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SIMULATION OF DSTATCOM FOR THE PERFORMANCE OF REACTIVE POWER OF PV TIED GRID

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ABSTRACT
In order to compensate for reactive power in radial distribution system, this study demonstrates the coordinated control Distribution Static synchronous compensator (DSTATCOM). The power factor can be increased to a level that is close to unity by controlling the reactive power in a radial distribution system. The system performance can be improved by several recommendations. Performance of DSTATCOM and switchable capacitor bank under one control. In this research, an appropriate compensation device or a custom power device is used to offset the current harmonic distortions and reactive power demand caused by the integration of a PV-tied grid system. The use of suitable control techniques and pulse generation schemes affects the performance of device.

Keywords *Power system, Reactive Power, Electrical Power Distortions, Neural Network*

INTRODUCTION
The worldwide electric power supply networks are interconnected, involving connections within the utilities, internal connections between utilities, external connections between utilities, international connections between regions, and finally connections across international borders. This is done for financial reasons in order to lower electricity costs and increase power supply reliability. In order to reduce the total power producing capacity and fuel cost, we require the linkages to group power plants and load centres. Interconnections between transmission lines make it possible to supply loads with power at the requisite dependability while keeping costs to a minimum. The FACTS Technology (Flexibility alternating current technology transmission system) is used in transmissions to improve grid reliability and get around the practical issues that arise with mechanical devices employed as transmission network controllers. The ability to manage power, increase the current usable capacity, and modernise the transmission lines has been made possible by this technology. The capacity of existing lines with big conductors can be greatly increased because the current through the line can be managed at a reasonable cost, and the power flow through the lines is kept steady by using FACTS controllers.

ELECTRICAL POWER DISTORTION
Modern grid connected integrated systems are being encouraged to enter the market by recent developments in the power electronics area. Due to the enormous global need for electricity, grid-tied systems have received increased attention. The conventional grid system is unable to meet the high demand for electricity [1]. As a result, in recent years more study has been conducted on renewable energy sources that are connected with grid systems. The most sustainable source of renewable energy is the photovoltaic (PV) system. Due of the enormous impact, PV systems have become crucial to grid-connected systems [2]. Power distortions are greatly increased by the tremendous power consumption of electronic gadgets in PV-tied gridsystems. Additionally, the electrical power distortions are exacerbated by the increased employment of linear and non-linear loads in commercial and residential applications (EPD). Harmonics and other utility-side pollutants are produced by the expansion of non-linear and sensitive loads linked to the electrical grid [3]. Current and voltage distortions, rising demandfor reactive power, and an imbalanced load on the electrical system are the most significant power distortions. Both the utility and the grid system's performance are impacted by these aberrations [4]. Recent advancements in power electronics research have increased awareness of the need to compensate for these electrical power aberrations. The task of providing high- quality electric power is difficult for electrical engineers. Designing a grid-tied system with theintention of operating it in accordance with IEEE standards is a crucial factor in the development of the power system. The system specifications must adhere to IEEE standard level [5].

REACTIVE POWER
Reactive power in electrical grid systems is the power that, in an alternating current scenario, flows back from a destination toward the grid. The path of energy is "one way" in a direct current system because the voltage and load are static, while there are different phases in an alternating current system because of system components like capacitors and inductors. During the passive phases, reactive power keeps energy flowing back into the grid. In a power system, there are three different forms of power. One of the three types of power found in loaded circuits is reactive power.

- **True power**

The actual amount of power in watts being dissipated by the circuit

- **Reactive power**

The dissipated power resulting from inductive and capacitive loads measured in volt-amperesreactive (VAR)

- **Apparent power**

The combination of reactive and true power measure in volt-amperes (VA)

Since it's unclear where reactive power goes, it is often known as "phantom power." Reactive loads, such as capacitors and inductors, are known to draw current and drop voltage despite thefact that electricity is not utilised to power them. This is shown by monitoring the voltage andcurrent around these devices.

Engineers have looked for solutions to reduce the power squandered by this voltage drop and current draw because it is waste energy or heat rather than actual effort. Due to this phantom power, conductors and generators must be rated and sized appropriately to transport both the useful current as well as the waste current, not only the useful current.

Reactive power is sometimes described by energy experts as a component of a capacitor's motion that resembles the swing of a pendulum clock from its apex to its nadir. In this scenario,the alternating current is sending active power to a destination device as the pendulum swings upward. Reactive power is returning to the grid to be absorbed as the pendulum descends.

1.6.1 Reactive Power in the Grid

Planners are sure to include voltage control methods to deal with the realities of alternating current and shifting energy routes. Energy experts remind out that voltage fluctuations of even 5% inside a system might result in blackouts and other issues.

To achieve this, numerous electrical system components, including transformers, can alternatebetween supplying and absorbing reactive power in phases. However, many who are familiar with the sector emphasise that as we transition some of the American electrical system to renewable sources, this will become even more crucial.

1.6.2 Reactive power demand

Power electronics loads, particularly rectifier loads, are what drive the demand for reactive power in the electrical grid. A healthy system should have a power factor of unity and zero reactive power. Voltage unbalance, or unregulated voltage level,is brought on by variations in reactive power. A compensating device may be used to make up the necessary reactive power. Devices like capacitor banks, synchronous condensers, STATCOM, SVS, and FACTS are some of the ones used to compensate for reactive power suppression [11].

1.7 Need for Reduction of Electrical Power Distortions

To meet the demand for electrical power while maintaining high standards for system parameters is the main problem facing the power system. Due to the catastrophic calamity thatthe various varieties of EPD cause on the utility and customer sides. More power distortions are produced by the increasing usage of non-linear and power electronics-based loads in commercial and residential applications [12].

Some of the effects of this electric power distortions is,

- Mal operation of device and it affects the plant performance
- Overheating of motors and equipment,
- Mis operation of protective devices
- Poor power factor
- Reduced efficiency
- Improper operation of devices and equipment
- Makes damage to the appliances coupled with the system
- Harmonics results severe series and parallel resonance in the network
- Overloading of transformers and other devices
- Causes measurement errors in meters etc.

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The combined loss of production and consequently significant economic loss is the end result of the aforementioned effects [13]. More communications and electromagnetic interference inthe network as a result of the aforementioned consequences. Electrical power pollution needs to be balanced out and kept below the IEEE guideline. Therefore, in order to secure their gadgets, all customers must install compensating devices. Government has taken action against customers who didn't stop those distortions by making them pay a hefty fine. A compensation mechanism needs to be installed at the point of common coupling (PCC) in order to prevent this [14]. The following section discusses the many types of compensation devices and how they operate.

1.8 Role of Compensation Device

The most important and critical function of a compensating mechanism in a contemporary power system. The term "compensation device" is generally used to refer to a specialised power device, which is abbreviated as (CPD). Researchers have proposed a wide variety of compensating devices to account for various power distortion kinds. The first bespoke power device was revealed [15–18]. The stability and improved reliability of the electrical power supply are the device's ultimate goals. FACTS devices and bespoke power devices are two major categories for the compensation devices. To prevent distortions, FACTS devices are installed between the transmission side. The Thyristor controlled reactor (TCR), the dynamic voltage restorer (DVR), the static compensator (STATCOM), and the universal power flow controller (UPFC) are a few of the FACTS devices [6]. On the distribution side, specialized power devices are placed to offer protection against electrical power outages. The many forms of bespoke power devices include distribution static compensator, unified power quality conditioner (UPQC), series active power filter (APF), and shunt active power filter (APF) (DSTATCOM). Each device carries out various tasks. For example, series APF compensates for voltage issues, shunt APF guards against current-related problems, and UPQC carries out both series and shunt compensation [19]. A cost-effective tool for current harmonic and reactive power adjustment is DSTATCOM [20]. DSTATCOM is set up simultaneously with source and load. It consists of a DC link capacitor and three phase VSI. To counteract the harmonic current produced by the load, it injects a compensation current at the point of coupling [24, 21].

RESULTS AND DISCUSSION

Analysis on Hysteresis Bandwidth Estimation Using Neural Network

This section provides extensive information about the simulation analysis of the estimation of hysteresis bandwidth by NN technique. Figure 1 displays the simulation outcomes for case 1'sestimation of HB using the NN approach. From the response, it can be observed that the HB issuccessfully estimated using the suggested NN technique in every case study. Due to the strongproperties of NN, the HB is correctly estimated in every scenario. Therefore, for all case scenarios, the proposed NN-based DSTATCOM effectively adjusts THD and reactive power.

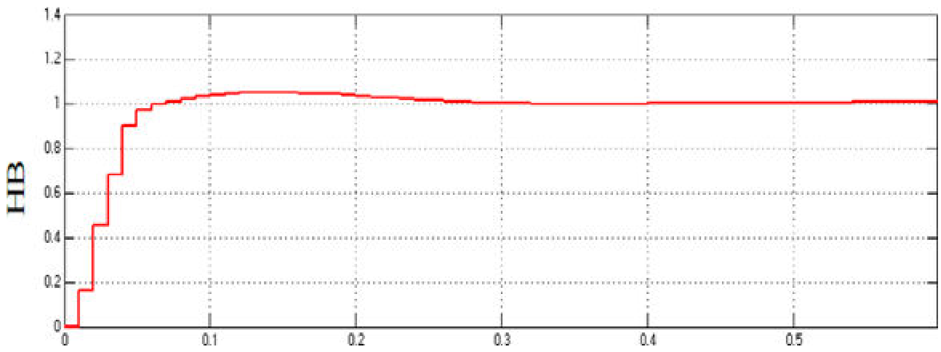

Figure 1 Estimation of HB Using NN under grid alone condition

5.2.2. Analysis on Reference and Actual Source Current Tracking

For the NN-based HB approach, tracking of the reference and actual source currents is examined in cases 1, 2, and 3. Figure 2 displays the matching simulation findings. The suggested NN-based hysteresis bandwidth approach successfully tracked these currents underall operational conditions, as seen in the figure. This is made possible in large part by accuratehysteresis bandwidth estimation. According to the investigation, the suggested NN-HB based DSTATCOM provides outstanding protection against current THD and reactive power. Additionally, this approach gets rid of issues with traditional and variable hysteresis band approaches.

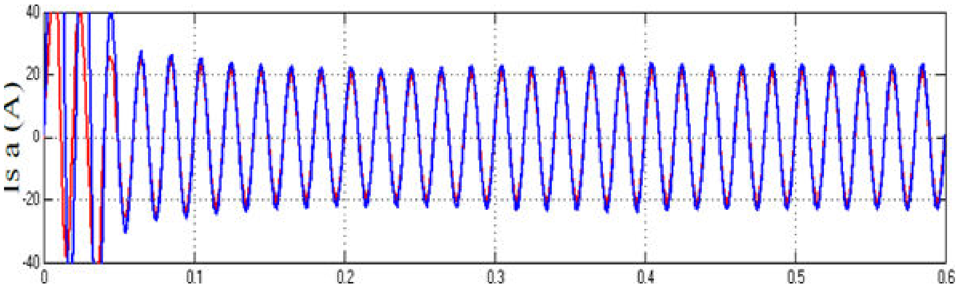

Figure 2 Simulation results for tracking of reference and actual source current

5.2.3 Current Error Signals

In case 1 of Figure 3, the current error signals are shown. In each case, the current error signalsare kept within the allowed range. This is accomplished by keeping track of reference and actual source current data effectively.

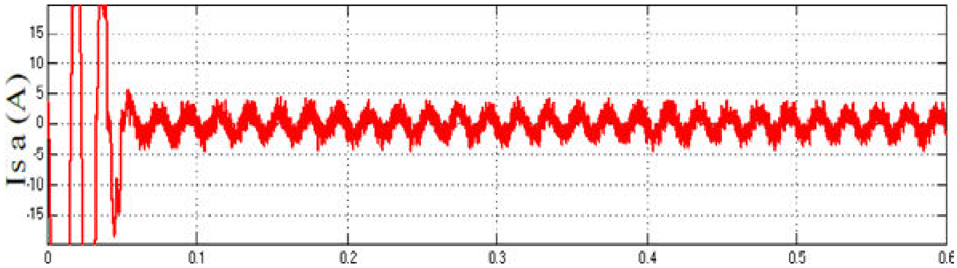

Figure 3. Waveforms for Source Current Error by Variable Hysteresis Band Technique

CONCLUSION

the effectiveness of DSTATCOM's NN-based variable hysteresis band approach. The DSTATCOM employing NN-based variable hysteresis band technique is created in MATLAB simulation software, and the results are examined and contrasted with traditional and variable hysteresis band schemes. According to the findings, case B's THD and reactive power were notcompensated by the conventional scheme. This problem results from the pulse generation scheme's usage of a fixed hysteresis band. THD and reactive power over scenario C were not adequately compensated by the variable hysteresis band system. This constraint is primarily caused by a system parameter reliance. THD and reactive power are efficiently adjusted for in all case studies using the suggested NN-based variable hysteresis band technique. To correct problems in the PV-tied IEEE 9 bus system, DSTATCOM is used.

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