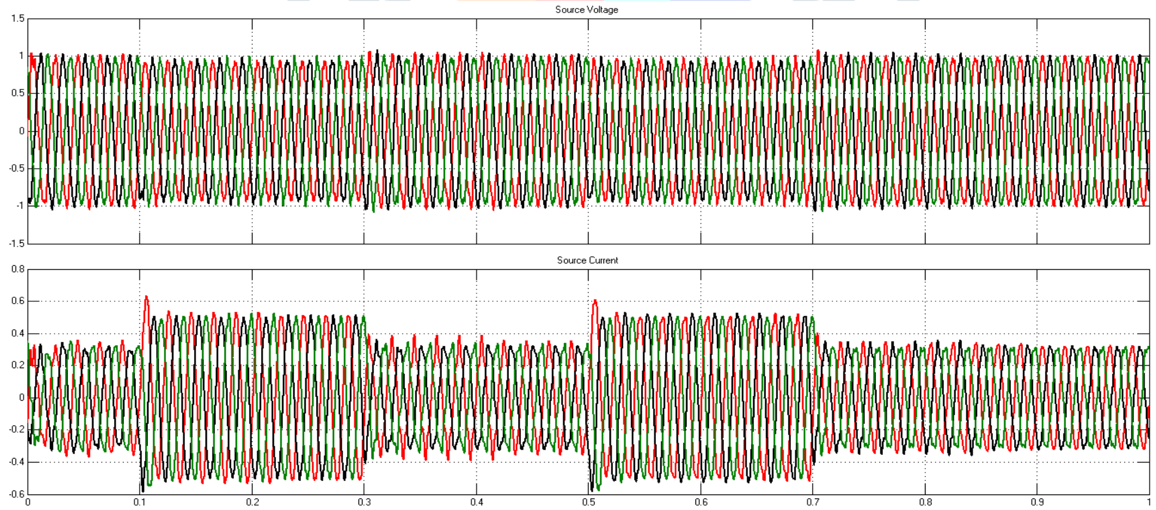


Figure 8. Source Voltage and Current output waveform

The above figure 8 shows the source side voltage and current waveforms in this simulation. As stated before the extra reactive loads are added at two aforementioned intervals and the source voltage profile is shown in the figure and source current at the intervals are high because of the effect of overloading.

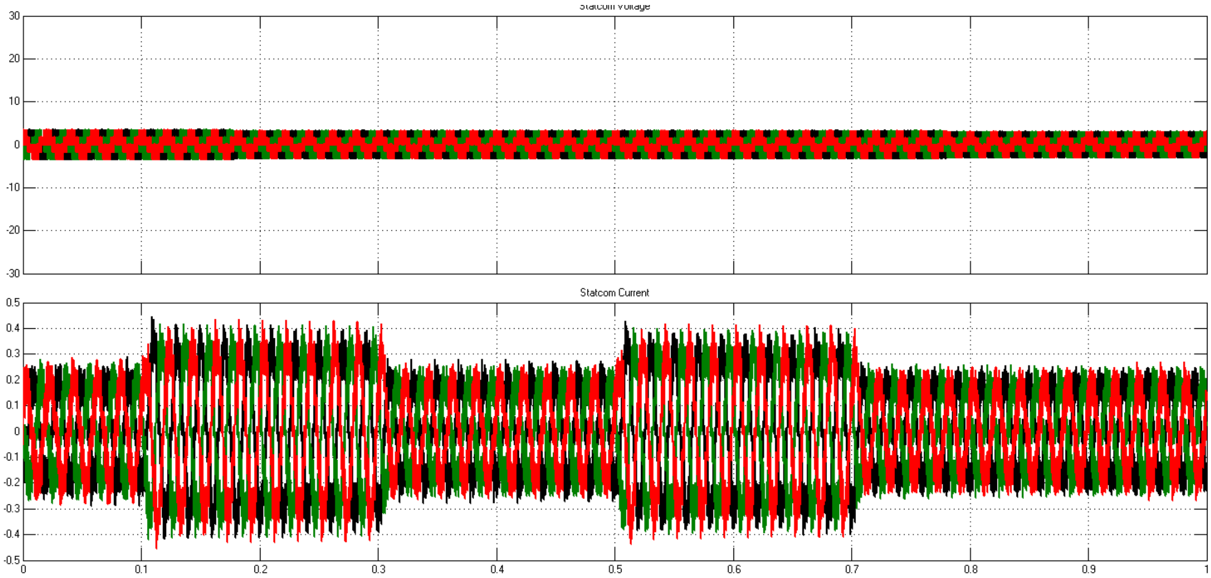


Figure 9. Source Voltage and Current output waveform

The power factor comparison at source and load side is shown in the following figure. The waveforms represent the power factor drops at the source side during the overloading periods. On the other hand, the load side power factor is maintained at higher degree because of the impact of STATCOM.

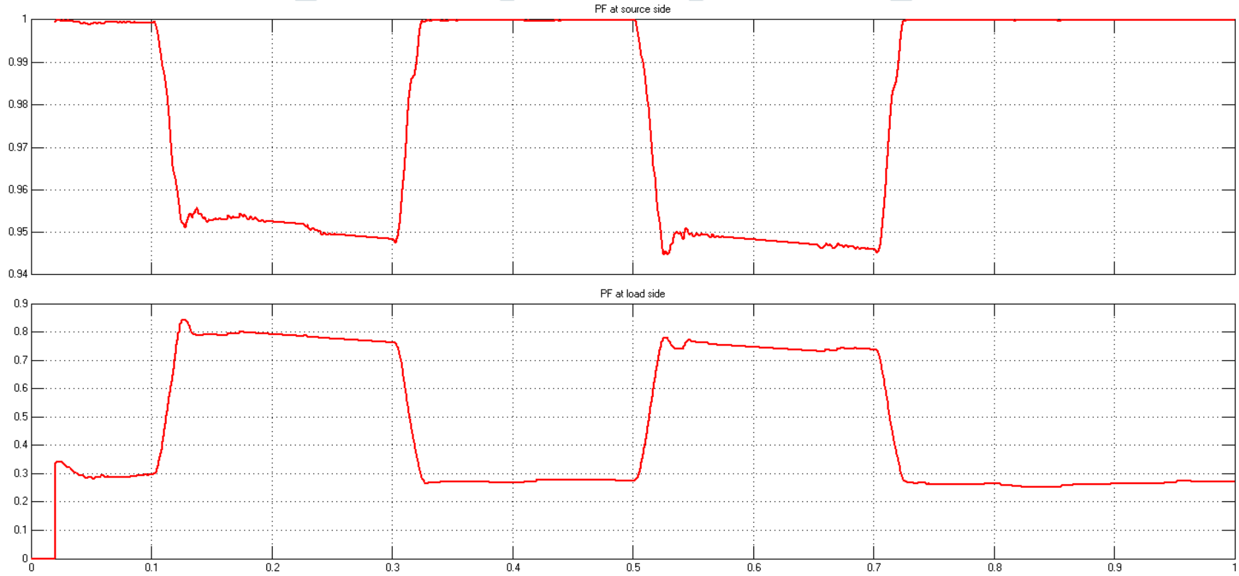


Figure 10. Power Factor , source side and load side output waveform

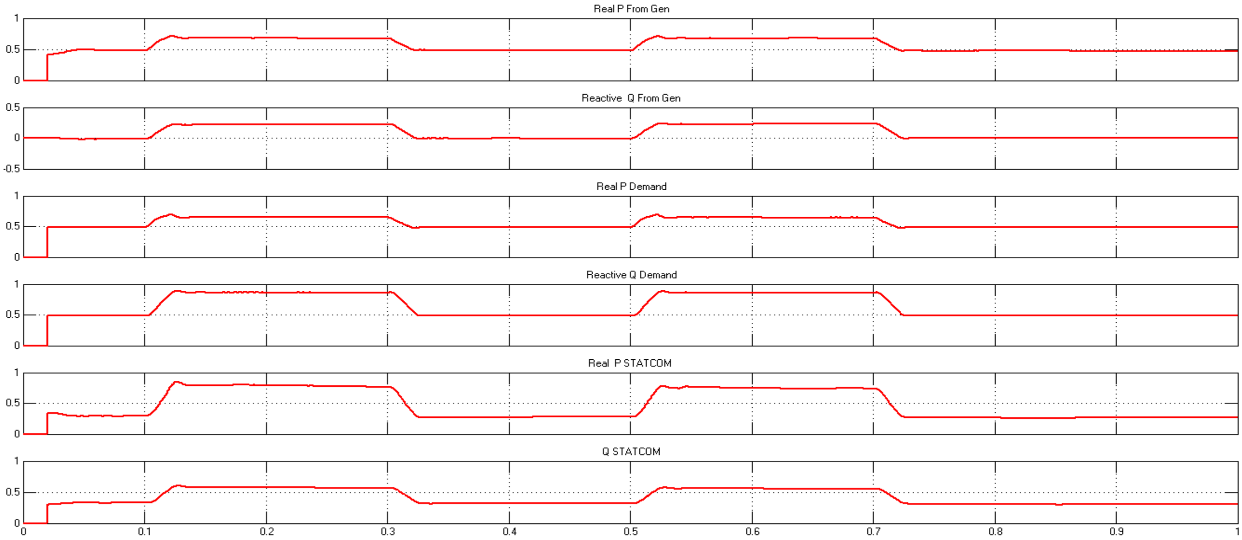


Figure 11. Real and Reactive Power output wave form

V. CONCLUSION

The proposed method a propelled voltage bolster plan to correctly direct the stage voltages of a three-stage framework associated converter inside the pre-set wellbeing limits. Existing strategies fundamentally experience the ill effects of three issues (i) Their execution ends up wrong much of the time in view of disregarding the zero-succession voltage segment (ii) They can be just connected in inductive lattices (iii) Zero dynamic power conveyance is proposed. The proposed ZCVS technique tends to these three issues. Additionally, two integral goals, identified with the dynamic power conveyance, are likewise expanded in the proposed plan. To begin with, the restricted dynamic power wavering is proposed under extreme lopsided shortcomings to diagnostically get a point of confinement for the infused negative receptive current. This element gives a customizable restricted dynamic power swaying, and enhanced DC voltage while supporting the air conditioner side voltage. Second, the outflows of the greatest dynamic power conveyance are proposed to misuse the most extreme admissible dynamic intensity of an appropriated vitality asset even under serious unbalances and keeping in mind that as yet controlling the stage voltages. The proposed voltage bolster plan and two correlative procedures convey huge favorable circumstances to developing dispersed age units. In Future, design and implementation of Real and Reactive Power Management in Distribution System for Unbalanced Conditions.

REFERENECES

1. M. K. Hossain and M. H. Ali, "Transient Stability Augmentation of PV/DFIG/SG-Based Hybrid Power System by Nonlinear Control-Based Variable Resistive FCL," in *IEEE Transactions on Sustainable Energy*, vol. 6, no. 4, pp. 1638-1649, Oct. 2015.
2. H. Xiao, et al. "An Improved Control Method for Multiple Bidirectional Power Converters in Hybrid AC/DC Microgrid," in *IEEE Transactions on Smart Grid*, vol. 7, no. 1, pp. 340-347, Jan. 2016.
3. P. Wang, et al. "Distributed Control for Autonomous Operation of a Three-Port AC/DC/DS Hybrid Microgrid," in *IEEE Transactions on Industrial Electronics*, vol. 62, no. 2, pp. 1279-1290, Feb. 2015.
4. K. A. Alobeidli, et al. "Novel Coordinated Voltage Control for Hybrid Micro-Grid With Islanding Capability," in *IEEE Transactions on Smart Grid*, vol. 6, no. 3, pp. 1116-1127, May 2015.
5. A. Camacho, et al. "Reactive Power Control for Distributed Generation Power Plants to Comply With Voltage Limits During Grid Faults," in *IEEE Trans. on Power Electronics*, vol. 29, no. 11, Nov. 2014.
6. S. Chaudhary, et al. "Negative sequence current control in wind power plants with VSC-HVDC connection," IEEE Trans. Sustainable Energy, vol. 3, no. 3, pp. 535–544, Jul. 2012.
7. Y. Mohamed and E. El-Saadany, "A control scheme for PWM voltage source distributed-generation inverters for fast load-voltage regulation and effective mitigation of unbalanced voltage disturbances," IEEE Trans. Ind. Electron., vol. 55, no. 5, pp. 2072–2084, May 2008.
8. Abdul MotinHowlader, TomonobuSenjyu, "A comprehensive review of low voltage ride through capability strategies for the wind energy conversion systems", Renewable and Sustainable Energy Reviews, Volume 56, April 2016, Pages 643-658, ISSN 1364-0321.

9. Mohammadalizadeh-Shabestary M., et al. “A general approach for optimal allocation of FACTS devices using equivalent impedance models of VSCs” International Transactions on Electr. Energ. Syst., 25, 1187–1203, July 2015.
10. HamedHashemiDezaki, et al. ″A New Method based on Sensitivity Analysis to Optimize the Placement of SSSCs″, Turkish Journal of Electrical Engg and Computer Sciences, Vol. 21, Issue 1, Dec. 2013.
11. A.K. Pathak, M.P Sharma, Mahesh Bundele, A critical review of voltage and reactive power management of wind farms, Renewable and Sustainable Energy Reviews, Volume 51, Nov. 2015, pp. 460-471.
12. M. Nasiri, J. Milimonfared, S.H. Fathi, A review of low-voltage ride-through enhancement methods for permanent magnet synchronous generator based wind turbines, Renewable and Sustainable Energy Reviews, Volume 47, July 2015, Pages 399-415.