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A Grid Connected PV System Using Bifred Converter With Neuro Fuzzy Based MPPT Algorithm

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ABSTRACT*:* The implementation of a Fuzzy based maximum power point tracking in Grid-connected PV system alongside Reactive power compensation. For array, a single diode model is used, and MATLAB is used to perform the simulation analysis. In the fuzzy logic controller, voltage and current are taken as inputs and the effective value of AC current corresponding to the maximum power point is the output. Thus the reactive power doesn't outperform its power rating in addition to providing voltage by the inverter with transformer to compensate for. This results in the use of a PV system around evening time and at times of low irradiation. Rules relating to Fuzzy logic controller input and output are composed and simulation is done a DC-DC Bifred converter is utilized for keeping up DC input to the inverter at different states of irradiations and temperature. Gating pulses to the inverter are created by the PI (Proportional controller) controller. Solar panel simulation model is developed and results for various irradiation and temperature conditions are acquired with the Fuzzy logic controller. Results show the viability of the technique proposed for utilizing the PV system. This project is implemented in MATLAB simulation and experimental results.

KEYWORDS: Second Harmonic Current, Fuzzy Logic Controller, Transparent Conductive Oxides, Boost Integrated Flyback Rectifier Energy Storage DC-DC Converter, Maximum Power Point Tracking.

1. INTRODUCTION

With the expanding worries on vitality emergency and ecological issues, sustainable power sources, for example, sunlight based and wind vitality, have increased an extraordinary enthusiasm for their perfect and feasible highlights. Photovoltaic (PV) Grid-connected inverter assumes a significant job in the disseminated power ages, which moves the dc power produced from the PV panel into the power grid. For the most part, the PV Grid-connected inverters can be arranged into a single-stage and two-phase types. Contrasted and the single-stage ones, the two-phase PV Grid-connected inverters, which are made out of a front-end dc-dc converter and a downstream dc-ac inverter, have prevalent exhibitions in the applications where the input has a wide voltage variety range[3],[4]. The front-end dc-dc converter targets acknowledging the maximum power point tracking (MPPT) of the PV panel, and the downstream dc-ac inverter is responsible for regulating the intermediate dc bus voltage and infusing top-notch ac current into the grid.

In the two-stage single-phase PV Grid-connected inverter, the prompt output power throbs at double the line frequency (2f0), bringing about a second-order harmonic inverter, which is known as the second Harmonic Current (SHC) hereinafter. The SHC will debase the changing productivity, and the SHC into the PV Panel will bring about wavering in the PV panel's output power and along these lines crumble the vitality conversion efficiency. Consequently, it is important to decrease the SHC streaming into the front-end dc-dc converter and the PV panel.

The salient features of the decrease of the transformer and proposed power converter are just two force electronic switches of the power converter are worked at high exchanging recurrence all the while (one is a dc-dc power converter, the other a dc-ac inverter), and the negative solar cell terminal array is joined straightforwardly to the ground to take care of the issues of TCO consumption and spillage current for certain sorts of thin-film layer solar cell array. The experimental results show that the proposed grid-connected power converter can follow the most maximum power point tracking of the solar cell array, convert solar power to a top-notch ac power to infuse into the utility, and spillage current of the solar cell array.

In general, there will be induced earth-parasitic capacity between solar modules and their base. This parasite capacity is to be produced between the solar modules and their soil. For a glass-confronted solar cell array, this parasite capacitance is around 50-150 nF/kW. In any case, if the thin-film solar cell exhibit is utilized, this capacitance will be expanded to 1 nF/kW. Genuine spillage current happens when a throbbing high-recurrence voltage is applied between

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||Volume 9, Issue 4, April 2020||

the thin-film solar modules and the ground. In thin-film modules, erosion harm brought about by alleged transparent conductive oxide (TCO) corrosion of cadmium telluride (cd Te) or amorphous silicon (A-Si) is seen when the voltage of a sun oriented module's negative terminal is lower than that of the substrate. The harm to the electrical conductivity inside the glass spread can't be fixed and causes huge loss of intensity. While the life of solar thin-film modules is abbreviated. Nonetheless, the negative establishing of solar modules will prevent corrosion at TCO.

II. PV SYSTEM

Photovoltaic (PV) systems are turning out to be main stream due to innovative advances, ecological issues, and rising fuel costs.However, a PV panel output power is to a great extent controlled by the panel solar irradiation and temperature.

To get the greatest usage effectiveness, the coordination of the PV module to stack is required. This coordinating requires scanning for a equilibrium, working point which concurs with the maximum power point tracking of the PV module. As the expense of PV arrays and their establishment is moderately high. Coordinating gadgets ought to be utilized which guarantees that the PV generator works around the maximum power point under every meteorological condition, with ideal vitality usage and productivity [6-8]. A dc-dc converter goes about as an interface between the load and the PV framework and it coordinates the load to PV source. which consistently alters the voltage, current levels and moves the working point the load impedance as gave by the source is differed by modifying the administration cycle and adjusted at where the full power is moved with the source.

MPPT controller (maximum power point tracking) is utilized to harvest the full power from the solar PV module and pass the power to the load. Along these lines MPPT procedures are required to keep up the PV system activity at maximum power point (MPP) different strategies to streamline the force yield of PV array are referred to [10-13]. The open-and short circuit strategy for MPPT control depends on terminal voltage (v) and current (I) of the PV array. By estimating the open-circuit voltage or short circuit current progressively, the MPP of the PV array can be assessed with the predefined I-V curves. This technique includes a generally quick reaction and doesn't cause wavering in consistent state.

In any case, these strategies don't deliver a constantly the maximum power accessible from PV array because of the utilization of the predefined PV curves that bombed regularly to mirror the reasonable circumstance inferable from the non-linear qualities of PV cells. In this circumstance, artificial intelligence techniques are progressively fit because of the adaptable idea of the control offered by such systems. These strategies are blasting in non-straight frameworks because of the way that once appropriately prepared they can introduce and extrapolate the arbitrary information. some algorithms such as fuzzy logic or artificial neural network control with non-straight and versatile might be utilized to separate MPP utilizing information based fuzzy rules. Fuzzy control, the capacity of artificial neural network (ANN) to build complex nonlinear mapping through a preparation procedure helps in finding the most maximum power.

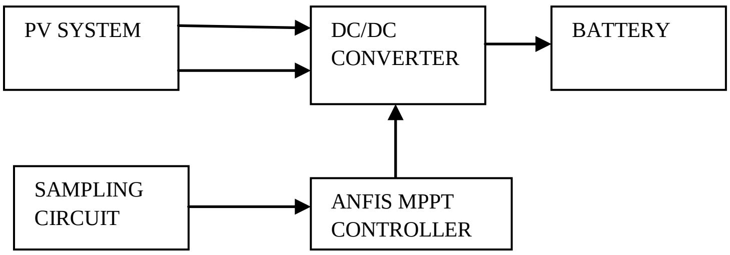

Fig.1 Over all PV System

III NEURO FUZZY LOGIC CONTROLLER

Neuro-fuzzy logic communicated operational laws in linguistics terms rather than mathematical equations. Many procedures, even with complex numerical conditions, are too hard to even consider modeling precisely. Along these lines, conventional strategies become infeasible in these frameworks. However Neuro-fuzzy logics linguistic terms give a practical technique to characterizing the operational qualities of such a framework. The Neuro-fuzzy rationale controller can be considered as an extraordinary class of symbolic controller.

The Neuro fuzzy logic controller has three main components

a)Fuzzification

b)Neuro-fuzzy inference
c)Defuzzification

a) FUZZIFICATION

The following functions:

1) Numerous deliberate crisp input must be mapped into the Neuro-fuzzy membership function work this method is called fuzzification.
2) Carries out scale mapping that moves the scope of values of input factors into relating discourage universes into corresponding discourse universes.
3) Performs the fuzzification highlight, which changes input data into appropriate linguistic values, which can be deciphered as Neuro-fuzzy sets labels.

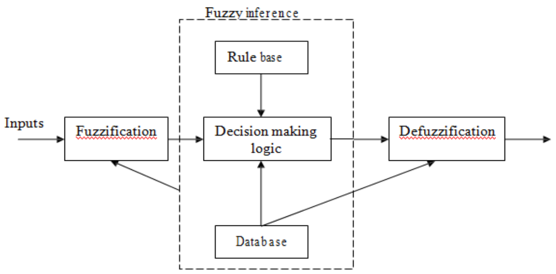

Fig.2. Block Diagram of Neuro-fuzzy Logic Control

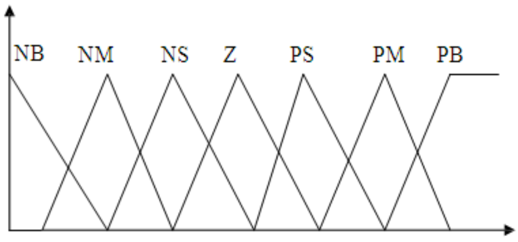

Fig.3. Seven Levels of Neuro-fuzzy membership function

Neuro-fuzzy logic linguistic terms are frequently communicated as logical implication, for example, in the event that rules. These standards characterize a scope of qualities known as Neuro-fuzzy membership functions. Neuro-fuzzy membership function might be as a triangular, a trapezoidal, a ringer or another suitable structure. The contributions of the Neuro-fuzzy controller are communicated in a few language specialist levels. These levels can be portrayed as Positive big(PB), Positive medium(PM), Positive small(PS), Negative small(NS), Negative medium (NM), Negative big(NB) or on different levels, each level is depicted by Neuro-fuzzy set.

b) NEURO FUZZY INFERENCE

A type of artificial Neuro network- based on the Takagi-Sugeno Fuzzy interference method is an adaptive Neuro-fuzzy inference method or an adaptive network-based fuzzy inference system ANFIS. In The early 1990s, the technique was established. Since it incorporates neural networks as well as fuzzy logic concepts. It has the potential to harness the advantages of both within a single system. The inference method is a collection of fuzzy IF-THEN rules that have the ability to learn to approximate non-linear functions. ANFIS is thus known to be an estimator of universality. This called a universal estimator for using the ANFIS. This is called a universal estimator for using the ANFIS. One can use the best parameters obtained by the genetic algorithm to use the ANFIS in a more effective and optimized way. This uses energy management devices in intelligent situational awareness.

C) DEFUZZIFICATION

The output of the deduction system is Neuro-fuzzy output variables. The Neuro-fuzzy logic controller must change over its inward Neuro-fuzzy output factors into crisp qualities with the goal that the genuine framework can utilize these factors. This change is called the Defuzzification. One may play out this activity in a few different ways. The ordinarily utilized control defuzzification procedures are.

(a)The max criterion method (MAX)

The max criterion produces the point at which the membership function of Neuro-fuzzy control activity arrives at the most extreme worth.

(b)The height method

For each standard, the centroid of every membership function is assessed first. The last execution U0 is then decided as the normal of the individual centroids, weighed according to their heights.

$$U0 = \sum_{i=1}^{n} u_{i\mu(u_i)} / \sum_{i=1}^{n} \mu(u_{i)} \ldots.(1)$$

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(c)The centroid method or center of area method (COA)

The broadly utilized centroid technique produces the focal point of gravity of region limited by the membership functions are

$$\overline{V} = \int \mu_{r(y)} . Y\, dy / \int \mu_r . Y\, dy \text{....(2)}$$

VI BIFRED CONVERTER

The Bifred converter comprises a boost circuit incorporated with a flyback circuit So that just one switch is planned over the whole scope of working conditions while the flyback converter works in a constant conduction mode over the predefined load run. The mass capacitor is as a rule, sufficiently huge to fulfill hold-up necessities, and consequently, its voltage is basically consistent over the line time frame under typical working conditions.

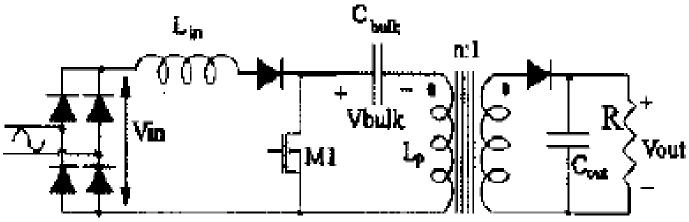

Fig .4. Bifred Converter

In this manner, the duty cycle can likewise be viewed as steady over a similar period. Since a discontinuous conduction mode support converter draws a practically sinusoidal current from the mains for steady duty cycle, power factor more prominent than 0.95 are feasible for a boost increase more noteworthy than 1.25

$$\frac{\text{Vout}}{\text{Vin peak}} \geq 1.25 \text{ ... (3)}$$

Henceforth, the Bifred converter accomplishes input power factor adjustment and output voltage hold up. For open-loop operation, the output voltage ripple is considerably less than that of the more traditional power factor correction topologies due to the nearness of the enormous moderate mass capacitor. In this manner, the output voltage can be managed with a high bandwidth loop without causing critical bending of the line current.

Madigan shows that by an averaging the equations representing the huge-sign model of the converter over a half-line period, the accompanying equation for the consistent state gain is settled.

$$M = \frac{n^2}{K1}\left[-\frac{2}{\pi} - M + \frac{2}{\pi}\frac{M^2}{\sqrt{M^2-1}}\left(\frac{\pi}{2} + \tan^{-1}\frac{1}{\sqrt{M-1}}\right)\right] \text{... (4)}$$

Where,

M is the lnput inductance, for example, the ratio of the voltage at the boost inductor output during the off-time to the peak amplitude at the input. This non-linear condition can be settled numerically for a particular case. In any case, it very well may be indicated that the Bifred as a single-stage converter has a genuine disadvantage. The input power to a continuous mode boost converter is given by

$$Pin\ boost = \frac{D^2 Te}{2\pi L}\frac{V^2 peak}{M}\int_0^{\pi}\frac{\sin^2 wt}{1 - Msinwt}\, d(wt) \text{...(5)}$$

Where,

L is the input inductance, T1 is the switching period and D is the switch duty cycle. Subsequently, a small duty cycle is required for light loads. Be that as it may, the voltage gain of n continuous conduction mode flyback converter is given by

$$\frac{\text{nVout}}{\text{Vbulk}} = \frac{\text{D}}{1-\text{D}} \text{ ... (6)}$$

This voltage gain is free of the load conditions. Thusly, the main path that in input power can be diminished and the output voltage kept up consistent for decreasing loads, is for the bulk capacitor voltage to increment.

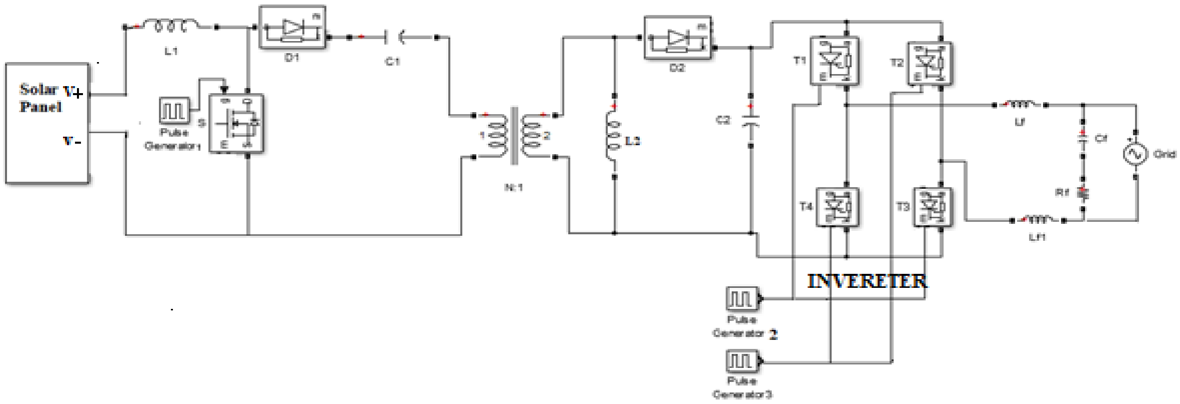

Fig.5. Proposed System Circuit Diagram

The circuit diagram for the grid-connected systems with Bifred converter. The T1,T2, T3,T4 are the inverter switches. The switched capacitor allows the guided transfer of energy from an unregulated source to the regulated output voltage. During switch ON(S=ON), the current flows in V(+)-L1-D1-C1-transformer-L2-D2-C2-Grid. During switch OFF(S=OFF), the current flows in V(+)-L1-D1-C1- transformer-L2-D2-C2-Grid. Hence during the switch ON AND OFF, the current flows to the grid are not interrupted and provides the continuous supply to the grid. Inverter and other devices are used to get the maximum possible power from the photovoltaic devices.

V SIMULATION DIAGRAM

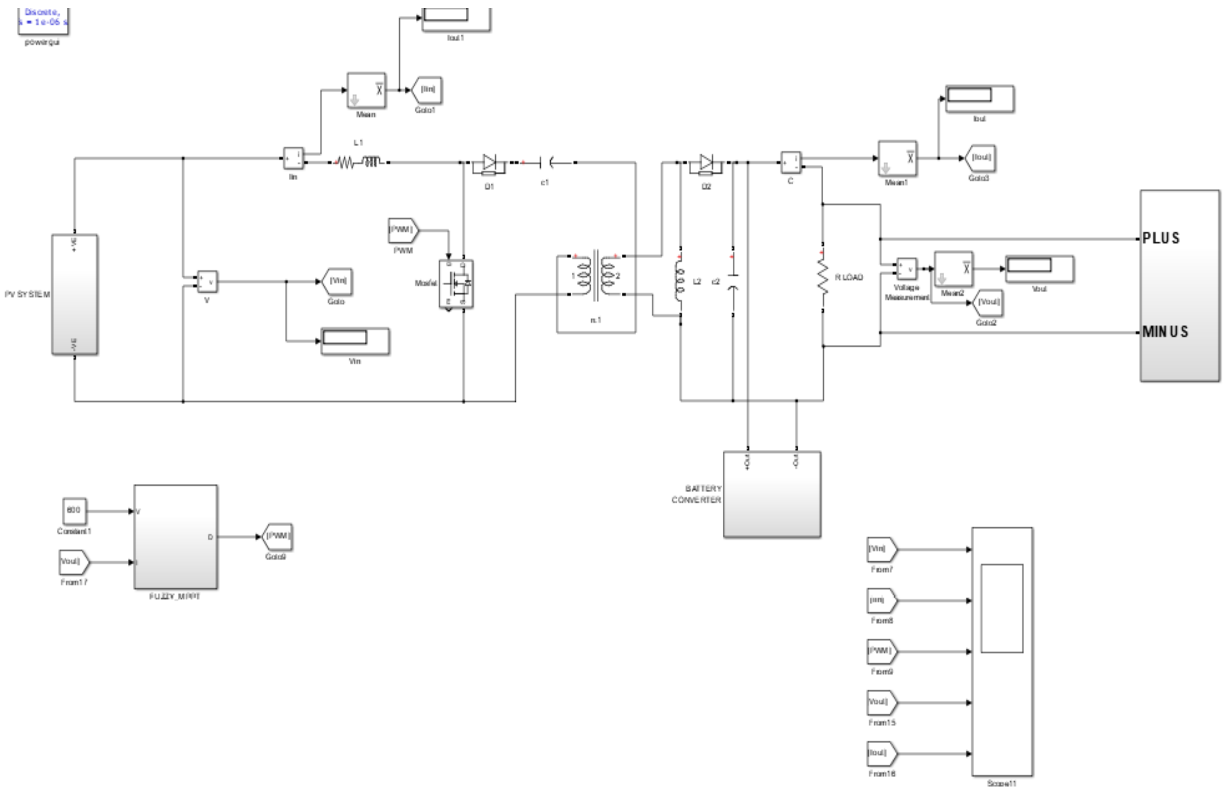

Fig.6. Simulation Diagram

A Grid-connected PV system is simulated using MATLAB/SIMULINK environment. The grid-connected mode operation is performed. Along the grid performance of the high gain DC-DC converter, the photovoltaic system is

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||Volume 9, Issue 4, April 2020||

analyzed. The solar radiations, cell temperature taken into consideration for the study of the grid. Analysis of the output is achieved using simulated effects that are obtained using MATLAB.

VI.SIMULATION RESULT

A Grid-connected PV system utilizing Bifred converter with Neuro-fuzzy based MPPT algorithm Simulation Results are shown in below

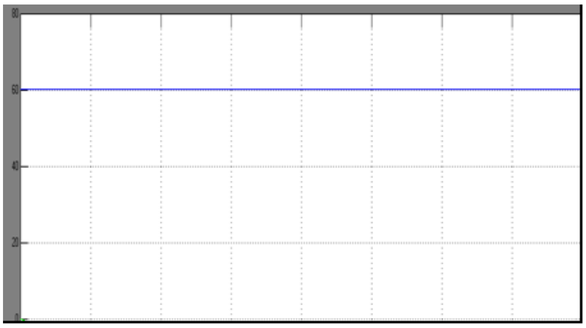

Fig .7 .Converter Input Voltage

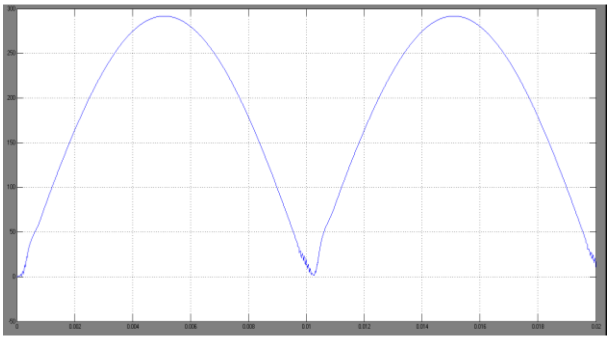

Fig .8 .Converter Output Voltage

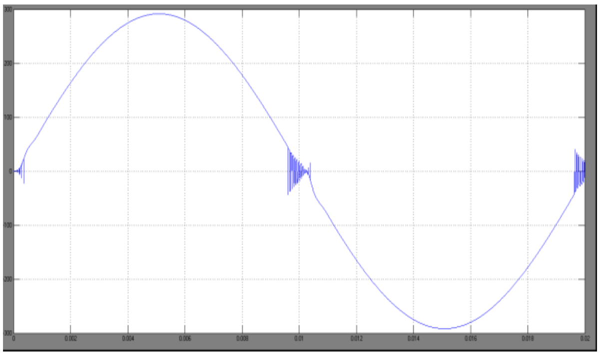

Fig .9.Inverter Output Voltage without Filter

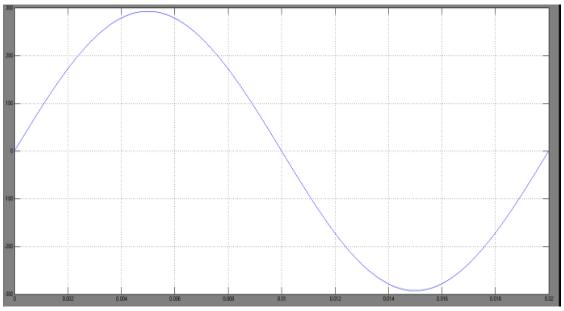

Fig.10.Inverter Output Voltage with Filter

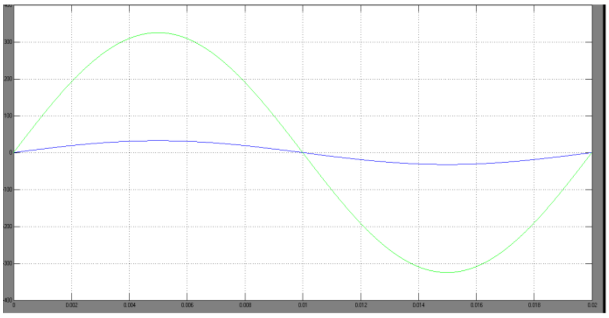

Fig.11. Grid Voltage and Current

VII.CONCLUSION

Closed-loop simulation of the Grid-connected PV system with reactive power compensation is simulated in the MATLAB/SIMULINK. A Bifred converter based grid-connected with PV system capable of resolving reactive power compensation problem in the transmission line has been reviewed. In this project maximum power point of the solar panel is obtained using NEURO FUZZY logic controller in the MATLAB/SIMULINK. The utility of the system is increased by modifying the inverter control to compensate for the reactive power in addition to real power without violating the current rating of the inverter of the PV system. The reactive power compensation is done by using the PI controller for different load conditions. The corresponding simulated result shows that the voltage and current of an inverter to Grid are in phase and thereby the real power in the system is maintained constant. Subsequently, the reactive power is compensated in the system by maintaining the real power as constant.

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