A Review of DSTATCOM Control Algorithms

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Abstract: The idea that an inverter can be utilized as a generalized impedance converter to provide either capacitive or inductive reactance has been applied extensively to address distribution networks' power quality problems. The DSTATCOM, which is linked in shunt at the load end, is one such device. A converter is the central component of the DSTATCOM.
The concept of using an inverter as a generic impedance converter to produce either capacitive or inductive reactance has been widely used to solve power quality issues in distribution networks. One such device is the DSTATCOM, which is connected in shunt at the load end. The main part of the DSTATCOM is a converter.

Keywords: PWM, symmetrical components, power quality, hysteresis control, and DSTATCOM

I. Introduction

The customer's perspective on the amount of electrical power he is willing to receive has changed dramatically as a result of technological advancements and the ensuing upgrades to the power system's loads. The increase in nonlinear loads is contributing to the reactive power adjustment issue by raising the level of harmonics in the received voltage. These days, a vigilant consumer requests a power supply that is balanced, flicker-free, harmonic-free, voltage-regulated, and outage-free.

Hingorani introduced the idea of bespoke power. Custom power (CP) devices are similar to FACTS devices, which are used to address transmission line problems, in that they utilize power electronic controllers to address distribution system problems. DSTATCOM is one of the several CP devices that can address the majority of load-related power quality issues for customers. Reactive power compensation [3], which was first thought of with fixed or passive capacitors, is where the idea of compensation originated.

Later, the Static Var Compensator was used for load-end voltage regulation and var compensation. These systems had the following shortcomings: they struggled with granularity, or the least amount of var compensation that was feasible; they performed poorly dynamically; they required filters to be added because they introduced harmonics into the network; they malfunctioned in low voltage situations; and they lacked load balancing and load levelling.

II. Load Compensation by DSTATCOM

Figure 1 displays the schematic diagram for load correction using DSTATCOM. At its core, the DSTATCOM is thought to be a current-controlled voltage source converter. Therefore, in a perfect scenario, an ideal current source ic takes the role of the DSTATCOM. Additionally, it is assumed that the load is reactive, nonlinear, and unbalanced, as is typically the case. Assume first that there is no compensator for the load L-1. As a result, the voltage at the PCC bus will also be imbalanced and distorted since the current passing through the feeder is also unbalanced and distorted.
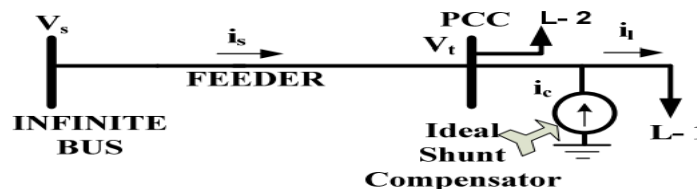

Fig 1: Load Compensation schematic diagram

III. System Configuration

The operation of the DSTATCOM and its controls inside a typical distribution system has been studied. The proposed distribution side of the power system, which includes the DSTATCOM, an infinite bus, and a delta-connected RL load, is depicted in Figure 2.
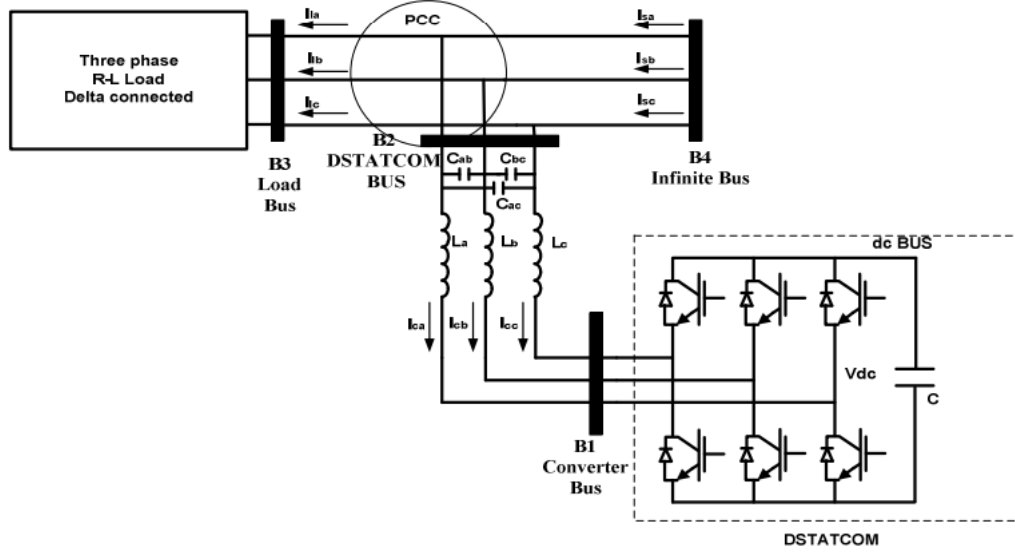

Fig 2: Distribution System compensated by DSTATCOM

IV. Phase Shift Control

The Phase Shift Control system is easy to understand. Maintaining a steady voltage at the load terminal is the goal. The control algorithm creates a phase shift in the VSC's output voltage in relation to the ac supply voltage and applies a voltage angle control. When the measured PCC voltage is compared to the reference or target voltage, an error signal is produced.

To drive the voltage error to zero, the error signal is sent to a PI controller, which creates an angle δ. As a result, the PCC voltage is controlled to the appropriate level. The sinusoidal voltage signal is phase-modulated by angle by the PWM generator, which then compares it with a triangular carrier signal to provide the switching signals for the VSC switches. A separate dc source maintains the dc side voltage. Figure 3 displays a schematic diagram for DSTATCOM's phase shift control.
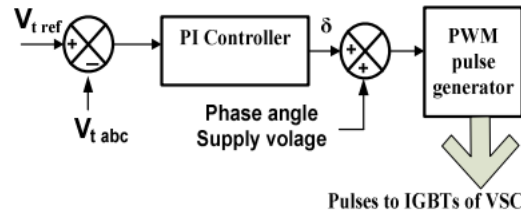

Fig 3: Phase shift control

V. Carrier Based PWM Controller

Figure 4 displays the schematic diagram for the carrier-based PWM control. For the VSC's IGBTs, the switching pulses are produced using a sinusoidal PWM based on a fixed frequency carrier. The instantaneous reactive power theory serves as the foundation for this method. Measurements are made of the load's and the supply system's instantaneous voltage and current. Park's transformation is used to convert the three-phase system to a reference frame that rotates synchronously.
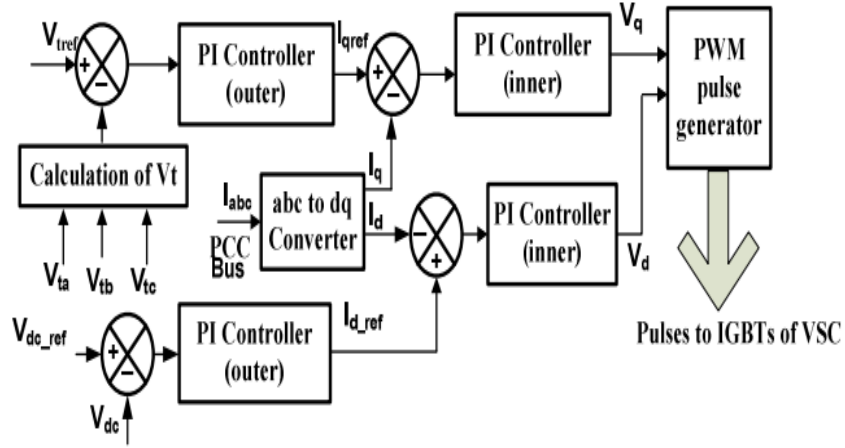
Fig 4: Carrier based control

VI. Algorithm of Carrier Based Controller of DSTATCOM

The MATLAB platform's ode 23tb is used to mimic the discrete mode of the DSTATCOM's VSC control, as seen in Figure 4. The PI controller is implemented using the discrete-time integrator block. Integration is done using the forward Euler method.
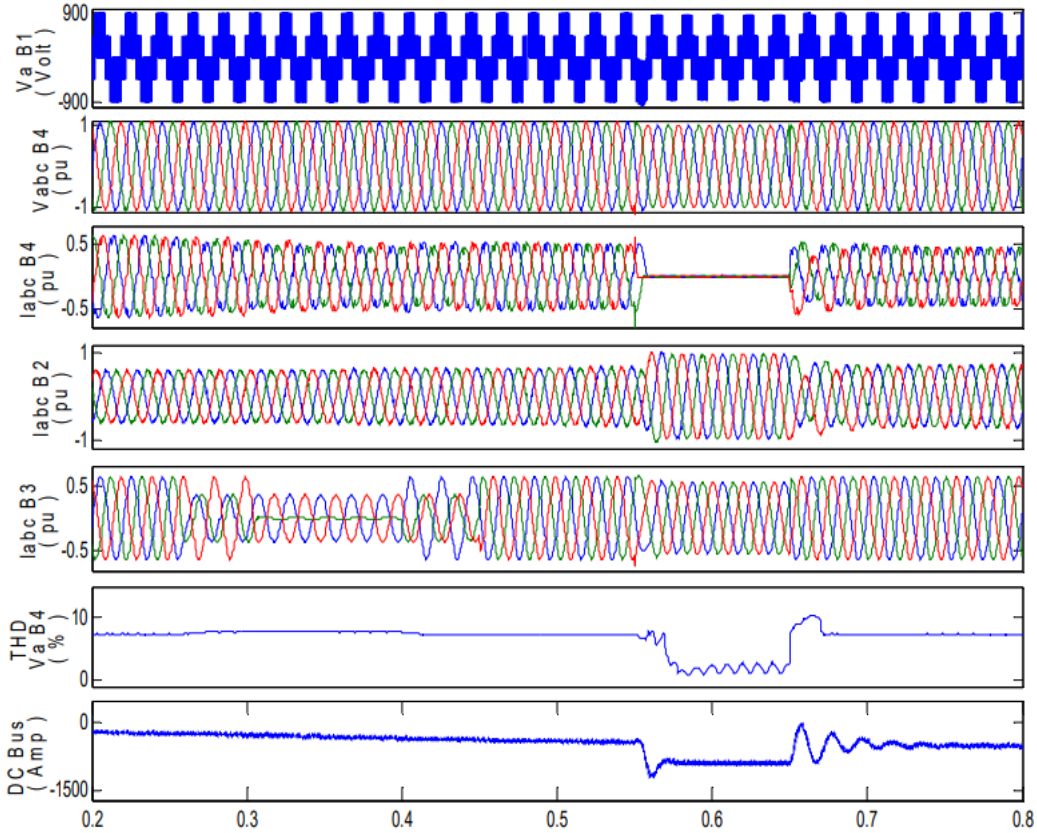

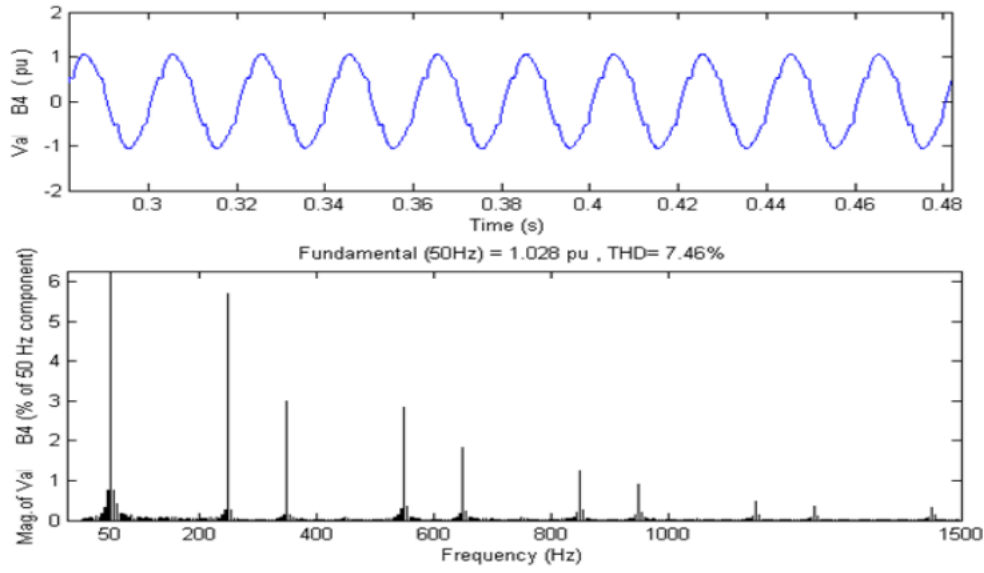Fig 5: DSTATCOM using carrier based PWM response

Fig 6: Harmonic Spectrum of source voltage for carrier based PWM control

VII.   Conclusion

This chapter presents a comparative analysis of the fundamental algorithms used to regulate DSTATCOM. Simulation studies are used to highlight each scheme's advantages and disadvantages. It is discovered that a DSTATCOM performs reactive power compensation, voltage control, harmonic reduction, load balancing, and load levelling regardless of the algorithm employed.

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