Original Article
ISSN (Online): 2582-7472

ShodhKosh: Journal of Visual and Performing Arts
March 2024 5(3), 1262–1268

REVIEW ON THE DESIGN AND SIMULATION OF A SOLAR PV-POWERED DSTATCOM FOR POWER QUALITY IMPROVEMENT IN DISTRIBUTION LINES

Tamboli Madina Shahajahan [1], Anarase Bhausaheb Vishwanath [1], Bhosale Shivaji Subhash [1], Dhumal Shital Dnyandeo [1]

[1] Assistant Professor, Department of Electrical, Datta Kala Group of Institutions

Corresponding Author

Tamboli Madina Shahajahan, mstamboli.foe@dattakala.edu.in

DOI
10.29121/shodhkosh.v5.i3.2024.4281

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

ABSTRACT

The purpose of this study is to enhance distribution system power quality by presenting a design and control approach for a distribution static compensator, or DSTATCOM. The purpose of the DSC (DSTATCOM) is to regulate the flow of reactive electricity in distribution networks. The rising price of fossil fuels has led to a shift towards using solar systems to generate power. Power quality is the primary issue with transmission lines. Power quality compensating devices, such as DSTATCOM, are used to fix difficulties with high voltage transmission lines, such as voltage dips and rises. Equipment used by end users is safer when gearbox lines are economically efficient.

Keywords: Dstatcom, Power, Voltage, Transmission Lines, Pv System, Sag, Swell

1. INTRODUCTION

This study investigated the utilisation of various solar cell and battery sources for the distribution of STATCOM input dc link channels of voltage source converters (VSC) (DSTATCOM). A high-coordination design is used to feed three-legged VSC input. Over time, DSTATCOM does not disrupt or delay the voltage. control circuit and direct current to direct current power conversion system for solar cells

Photovoltaic (PV) systems generate energy and send it into the power grid when the sun is shining strongly. It is possible to conserve more energy by compensating for power demand using DSTATCOM's three-leg VSC. Years are the unit of measurement for the battery's lifetime. The lights use more power when the weather is cloudy or gloomy. VSC is a How DSTATCOM will fare in the future. Built with a Star/Delta transformer. The three-legged VSC-created circular zero-sequence route may be used by DSTATCOM. Use of this device results in a decrease of harmonics in the neutral current. Lowering the quantity of data gathered is DSTATCOM's primary goal. The central point of connected currents

(PCC) is ground compensation, which also includes power source harmonic compensation and reactive current compensation. Implementation of a predetermined strategy for coordinating operations As part of its compensatory method, DSTATCOM employs a synchronised reference frame (SRF).

Recent research suggests that the widespread use of renewable energy sources has led to an increase in the prevalence of non-linear electronic loads. Microgrids may be structured in many ways; one example is using renewable energy sources like wind, solar, and fuel cells [3-5]. In order to enhance an alternating voltage source, inverters may be powered by low-voltage sources like fuel cells or solar cells, which provide the DC voltage input [6]. A solar panel's rated voltage and current are provided by photovoltaic cells that are linked in series and parallel. Because of variations in temperature and radiation, solar panels need continuous regulation to maintain a consistent voltage. The DC-to-DC boost converter may provide the three-leg of the VSC with the necessary fixed voltage 3. The (hybrid) method uses an additional DC converter, a Dc-to-DC buck-boost converter, to charge and discharge. On days with good sunshine, the inverter may run on the electricity from solar cells; when the sun goes down or the clouds roll in, the excess energy can be stored in a battery for later use. The optimal performance for balancing non-linear loads cannot be achieved just by DC link charging from the grid through VSC converter. The number ten. references 10 and 11 To address concerns regarding power quality, the controllers of the distribution power system, which are called custom power devices (CPDs), have been improved. Three different kinds of CPDs are available to make up for power outages: DSTRATCOM, a dynamic voltage restorer, and the UPQC, or universal power quality conditioner. Two ways to fix voltage harmonic distortion are UPQC (power factor correction and non-load current correction) and DVR (voltage balancing). Power supply based on the load switch technique, modern lighting ballasts, and welding equipment all constitute examples of non-linear loads seen in commercial and industrial settings. Using the synchronous reference frame theory, DSTATCOM may be adjusted and corrected. Typical power quality difficulties in three-phase systems with four wires include an imbalanced neutral load [12]. Citations [10, 11] With the exception of optimising the PWM to increase PV power, no optimisation methods are used to monitor the Maximum Power Point Tracking (MPPT) in this study. Losses increase, distribution system equipment strains, sensitive loads are damaged or malfunction, and the feeders' loads become unevenly distributed, leading to three wires being unbalanced [13–17]. Thus, the current along the neutral line is not zero. Power quality concerns may be addressed with STATCOMs and SVCs. In order to alleviate these limitations, this work introduced a DC connection channel that could concurrently draw power from two different kinds of multiple sources: solar cells and batteries. Fast response is achieved by DSTATCOM's inverter at the dc capacitor connection by the use of IGBT type transistors for transistor switching in the VSC [20]. [According to the article, a Star-Delta transformer connected in series with the Delta coils may reduce neutral currents.

As the usage of renewable energy sources increases, the use of conventional energy sources decreases. Distributed generation is now the centre of attention in research, with less emphasis on more conventional methods. Renewable energy is quickly becoming the norm due to its many advantages, including its low environmental impact, increasing affordability, and the need to combat climate change [1,2]. One possible solution to the problems caused by the unpredictable solar intensity is to link a battery energy storage system to a PV-connected utility system. Hence, the dependability of the system is improved. Maximising the amount of peak PV power that can be harvested is best achieved using the Maximum Power Point Tracking (MPPT) algorithm. Electricity may be supplied to a load, whether it an ac or dc device, using PV systems. The grid connection requirements determine the phase of the PV system, which may be either single or three phase. The schematic for PV systems that are linked to the grid is shown Success with solar systems depends on paying attention to a number of details. When it comes to photovoltaic (PV) systems, the two most important factors are the surrounding environment and the architecture of the system. These two factors may greatly affect the system's overall responsiveness and efficiency. The power quality of photovoltaic systems is impacted by several variables, including solar irradiation, temperature, and the choice of power semiconductor devices.The distribution system is susceptible to voltage transients, waveform distortions, and interference from both utilities and customers. In recent years, there has been a rise in the non-linear loads.The distribution network is experiencing power quality challenges due to industrial activities and the complexity of their control systems. With the proliferation of FACTS devices comes heightened interest in their ability to reliably and quickly regulate transmission parameters like voltage, line impedance, and phase angle between sensitive loads' sending and receiving voltages. This article examines customised power devices, one of which is DSTATCOM, and its capacity to enhance power quality.

2. LITERATURE REVIEW

Shamshad Ali, Shoyab Ali, Nitin Mahela, and Nitin Gupta An approach to improving the reliability of electricity produced by renewable energy (RE) sources is presented in this article. The suggested approach involves a distribution static compensator (DSTATCOM) that incorporates a battery energy storage system (BESS) and is positioned in parallel with a dc link capacitor. Controlling DSTATCOM (SRF) is based on the notion of synchronous reference frames. By including wind, solar photovoltaic (PV), and DSTATCOM into the IEEE-13 nodes test network, a hybrid power system may be simulated. Several operational events, including the synchronisation and outage of wind turbines and solar PV systems, contribute to improved power quality (PQ). The study's modelling findings show that RE generator outages and synchronisation events may improve hybrid power systems' power quality (PQ).

Bhim Singh I and Pavitra Shukl are the second set of individuals. This article discusses active power transfer from a solar photovoltaic (PV) array to the grid and load, as well as improvements to power quality (PQ) through the elimination of harmonics and the implementation of a control approach to compensate for the reactive power needed by the load in the distribution network. Power quality problems with voltage and current harmonics at the junction are on the rise as a result of renewable energy sources' integration. The recursive digital filter control that is outlined here for the PV grid interfaced system improves PQ indices by continually operating and sustaining power transmission between the utility grid and connected loads. The voltage source converter (VSC) is efficiently switched by the reference grid currents generated by direct current control (DCC). We can get the active power of the load currents by using the recursive digital filter. The system's reference grid currents can't be created without using the active power components of these load currents. Under different loads, changing solar isolation levels, and voltage swell, voltage sag, and voltage distortion scenarios, the system's performance is examined using a laboratory prototype.

Authored by Bhim Singh, Pavitra Shukl II An increase in renewable energy sources integrated into the utility system has increased concerns around power quality (PQ). We need control methods that can keep things running well even when the grid isn't perfectly stable. In this case, an infinite impulse response (IIR) peak filter is used to address harmonics, correct power factor, and other power quality (PQ) issues by providing DSTATCOM with capabilities. Plus, this control system still works in situations when solar photovoltaic (PV) power is not easily accessible. Indeed, it is. During the day, electricity is met by combining solar PV and grid power. When combined with a grid-connected solar PV array, DSTATCOM operations guarantee improved power quality and nighttime load fulfilment. For the purpose of maintaining its validity, this system is updated in compliance with IEEE-519. Weak grid circumstances include unbalanced loads and periodic power outages caused by solar panels. Also characterised as poor grid conditions are voltage spikes and sags. The capacity to execute adaptive calculations during filtering, hence lowering computational strain, is a key benefit of IIR peak filters. Also, even with a poor grid, speed is guaranteed quickly since less memory space is needed during execution. - Through the use of simulated data, the behaviour of the system is shown when faced with abnormal grid circumstances. A comparison with various control approaches is also provided. The dependability of the system is confirmed by building and testing a prototype in a controlled environment under adverse grid conditions, such as voltage distortion, imbalance, sag, swell, and load unbalancing.

In this work, Swaliya Firoj Kagadi and Prasad M. Joshi write the words. With more and more people living across the globe, the need for electricity is rising. Due to the insufficiency of fossil fuels, renewable energy sources like solar PV have become significant power generators. The global installed capacity of photovoltaic (PV) systems hit 408.3 GW at the end of April 2019. A considerable amount of electricity is generated by solar panels installed on the rooftops of individual homes and linked to the regional power grid. There are a number of power quality concerns that limit the use of PV on the LV distribution network. The focus of this study is on the penetration of solar PV installations into LV distribution networks. There is also a description of DSTATCOM's mitigation approach. Using a FACTS device such as DSTATCOM, the MATLAB/SIMULINK model illustrates the effects and solutions to power quality problems.

This study presents an adaptive control technique for grid-connected solar photovoltaic (PV) distribution static compensators, written by Gaurav Modi, Shailendra Kumar, and Bhim Singh. With the help of the solar PV array in its whole, the multi-objective system maximises energy extraction and sends it to the grid and loads via a single point of interconnection (PIC). Not only does this technology aid in reducing distribution network losses and improving voltage quality at the PIC, but it also helps balance grid current with a THD of less than 5%. The suggested augmented Widrow-Hoff algorithm manages the voltage source converter (VSC) using the perturb and observe technique based on maximum power point tracking. Boosts power supply quality by isolating the load current's essential component. It employs two weights to follow the target signal, which improves tracking accuracy, decreases steady-state error, and decreases oscillation, making it superior than other algorithms that do the same thing. Using the same method, the VSC is synced with the distribution network. Its performance in dynamic conditions is further improved since it does away with the need for a separate sync method. To improve its responsiveness in bad weather, the VSC control now incorporates solar PV array (IPVFF) electricity. To ensure the system works as intended, it is tested using both experimental and simulated data under a wide range of dynamic conditions.

3. SCOPE OF POWER QUALITY

This article showcases PV power supply systems that can regulate the voltage online. The dc-link of the three-arm rectifier-inverter setup is directly connected to the PV modules. A common-arm synchronised to the input voltage that utilises line-frequency switching decouples the rectifier and inverter sections. Therefore, the rectifier-arm and the inverter-arm may be used independently to control the rectifier and inverter sections, respectively. In order to achieve maximum power point tracking (MPFF) of the PV modules and to balance the power between the utility, PV, and the load, the rectifier-arm uses the MPPT control algorithm to adopt and regulate a changing DC link voltage. The inverter-arm then regulates the voltage to the load with low distortion and perfect control. A control mechanism with variable gain was created to ensure that the bandwidth of the current loop remains constant under all operating conditions. This mechanism includes feed forward and feedback.

Every commercial and industrial load has some non-linear characteristic. Some examples are computer loads, motor driving applications, and switched mode power supplies (SMPS). This causes the supply current to have harmonics and the neutral current to be excessive. The zero-sequence neutral current travels via the neutral conductor. When it comes to the neutral current, third harmonics are king [14]. When single-phase loads are imbalanced, it results in a high neutral current. To resolve these power quality difficulties, there exist mitigating alternatives such as SVC and STATCOM. Because of its inefficiency and the fact that its size and losses are increased due to increased passive components and limited bandwidth, the SVC is unable to provide reactive power correction or voltage support at the transmission level.

Thanks to DSTATCOM's lightning-fast distribution-level response times, these drawbacks may be addressed [15]. The four-leg Voltage Source Converters (VSC), three-phase VSC, three-leg VSC with split capacitor, and three-leg VSC with neutral terminal positive or negative of dc bus are all available for use in reducing harmonics in the source current, mitigating reactive power compensation, and balancing loads. [16] For the control of DSTATCOM [three-phase, four-wire compensators], the synchronous reference frame theory approach is the most appropriate.

4. RESEARCH METHODOLOGY

In conclusion, the D-STATCOM-integrated approach outperforms the PI controller method mediated by D-STATCOM; nevertheless, in the three phases without D-STATCOM, only 24% of the compensatory voltage sag was addressed.So, to reduce voltage sag issues, the D-STATCOM and FIS control method may be used broadly.Furthermore, it is reasonable to expect the proposed distribution system device to achieve future commercial success as a dependable consumer power device. In conclusion, voltage sag is a major problem with power quality.In order to fix voltage sag and find problems, a promising gadget called D-STATCOM was used. This device employs two control techniques, namely Fuzzy Inference Systems (FIS) and Proportional Integrals (PI). Elevated Quality StandardsThe idea behind smart grids is to improve or maintain the efficiency of the power system without laying down a tonne of new wires and other infrastructure. Customers will like several things, including the product's cost, voltage quality, and reliability.

5. BLOCK DIAGRAM

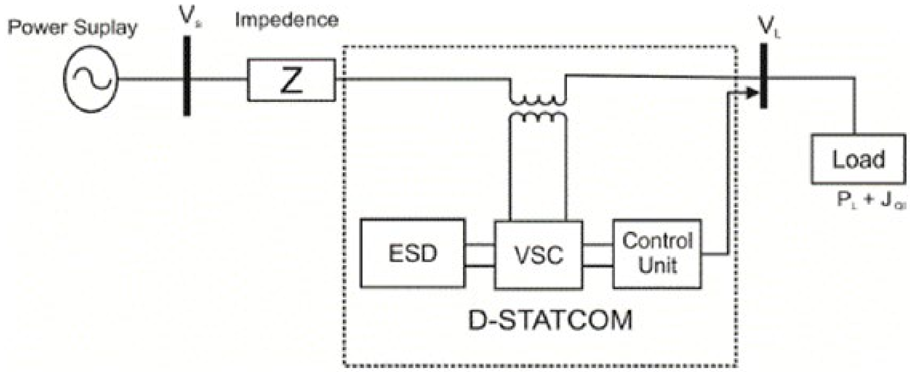

Figure 1 Block Diagram of DSTATCOM

A distribution static compensator (D-STATCOM) is a current tailored power device that is both efficient and effective. Its diminutive stature and rapid dynamic response to shocks are two of its most appealing features. The D-STATCOM links the DC energy storage device (ESD) and voltage source converter (VSC) to the distribution system via a coupling transformer. The VSC converts the direct current (DC) across the storage device into an alternating current (AC) voltage at the output. A high-reluctance coupling transformer is required to bring these voltages into phase with the AC system. By manipulating the amplitude and phase of the D-STATCOM output voltages, the AC system and the D-STATCOM may be efficiently regulated. Makes it possible for the device to produce or receive reactive and active power that can be controlled. The magnitude of the voltage at the point of connection to a sensitive load (PI) may be affected by system disturbances, as shown in the image. The control system just keeps an eye on the rms voltage at the load point; reactive power measurements aren't necessary for it. The VSC switching method offers responsiveness and simplicity via the use of a sinusoidal pulse width modulation (PWM) technique. Flexible alternating current transmission systems (FACTS) applications benefit from pulse width modulation (PWM) techniques over fundamental frequency switching (FFS) methods because to the low power consumption of custom power. Furthermore, the efficiency of the converter may be enhanced by employing high switching frequencies, which do not result in significant switching losses. An error signal is generated by the controller input by comparing the reference voltage with the terminal voltage that was actually detected. A PI controller takes care of it by producing an angle, which is then inputted into the PWM signal generator for correction. It is important to note that in this scenario, the indirectly controlled converter is involved in both active and reactive power exchange with the network simultaneously. To derive an error signal, the reference voltage is compared to the rms voltage obtained at the load point. In order to restore the load rms voltage to the reference voltage, the PI controller examines the error signal and determines the required angle. See Figure 2 [4] for an example of this. The PI Controller, also known as a proportional-integral controller, takes both percentage error and integral value into account. an benefit of this method for step inputs in PI Controller is that it has a steady-state inaccuracy of zero.

V in – V ref = Output of the comparator (1)

In cases when,

V ref: A reference voltage that is always one volt per unit.

A single volt is represented as V in, the input voltage at the load terminals.

The PI controller takes as input the voltage reference (V ref) minus the voltage output (V Output). At this angle, the PWM signal generator may fire in the exact sequence that is specified. With MATLAB,

6. CONCLUSION

Experts in power systems and electric power suppliers alike now face the formidable challenge of power quality. Power transmission lines may experience power quality deterioration due to dynamic loads, among other things. Reasons being, for instance, that voltage changes and harmonic distortion are not linear and exhibit time-varying characteristics. To get the end result, the system will be modelled using MATLAB/SIMULINK software. When the system is overloaded, the voltage drops, which causes the current to flow through the line to rise. The voltage sag in the system will be eliminated using D-STATCOM. A side-by-side comparison of the D-performance STATCOMs is in the works.

CONFLICT OF INTERESTS

None.

ACKNOWLEDGMENTS

None.

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