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Reactive Power Compensation Using STATCOM in PV grid connected system

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ABSTRACT

In this work, the use of a static synchronous compensator (STATCOM) is suggested for reactive power compensation of a three-phase PV grid-connected system. The STATCOM is used to reduce reactive power imbalance and voltage variations brought on by PV systems' singular output.

This study compares the benefits of using capacitor banks and STATCOM for reactive power adjustment in grid-connected solar systems. To reduce reactive power in the power system, STATCOM is used. A DC-DC step- up converter connects the solar photovoltaic panel system to the grid in order to maximize power extraction from the panels.

This proposed system has been tested with different loads. A detailed simulation of the STATCOM-based system was performed, and comparisons were conducted Because photovoltaic (PV) systems are intermittent, integrating them into the grid poses power quality and stability difficulties.

Keywords—STATCOM, Solar Panel, Voltage Control, Grid Integration, Renewable Energy ,Voltage stability, Compensation technique, Inverter control.

I. INTRODUCTION

The proliferation of solar photovoltaic system as a sustainable and eco-friendly energy source has been remarkable in recent years. Solar panels pay a pivotal role in reducing our dependence on fossils fuels and Mitigating the impact of climate change. However, the integration of solar panels into the electric grid present certain challenges ,one of which is the management of reactive power.

Reactive power is a crucial but often overlooked aspect of power quality in solar panel systems. It influences voltage stability, line losses, and can lead to power factor issues, all of which can affect the overall efficiency and reliability of the grid. To address these challenges, the integration of static synchronous compensators (STATCOM) has emerged as a promising solution.

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Although a capacitor bank can be used to compensate for reactive power on the load side, there are certain drawbacks, such as the fixed capacitor's constant reactive power supply depending on the installed bank of capacitors in the load side, meaning that the installed capacity of the capacitors is greater than the amount of reactive power needed in the load side power factor on the load side becomes leading if the load's reactive power requirement exceeds the installed capacity of the capacitor bank, and lagging if the load's reactive power requirement is greater.

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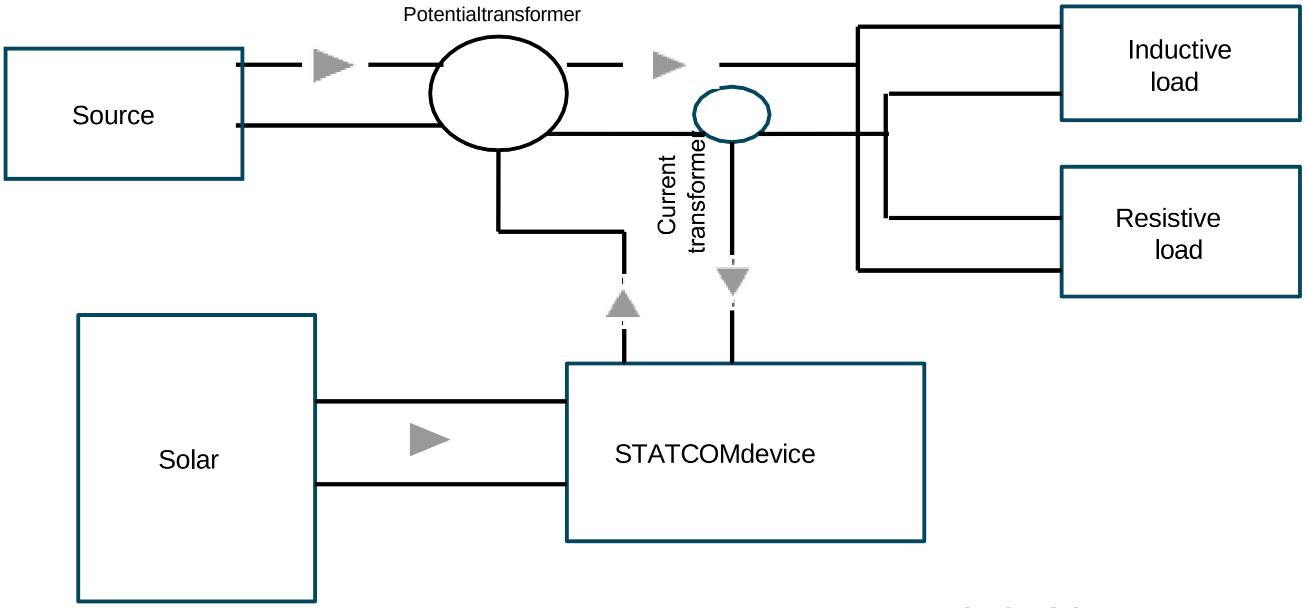

II. METHODOLOGY

Here is a lcd module ford is playing the various factor of line like power factor, current, etc. the lcd is connected to the microcontroller. We are using ATMEGA328P microcontroller in our project. The outputs from the potential transformer and current transformer are feed to the microcontroller through the analog to digital converting circuitry. As we are using PV plants as compensating device we using triac for switching PV cells.

In our circuit we make two modes of operation for better understanding the working of our project. first mode is normal mode and next mode is compensated mode

Normal mode:-when we set this device in normal mode we can just monitor the factors of line such as power factor, current, etc. as we switch on the inductive load current goes lagging as result of it power factor starts decreasing. as we set the device in normal mode nothing is happens there.

Compensated mode:- when we set this device in compensated mode the system is abele to maintain the lagging current and power factor.As we switch on the inductive load current goes lagging this changes in current is sense by the CT and feed to the microcontroller which process the input value and take action on it as result of it we can see that after 1 to 2 secondspowerfactorismaintainatnearabout1.Thisis done by switching the PVplant through the triac which controlled by the microcontroller

III. STATCOM

A. Definition and overview

In order to regulate and enhance the quality of electrical power, a STATCOM is a device used in electrical power systems. This kind of gadget is a flexible AC transmission system (FACTS).

1) **Voltage regulation**: The main purpose of STATCOM is to control grid voltage levels. Reactive power can be injected or absorbed as needed to keep the voltage profile steady.

2) **Reactive power compensation:** It provide dynamic compensation for reactive power, helping to mitigate issues like voltage fluctuation, flicker, and voltage sags or swells.

3) **Solid state technology:** Unlike traditional method of reactive power compensation that uses rotating machinery(such as synchronous condenser), STATCOM use solid state electronics to control and manage reactive power.

4) **Grid stability** : STATCOMs are frequently employed to increase the power system's stability and dependability, particularly when variable loads or renewable energy sources are present.

IV. REACTIVE POWER COMPENSATION

An electric power system cannot function without reactive power compensation; without it, transmission lines could not carry active power and rotating machinery could not spin.

There are numerous advantages of having reactive power control or compensation. The process of reactive compensation entails
To effectively achieve voltage management, a power system can have positive and/or negative VAs added or injected.

Reactive power adjustment can be accomplished either actively, with power electronics solutions like STATCOM and static variable voltage generators (SVGs), or passively, with capacitors and reactors, depending on the application.

V. SOLAR PANELS

Photovoltaic (pv) panels, another name for solar panels, are gadgets made to collect sunlight and turn it into electricity. They consist of several solar cells, which produce a direct current(DC)when exposed to sunlight. Solar cells are commonly constructed from semiconductor materials like silicon.

VI. VOLTAGECONTROL

In order to guarantee the safe and effective operation of electrical devices and equipment, voltage control in an electrical system refers to the process of regulating and keeping the voltage within an acceptable range. Proper voltage control is essential for the following reasons.

a) **Stability** : Voltage control helps maintain the stability of the electrical grid by ensuring that voltage levels stay within specified limits.

b) **Equipment protection**:Voltage control prevents overvoltage or under voltage condition, which can damage electrical equipment and appliances.

c) **Power quality**: It contributes to good power quality by keeping voltage levels steady, which is essential for sensitive electronic equipment.

VII. POWERQUALITY:

Power quality refers to the stability, reliability, and cleanliness of electrical power in an electrical system. It encompasses various aspects of the voltage and current waveforms and is crucial for the proper functioning of electrical and electronic equipment. Good power quality ensure that the electrical supply meets the specific requirements of the devices connected to it. Key aspects of
Power quality include

1) **voltage quality**: This involves maintaining a stable voltage with minimal deviations, such as voltage sags or swells and avoiding voltage interruptions or surges .

2) **frequency stability**: The power supply should maintain a consistent and standard frequency, typically 50HZ or 60HZ depending on the region.

VIII. GRIDINTEGRATION

Grid integration refers to the process of connecting various source of electrical power generation. such as a system of renewable energy that integrates seamlessly and effectively with the electrical grid. This integration is essential for the reliable and sustainable operation of power system.

VIII.RENEWABLEENERGY

Energy that comes from naturally occurring, replenishable sources that are long-term environmentally sustainable is referred to as renewable energy. Because they can be constantly harnessed and donot deplete when consumed, these sources are regarded as renewable.

LITERATURESURVEY

L.Liu,H.Li,Y.Xue, W.Liu[January2015]

In order to solve these problems, this study investigates how reactive power optimization and compensation affect system reliability and power quality.As a solution, it also offers coordinated distribution of active and

Reactive electricity. First, a vector approach is created to show the power distribution principle. As a result, a broad operating range is used to investigate the power and voltage relationship.

Dynamic reactive power compensation has recently been used to static compensators (STATCOM). This article focuses on how solar PV and STATCOM can be integrated for reactive power correction as well as active power sharing with the grid.

RESULT OF PROJECT DONE

There are two modes in these project one is normal mode and second dis COMPENSATE mode. We use two loads inductive and capacitive. In inductive load we use 2 bulbs and in capacitive load we use motor.

COMPENSATEMODE:-In compensate mode when the value of current is reaches 1 ampere then the device is switch to COMPENSATE mode where energy from battery is used which is charged by solar panel.

	Power factor	Current	voltage
1st bulb	0.99	0.4	214
2nd bulb	0.96	0.7	212
motor	0.94	1	232

NORMAL MODE:-In normal mode when value is reaches to 1 ampere device can not switch.

	Power factor	Current	voltage
1st bulb	0.98	0.5	226
2nd bulb	0.97	0.7	223
motor	0.96	1	210

ACKNOWLEDGMENTS

" We acknowledge the significant contribution of the STATCOM in our solar panel system. By providing dynamic reactive power compensation the STATCOM enhance the systems power quality, voltage stability, and grid integration capabilities. This technology has been instrumental in ensuring a reliable and efficient operation of our solar power generation facility."

Conclusion

Utilizing STATCOM for three-phase reactive power compensation in a PV grid-connected system would yield research findings regarding the efficacy of STATCOM in enhancing power factor and voltage stability in PV grids. Analysis of the impact of STATCOM on system performance under various operating conditions and load scenarios. Comparison of the performance of the system with and without STATCOM to quantify the benefits of reactive power compensation.

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