POWER QUALITY ENHANCEMENT BY VOLTAGE REGULATOR IN DISTRIBUTION GRID

BANOTH ANUSHA*, K.RAJANI**

*Pg scholar, Department of Power Electronics and Drives, Anurag Engineering College, Kodad, TS, India.

** Assistant Professor, Department of Electrical and Electronics Engineering Anurag Engineering College, Kodad, TS, India.

ABSTRACT: This Project exposes a Voltage-Controlled Dstatcom-Based Voltage Regulator for Low Voltage Distribution Grids. The Voltage Regulator is intended to momentarily meet the grid code, postponing unplanned investments while a definitive solution could be planned to solve regulation issues. The power stage is composed of a three-phase four-wire voltage source inverter (VSI) and a second order low-pass filter. The control strategy has three output voltage loops with active damping and two dc bus voltage loops. In addition, two loops are included to the proposed control strategy: the concept of Minimum Power Point Tracking (MPPT) and the frequency loop. The MPPT allows the voltage regulator to operate at the minimum power point (MPPT), avoiding the circulation of unnecessary reactive compensation. The frequency loop permits the voltage regulator to be freelance of the grid voltage information, especially the grid angle, using only the knowledge available at the point of common coupling (pcc). Preliminary results show the regulation capacity, the choices of the MPPT algorithm program for linear and nonlinear loads and therefore frequency stability.

Keywords: DSTATCOM, Minimum Power Point Tracking (MPPT), second order low-pass filter.

I.INTRODUCTION: At the terminal of low voltage regulation arrange grids may experience extremely poor voltage regulation. According to Brazilian system code, control associations have obliged due dates (15 to 90 days) to restore the voltage levels at the Point of basic Coupling (PCC) if voltages are outside the reasonable dimensions. The time required for everlasting arrangements, like framework modifying or capacitor banks connection, to be at the operational may outperform the due dates. Because of powerlessness to meet the dead lines, the power association needs to limit every customer and client in the appropriation system and framework in the midst of the time amid poor voltage regulation will be hung on.

So as to turn away discounts to clients, an appropriate voltage controller can be utilized as a temporary arrangement. The voltage controller ought to have brisk voltage direction, diminish weight and basic foundation. Using the proposed game plan, the matrix and system control quality is reestablished and the PCC voltages are reestablished in a short time. In the mean time, the interminable arrangement ought to be masterminded and introduced in a timeframe. At the point when the unmistakable courses of action are authorized, the voltage controller could be isolated from the network and combined with another structure with similar issues.

In genuine and certified applications, exceptionally poor voltage regulation happens when the PCC is at long path from the fundamental system and matrix transformer. The partition between the PCC and the transformer can without a doubt be progressively inaccessible roughly 100 meters. Estimation of framework voltage information will be difficult to obtain. So as to experience the voltage direction essential, the voltage-controlled DSTATCOM-based voltage controllers are proposed with shunt relationship with PCC, as showed up at Fig. 1. We know shunt association keeps up a vital separation from power supply impedance when the voltage controller is presented or disengaged. The present DSTATCOM licenses the power association to concede ventures and overhauls the dimension of flexibility of the matrix organization and the executives

The Voltage-control DSTATCOM can keep up the PCC voltages balanced even under framework or load vacillations. The PCC voltage is direct controlled through the DSTATCOM and sudden load varieties has no basic effect at the PCC voltage waveforms. In addition, the voltage-control DSTATCOM separate the system from the heaps, giving a low impedance route to the consonant mutilations because of the voltage source execution.

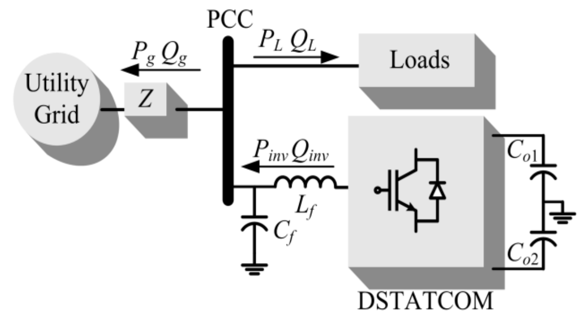

Fig. 1.1 A Low voltage distribution grid at under analysis with voltage controller.

The Current harmonic distortions by the loads have little effect in the network grid and the vice versa. But the network current quality, along these lines, is solely given by the grid voltage quality.

The angular position reference is required for the voltage-control DSTATCOM to operate appropriately. Prior to the DSTATCOM begins its working, synchronization circuits produce the precise angular position at the voltage controller.

When the activity operation starts, the voltage-controlled voltage controller take the position of the PCC voltage and the grid lattice voltage frequency and angle are never again visible. PCC voltage recurrence frequency and then the angle are than determined through the voltage controller. For a real and genuine application, because of the separation between the transformer and the PCC, just the PCC voltage sought to be reckoned to assemble the voltage reference made out of DSTATCOM.

In the past years, PCC voltage amplitudes (VPCC) for the reactive compensation techniques were normally embraced at the nominal grid voltage, i.e.1.00 p.u. Nonetheless, Brazilian network code decides a maximum (1.05 p.u.) and at minimum (0.92 p.u.) voltage amplitude for the very low voltage distribution frameworks and grids. But the PCC amplitude can be seen as a level of emancipation and the assembled power can be lessened with an appropriate control circle. At this exertion, proposes another strategy to decide the appropriate suitable PCC terminal voltage for the decrease in the DSTATCOM power rating. The strategy is planned by desired source current, expecting to accomplish the solidarity unity power factor at the network.

However, this strategy requires the data regarding the source current, network resistance and reactance. In the creators propose one more strategy to decide appropriate suitable VPCC utilizing the positive grouping components of the load current to register at the PCC voltage. In the above two cases, extra information's are required, expanding the procedure in the multiple nature, now there are three number of sensors and the expense of the arrangement and solution.

To keep up the simple establishment features, sensible and the decent costs, therefore it is advantageous to set the PCC voltage, in which the prepared power is insignificant, without observing any load or network data and utilizing just interior signs of the DSTATCOM, for example, the PCC voltages and the DSTATCOM output currents.

II.PROPOSED METHOD: In this effort, we propose another technique to decide the suitable PCC terminal voltage for decline in the DSTATCOM control rating. The procedure is formed by the pined for source current, meaning to achieve the solidarity control factor at the system framework. In any case, these procedures require information about the present source, structure matrix opposition deterrent and reactance. In the makers propose another methodology to decide proper VPCC using the positive progression portions parts at the heap current to make sense of the PCC voltage. In the over two cases, additional data is required, expanding the methodology multifaceted unpredictability nature, the quantity of sensors and cost of the arrangement. To keep up the straightforward foundation highlights incorporate and reasonable sensible expenses, in this way it is profitable to orchestrate the PCC voltage, in which the dealt with power is unimportant to be least, ailing in looking at any heap or network grid information and using internal signs of DSTATCOM, for instance, PCC voltages and DSTATCOM yield streams.

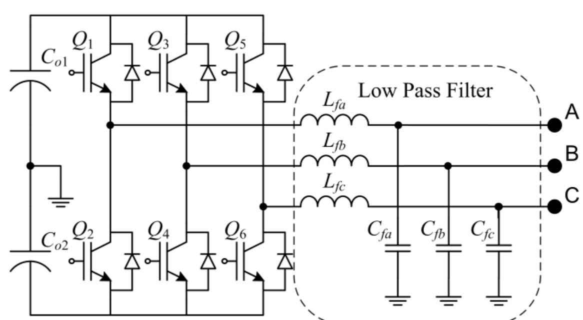

Fig 2.1. LC low-pass filter with 3-Φ 4 wire VSI

This point presents a voltage-control DSTATCOM based voltage controller for low voltage movement dispersion arrange frameworks, using a 3-Φ four-wire VSI with a LC low-pass yield reaction filter, as showed up in Fig.2.1. Action measures of that specific voltage control DSTATCOM and the control framework are presented. Moreover, two round circles are consolidated to the proposed control approach: the possibility of least power point following (mPPT) and the repeat frequency circle. The mPPT keeps up a vital separation in this way it stays away from unnecessary open pay, extending the compensation pay limit. The repeat recurrence circle overcomes the even minded inconvenience of synchronization by diminishing the repeat recurrence of the voltage reference.

The above square graph speaks to the general perspective of the venture; at first the electrical vitality is produced at the utility grid organize .when the utility network is far from the current end clients in the low voltage regulation grids, the end client may encounter a voltage change amid pinnacle hours this may prompts the power interferences. In such cases the heaps which are touchy ought to be secured by the compensator.

The voltage compensator utilized in low voltage dissemination matrices is called as dispersion static synchronous compensator (DSTATCOM). Presently this DSTATCOM is utilized to improve the power quality in the framework. The time taken by DSATCOM in restoration of intensity quality is extremely less when contrasted with time taken by the capacitor banks.

DSTATCOM is utilized in the power circulation matrix to supply the voltage when there is shortage in the voltage levels. The DSTATCOM works in both the routes amid ordinary time it stores the overabundance voltage as capacitors. This abundance voltage is utilized to upgrade the dispersion framework voltage amid lack of voltage levels in pinnacle hours.

The activity and control of voltage levels is constrained by the fluffy controller. The controlled voltages are sent to beat generator which incorporates six changes to manage the voltage go. Presently this working standard technique makes the voltage levels consistent .so then steady voltage is provided to the impasse clients in the power framework.

The control framework intends to create 3 balanced parity voltage waveforms over the PCC with adequate plentifulness, low THD and besides coordinate the voltage at the dc transport capacitors. In this way, the control philosophy has three yield voltage roundabout circles, one total of all and one differential dc transport voltage round circle. The recently referenced controllers were organized through the parameters showed in Table II and surveyed by an extent of the system impedance (0.1 to 10 of Rg and Lg) by repeat recurrence response examination. In this range organized controllers work truly.

Table II. Voltage Regulator Parameters

Nominal Power	S_o	30 kVA
Nominal dc bus voltage	V_o	800 V
Grid voltage	V_g	220 V
Grid frequency	f_g	60 Hz
Switching frequency	f_s	20 kHz
Dc bus capacitance	C_{oeq}	3,500 µF
Output filter inductance	L_f	560 µH
Output filter capacitance	C_f	47 µF
Grid resistance	R_g	0.685 Ω
Grid inductance	L_g	1.82 mH

Table 2.1 Voltage Regualtor Parameter

The above table shows to the parameters of the voltage controller which comprise of ostensible power, ostensible dc transport voltage, and network voltage, grid current, exchanging recurrence, dc transport capacitance, yield channel inductance, yield channel capacitance, lattice obstruction and framework inductance.

The scope of every parameter speaks to their greatest evaluated qualities, for example, Nominal power =30 kva, ostensible dc transport voltage = 800v, network voltage 220 V, matrix recurrence = 60 Hz, exchanging recurrence = 20 KHz, dc transport capacitance = 3500 µH, yield channel inductance = 560 µH, yield channel capacitance = 47µF, lattice obstruction = 0.685 Ώ and framework inductance = 1.82 mH.

Likewise, this subject consolidates two round circles: a roundabout circle accountable for the PCC voltage plenitude plentifulness and another responsible for calming the network lattice repeat recurrence affect over the voltage controller. Fig. 2.2 shows the all out control square outline with plentifulness and the repeat recurrence round circles.

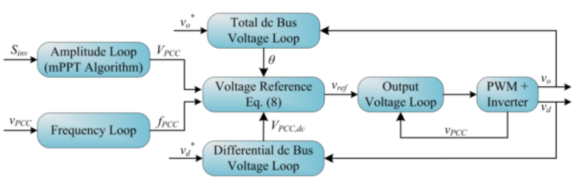

Fig 2.3 the proposed control technique with plentifulness and repeat Frequency loops.

The commitments of the yield voltage circle are three voltage references (vref). The voltage references are made out of the dc transport controllers yield reaction, the mPPT and the repeat recurrence roundabout circles, as outlined in Fig. 9. To achieve plentiful blend of voltage references, the yield voltage circle must have snappy ground-breaking response. The yield controller is of PID controller. The unraveled yield voltage circle square diagram can be found in Fig. 2.3. The yield voltage roundabout circle has dynamic damping controllers to enhance the enduring condition of the voltage controller against the system impedance assortments

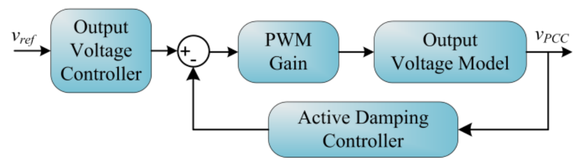

Fig. 2.4. block diagram of the output response voltage loop

The DSTATCOM is made out of 3-stage four-wire VSI and voltage adjusts at the split capacitors are required. The dynamic damping controller is utilized as an input circle controller to lessen the blunders in the framework. The recognize the split capacitor voltages (vd) is appeared differently in relation to the reference voltage (vd*) and a PI notwithstanding post adds to the reference generator with little dc portions (VPCC,dc). This dc part charges one capacitor more than the other.

III.SIMULATION RESULTS:

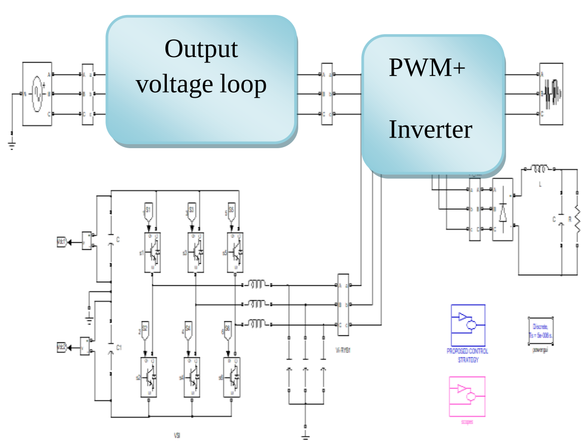

Fig 3.1: Simulation Circuit

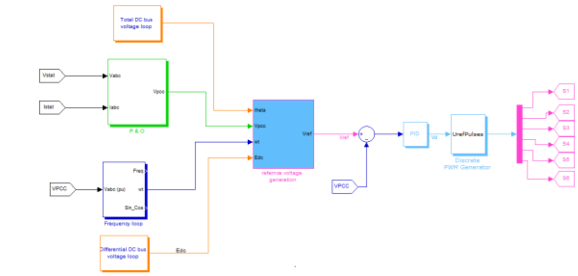

Fig 3.2: Proposed Control Strategies

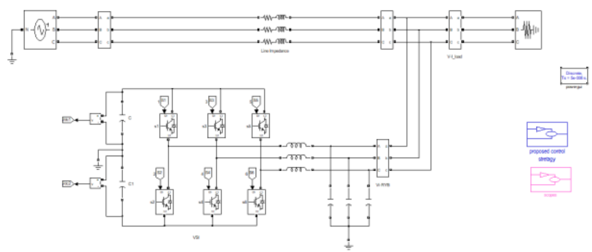

Fig 3.3: Dstatcom Compensator with Linear Loads

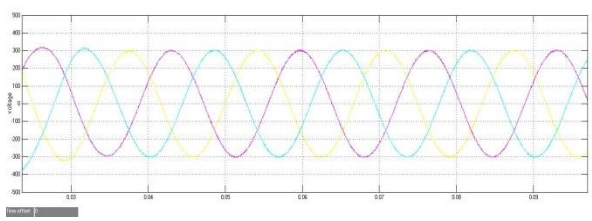

Fig 3.4 Dstatcom Compensator With Linear Loads Waveforms

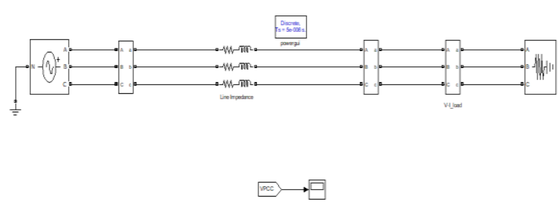

Fig 3.5 Linear Loads without Dstatcom Compensator

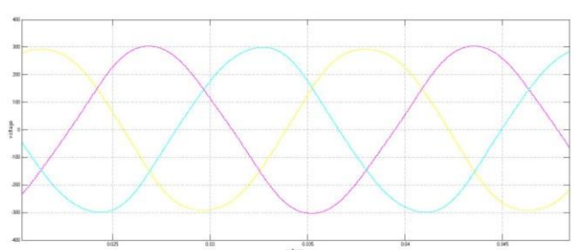

Fig 3.6 Linear Loads Without Dstatcom Compensator Waveforms

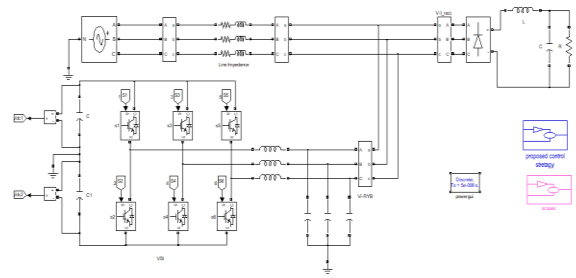

Fig 3.7: Dstatcom Compensator with Non Linear Loads

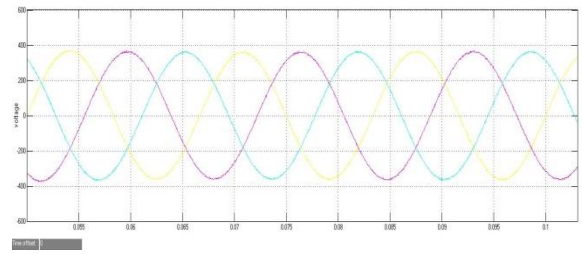

FIG 3.8 Dstatcom Compensator with Non Linear Loads Waveform

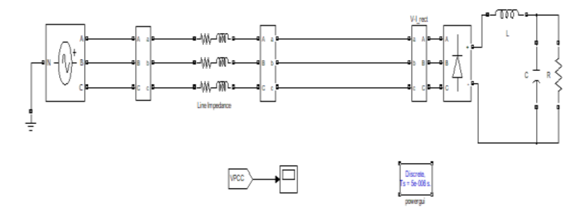

Fig 3.9: Non Linear Loads Without Dstatcom Compensator

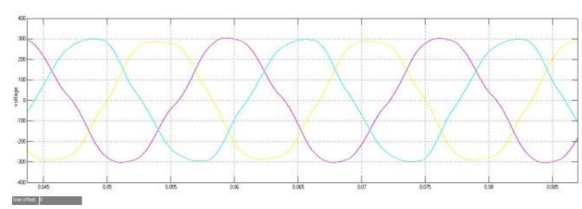

Fig 3.10 Non Linear Loads without Dstatcom Compensator Waveforms

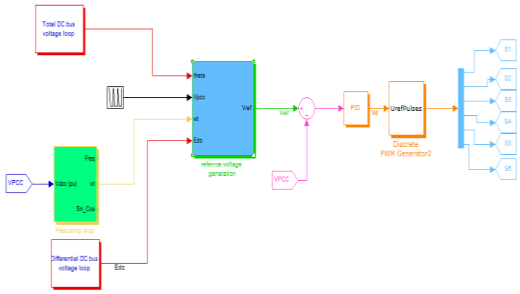

Fig 3.11 Linear Loads without Mppt

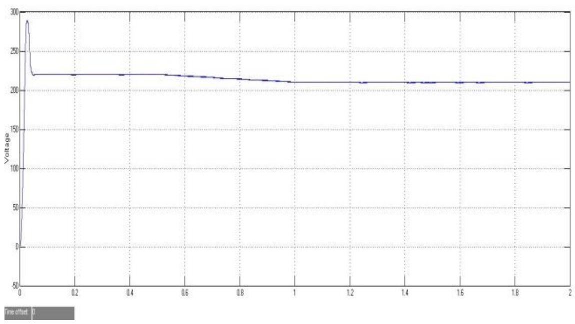

Fig 3.12 Voltage Waveform without Mppt for Linear Loads

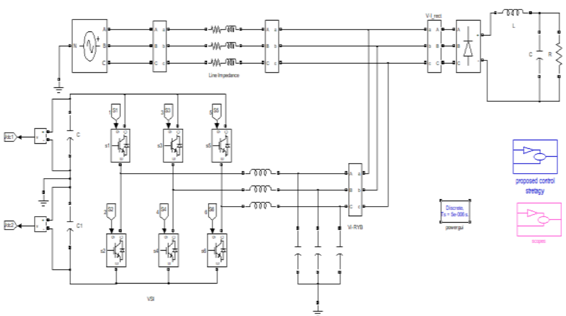

Fig 3.13 Non Linear Loads Without Mppt

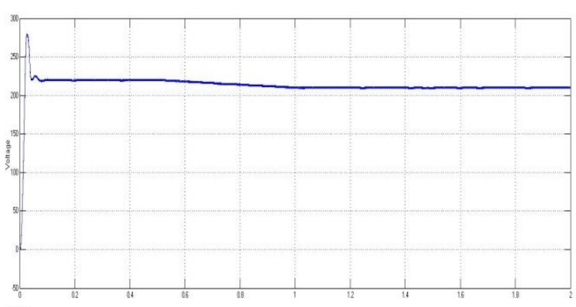

Fig 3.14 Voltage Waveform For Non Linear Loads Without Mppt

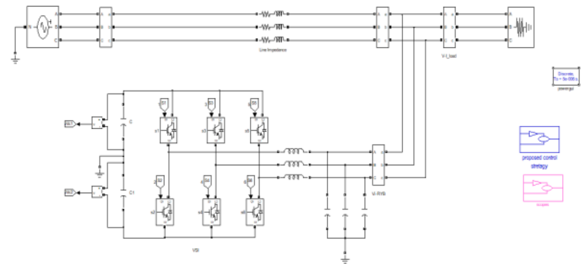

Fig 3.15 : Linear Loads With Dstatcom Compensator

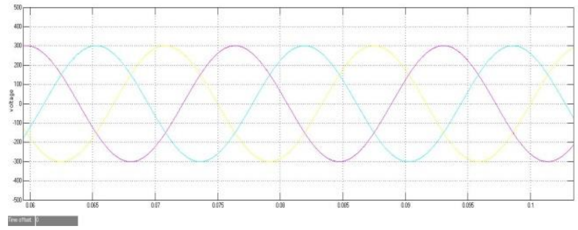

Fig 3.16 Linear Loads With Dstatcom Compensator Waveforms

The linear loads are made out of 10.4 kw three-phase resistive burdens. The PCC voltage sufficiency without remuneration is 212 V. one can see that the PCC voltages contain some symphonious contortion natural to low voltage dissemination arrange. Presently then the PCC voltages are managed with the extremely low THD 0.3% as explained in the wave frame. The symphonious bending showed up in the framework voltages are repaid by the controller.

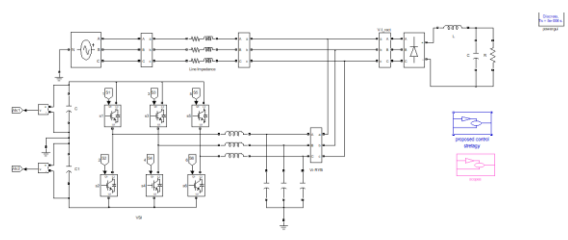

Fig 3.17: Non Linear Loads with Dstatcom Compensator

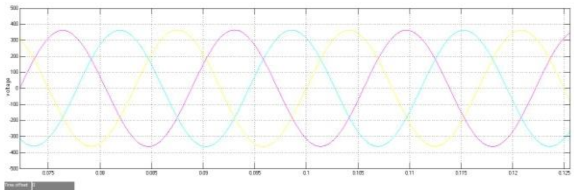

Fig 3.18 Non Linear Loads With Dstatcom Compensator Waveforms

The considered nonlinear loads are three 2 KVA single phase rectifiers with a capacitive filter, one in each phase added to 5.2 KW 3-phase resistive loads and the PCC voltage amplitude in the absence of compensation is at 203 V with 6.4 % THD, as appeared in above wave form.

IV.CONCLUSION

This project exhibits a 3 phase DSTATCOM with a voltage controller and its control technique, made out of the standard circular loops, yield voltage response and dc bus regulation with circular loops, together with the voltage sufficiency and consequently the Frequency loops.

Simulation test results exhibit the voltage control capacity, providing 3 adjusted voltages to the PCC, even underneath nonlinear burdens loads. The arranged amplitude circular loop could reduce the voltage controller prepared apparent power around 53 % with nonlinear load and significantly more with linear load (85%). The mPPT calculation algorithm followed the base minimum power point among the permissible voltage extend range when responsive power compensation isn't very much vital important. With framework grid and network voltage sag and swell, then the amplitude circular loops meets the grid and network code. The mPPT may be authorized in current-control DSTATCOMs, accomplishing comparable outcomes.

The circular frequency loop kept compensation point in as far as possible analog limits, expanding the independence of the voltage controller, and furthermore the dc bus voltage controlled at standard esteem results, thusly limiting the dc bus voltage consistent study state error. The parallel activity of the mPPT and furthermore the frequency circular loop was checked. The arranged voltage regulator may be the shunt associated arrangement that is attached to low voltage distribution network and grids with no power failures to the loads, with no framework and grid voltage and impedance data, and gives adjusted and low-THD voltages to the clients.

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