Voltage Flicker and Power Quality Enhancement using Robust Distributed Static Synchronous Compensator Technique

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Abstract : In the last decade power quality improvement is one of the most burning topic between different research group. There are different research organization focused on power quality improvement. Flicker and voltage fluctuation is common in rural and suburban areas. For the improvement of this problem we proposed an improved D-STATCOM method, that gives better power quality as compared to other power quality improvement methods such as D-STATCOM pulse width modulation scheme[PWM] etc. For the comparison of proposed method calculate the different parameters such as active power, reactive power and the most important parameter is total harmonic distortion[THD]. The THD of proposed method is only 1.92 with low rate of flicker. For the simulation and modelling purpose matrix laboratory (MATLAB) is used.

Keywords **—D-STATCOM, STATCOM, Flicker, Power quality improvement, Active power and reactive power.**

I. INTRODUCTION

Power quality principally deals with the interaction among the purchasers and therefore the utility or it is often same that it provides an interaction between the power system and individual load. The ultimate goal of power system is uninterrupted & continuous flow of electric energy to its customers. Within the last fifty years, due to the intensive growth of industries electricity demand has enormously enhanced that has led to institution of the many power generation and distribution grid. The demand for large amount of power for industrial and domestic use increased the burden on the generation. Electrical utilities working today are working as a subsystem of a large utility network that are tied together in order to form a complex grid. Due to all these factors power quality has deteriorated. High power quality is most important for the commercial facility design, beside well-being, trustable service and low investment and running expenses. Often when we talk of quality of power we actually mean the quality of voltage because it is the voltage which is controlled most of the times. The term power quality can be related with reliability of the system by the electrical utilities. The most difficult thing is maintenance of the electrical power quality so that it will lie within the acceptable limits. There are many disadvantages of poor or low power quality. It may result in higher power losses, abnormal and weird behaviour of electrical equipment, and interference with the close communication lines, poor voltage profile, harmonics, sag and swells within the voltage, poor and low distortion and displacement issue.

D-STATCOM

The state space modeling of a DSTATCOM is carried out in the synchronous reference frame Figure 1 shows the simplified single line diagram of a DSTATCOM. It consists of a DC link electrical condenser, an IGBT primarily based VSC, a filter and a voltage supply to represent the grid voltage. The DSTATCOM is connected through a filter circuit to the grid at the purpose of common coupling (PCC).

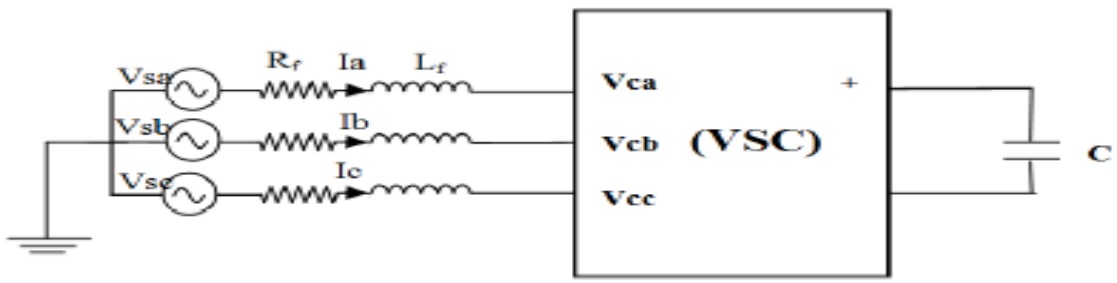

Figure 1 Simplified single-line diagram of the DSTATCOM

The three-phase instantaneous voltages at the PCC are given by Equations (1) to (3).

$$v_{sa} = \sqrt{\frac{2}{3}} V_s sin\omega t \quad (1)$$

$$v_{sb} = \sqrt{\frac{2}{3}} V_s \sin(\omega t - \frac{2\pi}{3}) \quad (2)$$

$$v_{sc} = \sqrt{\frac{2}{3}} V_s \sin(\omega t + \frac{2\pi}{3}) \quad (3)$$

These three-phase voltages can be expressed in the matrix form as Equation (4).

$$\begin{bmatrix} v_{sa} \\ v_{sb} \\ v_{sc} \end{bmatrix} = \sqrt{\frac{2}{3}} V_s \begin{bmatrix} sin\omega t \\ (\omega t - \frac{2\pi}{3}) \\ (\omega t + \frac{2\pi}{3}) \end{bmatrix} \quad (4)$$

II. IMPLEMENTATION OF PROPOSED MODEL

D-STATCOM is a custom power device. Custom power is a technology which combines concept of power electronics to the power distribution system for benefit of customer. The reconfiguring type custom power equipment's are applied for limiting the current quickly and breaking the circuit during fault condition. The compensating devices are used for reducing voltage flickering, voltage unbalance and improving power factor.

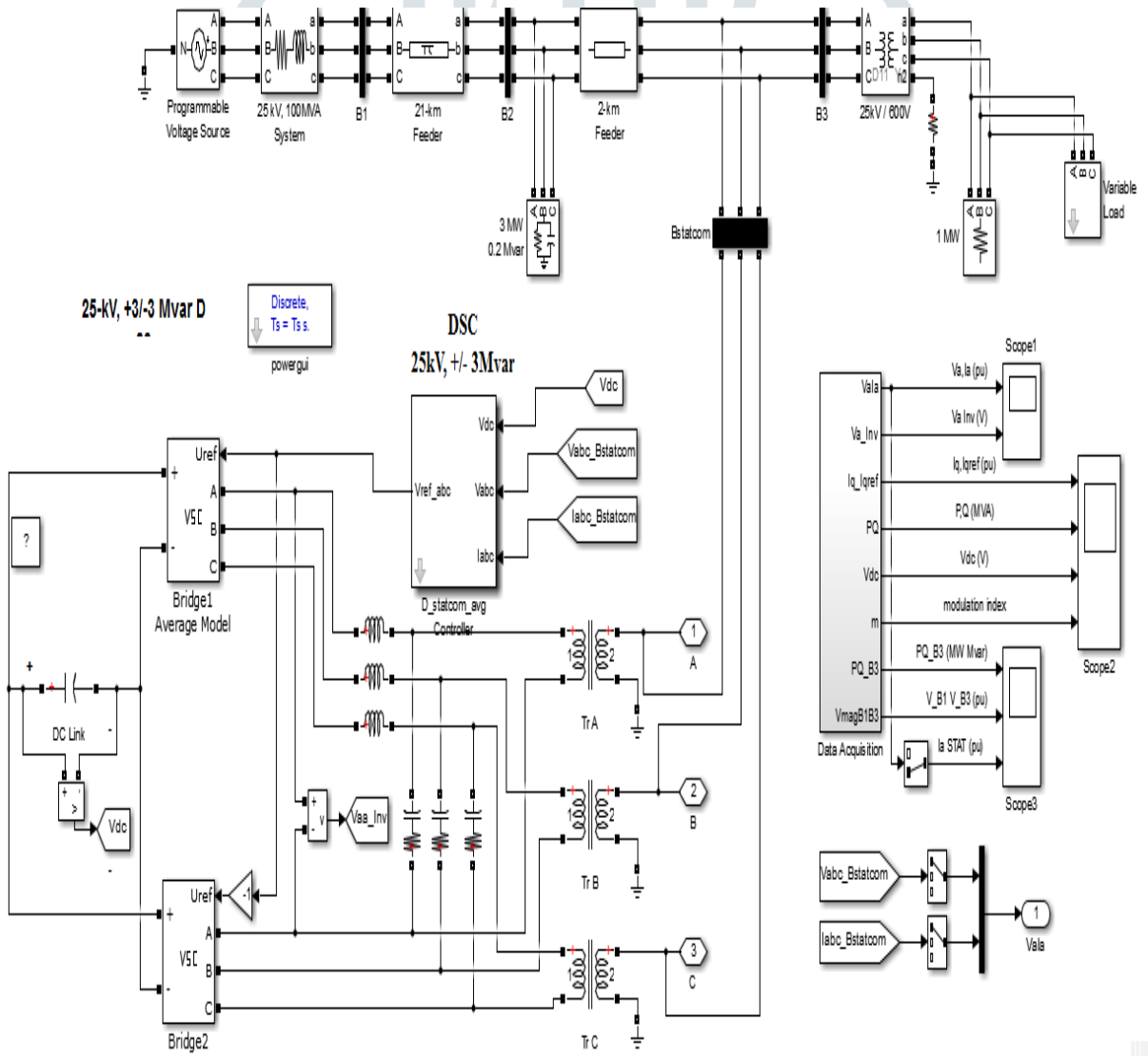

Figure 2. D-STATCOM based power quality enhancement [Complete Model]

In the above figure 2 shows the complete model of D-STATCOM based power quality enhancement.

Table 1. Parameter Values of proposed Model

S. No.	Parameters	Values
1	Source Voltage	25kV/50Hz
2	Source Power	100MVA
3	Total Line length	23Km
4	Coupling Transformer	25kV/1.25kV
5	Modulation frequency	1.40kHz
6	DC link Voltage	2.4kV

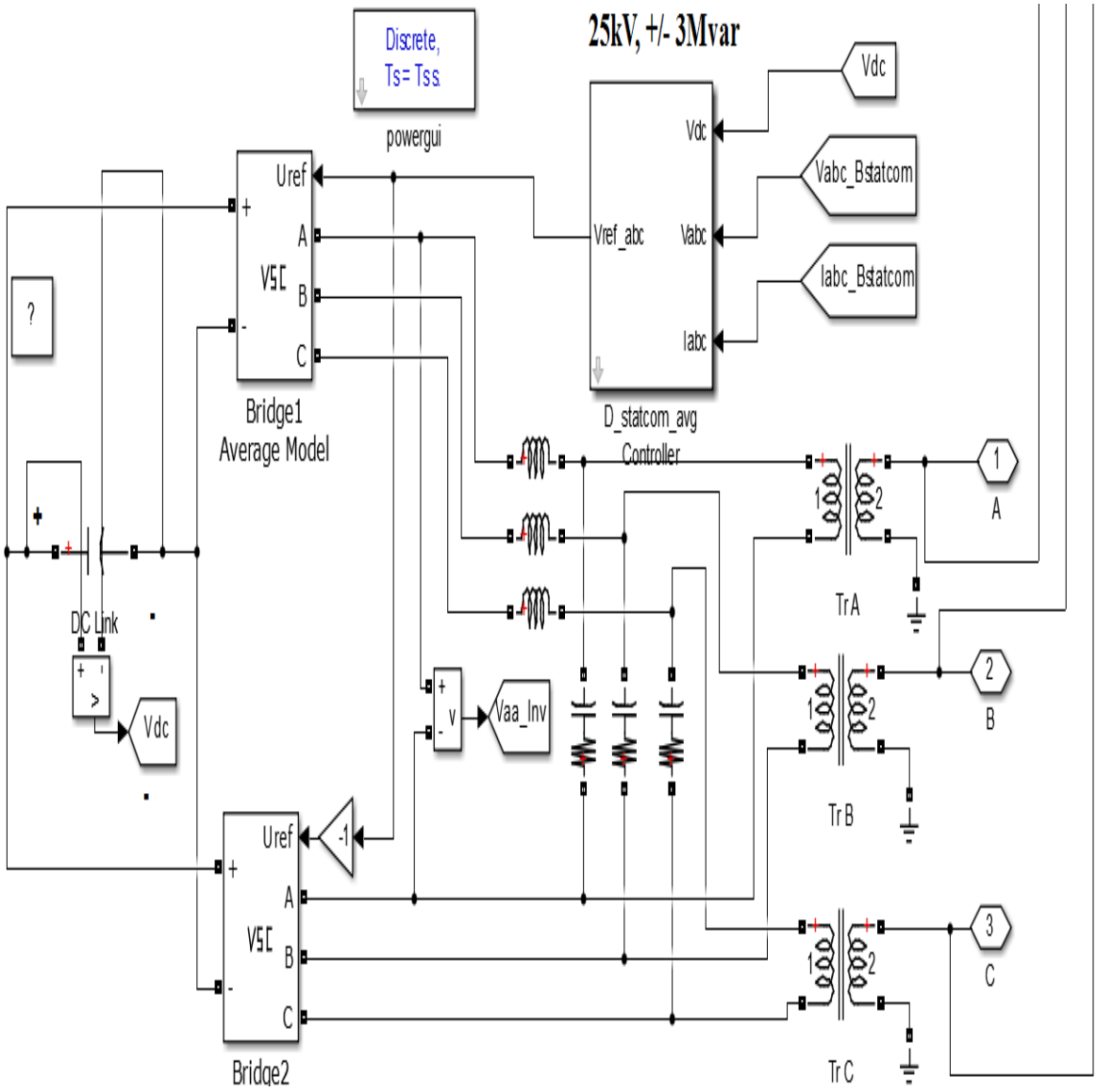

Figure 3.Shows D-STATCOM

above figure 3 shows D-STATCOM model and its component.

III. SIMULATION AND RESULT

In this section we discuss the simulation and result of proposed D- STATCOM based power quality improvement. For the calculation of results we used the input parameters. In this table shown the value of Generator (Sending End), Generator (Receiving End), Transformer (Sending End), Transformer (Receiving End), 3 phase mutual Inductance, Pi Network, 3 phase line (Transmission line), Resistance and Resistor & Inductor(Parallel). These are major values of proposed modal shown in below table 2.

Table 2 Input Parameters of STATCOM based proposed Model

S. No.	Parameters	Values
1	Source Voltage	25kV/50Hz
2	Source Power	100MVA
3	Total Line length	23Km
4	Coupling Transformer	25kV/1.25kV
5	3 phase mutual Inductance	[R1 (OHMS) L1 (H)][2 2*pi*50] [R0 (OHMS) L0(H)] [4 2*pi*50]/2
6	D – STATCOM (Vdc)	2400 Volt
7	Frequency	50 Hz

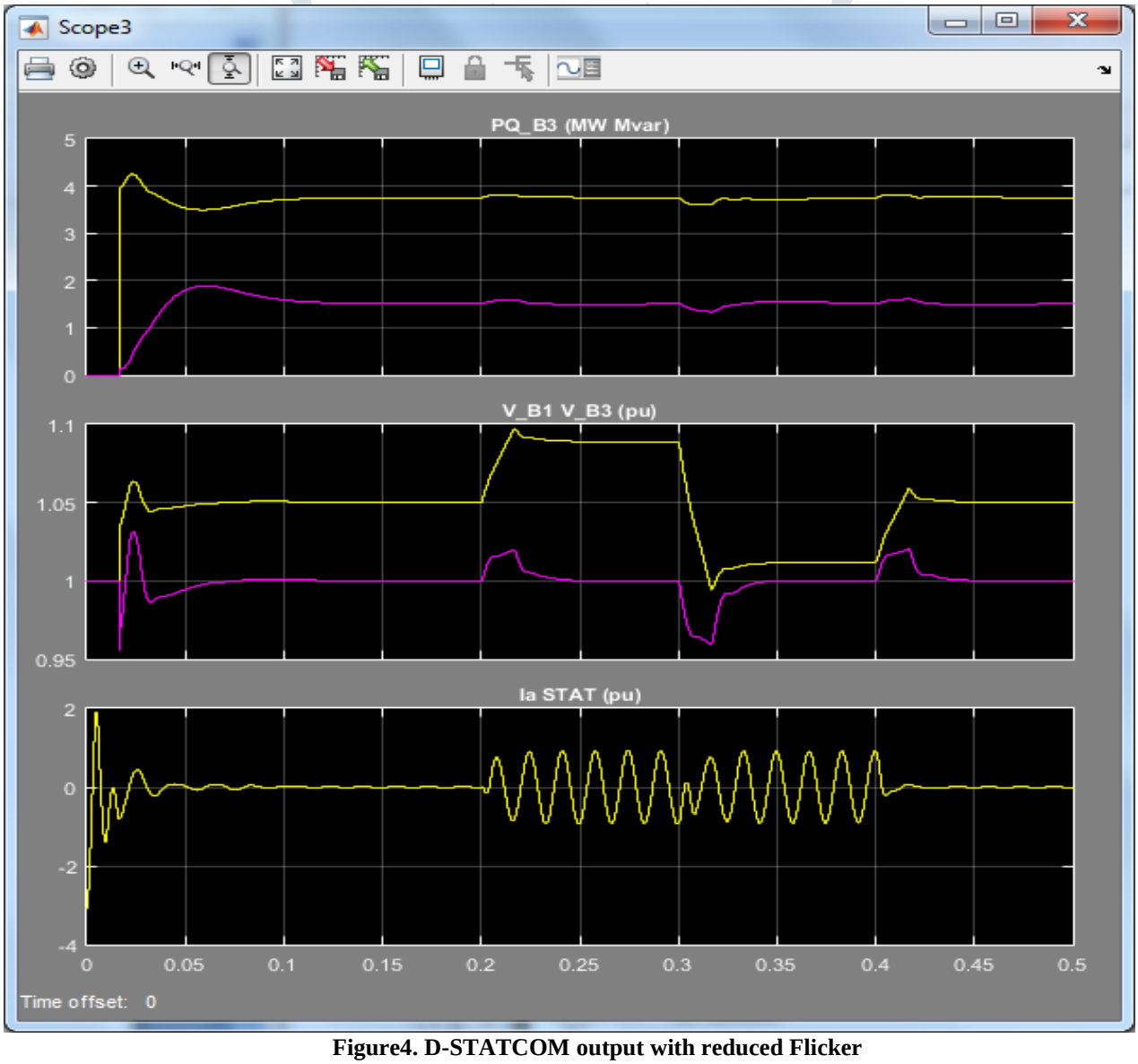

Figure4. D-STATCOM output with reduced Flicker

Scope3 shows the variation of P and Q at bus B3 (trace 1), still of voltages at buses B1 and B3 (trace 2). B3 voltage varies between 0.96 p.u and 1.04 p.u (four variation). Now, within the D-STATCOM controller, modify the "Mode of operation" parameter back to "Voltage regulation" and restart simulation. Observe on Scope three that voltage fluctuation at bus B3 is currently reduced to 0.7 %. The D-STATCOM compensates voltage by injecting a reactive current modulated at five Hz (trace three of Scope3) and ranging between 0.6 p.u capacitive once voltage is low and 0.6 p.u inductive once voltage is high.

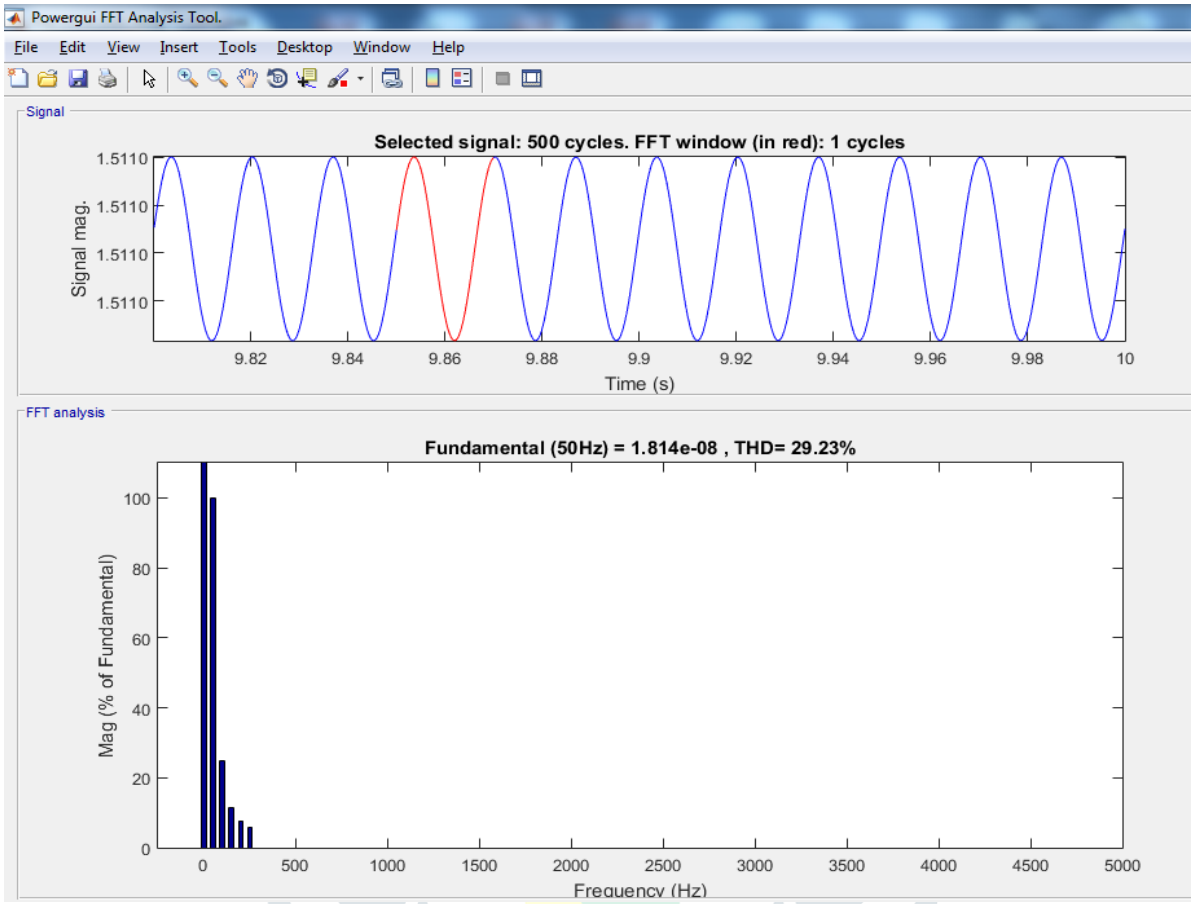

Figure 5. D-STATCOM output with Reduced THD

IV. CONCLUSION

In this proposed work the power system with variable load connected by making a simulink model in MATLAB. Proposed research shows how D-STATCOM has successfully been applied to power system for effective improvement of power quality of proposed system and improve the flicker problem. When system voltage is low the D-STATCOM generates reactive power, when system voltage is high it absorbs reactive power. Here in this proposed work we have concluded that D-STATCOM is better as compare to SVC and STATCOM based system. Proposed D-STATCOM contain lower harmonics as compared to SVC and STATCOM.

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