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Thyristor Controlled Series Compensation used Power System Stability Enhancement Under Three Phase Fault

Vikramarajan Jambulingam
Electrical and Electronics Engineering
VIT University

Abstract: In this research paper stability of power systems are analyzed by using a TCSC.The TCSC is a series connected facts devices. Mostly thyristor controlled series compensation enhances the power system stability under three phase fault. The control strategy is implemented by thyristor controlled series compensation devices and it is found that system performance is enhanced under three phase fault. Due to three phase fault the problems arises in generator voltage, generator current, Infinite bus voltage, Infinite bus current and generator load angle of a power system are investigated in detail and resolved by designing and testing a test system using MATLAB/SIMULINK.

Keywords: TCSC, FACTS, Transient stability

I. INTRODUCTION

The power generation and transmission is a complex process, requiring the working of many components of the power system in tandem to maximize the output. The shunt faults are the most regular type of faults taking place in the field [1]. Three phase faults caused due to falling tower, failure of equipment (or) even a line braking and touching the remaining phases can cause three phase faults [2]. The Flexible AC transmission system [FACTS] proposed in 1995.

The basic purpose of FACTS is installing the power electronics devices at the high voltage side of the power grid to make the complete system electronically controllable. Because of high power semiconductor devices and control technology FACTS devices plays a vital role in power systems.TCSC is a second generation of the Flexible AC transmission system device. It comes under the category of thyristor based devices compensator. Only switching on TCSC device is controllable, So TCSC can be otherwise called as half controlled device, In improvement of transient stability using FACTS controller are analyzed [3].

Nyati *et al.*, reported about the effectiveness of TCSC in enhancing power system dynamics [4]. Zhou *et al.*, developed control scheme for thyristor controlled series compensation device in system stability of power system [5]. In this paper the control strategy is implemented using TCSC devices. It is found that, system stability is enhanced with three phase fault. Similarly five parameters are investigated in detail by designing and testing a test system using MATLAB/SIMULINK.

Five different Parameters are represented as follows:

1. Generator Voltage as [V_g]
2. Generator Current as [I_g]
3. Infinite Bus Voltage as [V_b]
4. Infinite Bus Current as [I_b]
5. Generator load angle as [∂]

II. BLOCK DIAGRAM OF TEST SYSTEM

The below test network is tested and parameters such as generator voltage, generator current, bus voltage, bus current and generator load angle performances are examined by connecting TCSC devices.

Test system specification			
S.No.	**Generator 1**	**Generator 2**	**STATCOM**
1.	10KV	10KV	10KV
2.	110MW	10MVAR	10MVAR
3.	300 RPM	NA	NA

Table.1.Test system specification

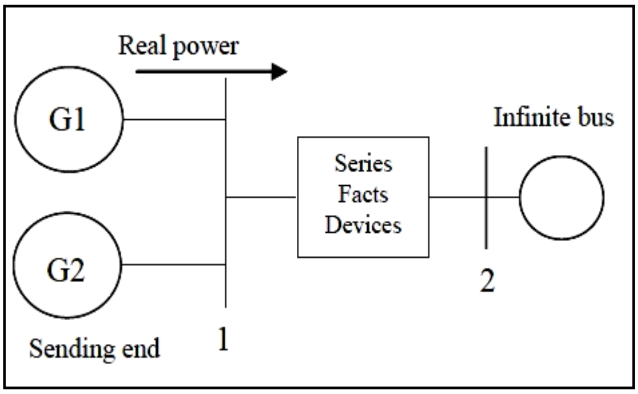

Figure.1.Test system with shunt FACTS device

III. DESIGN AND WORKING OPERATION OF THYRISTOR CONTROLLED SERIES COMPENSATION

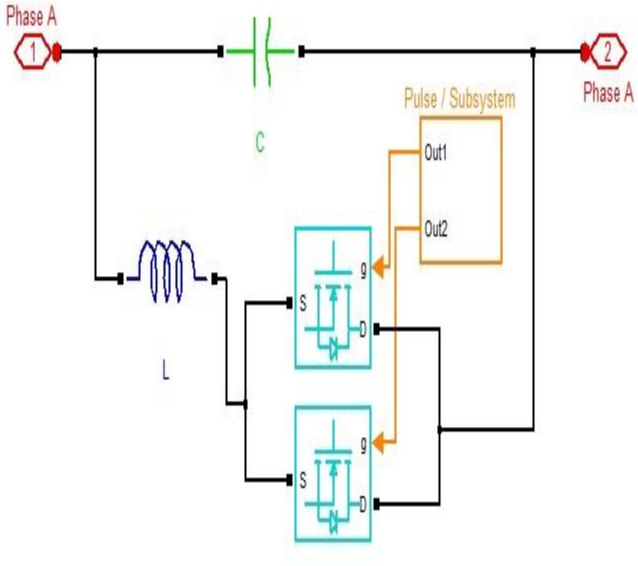

Figure.2.Design of Thyristor controlled series compensation

Thyristor controlled series compensation is a device consists of capacitor and thyristor controlled reactor connected in parallel. Power flow control is achieved using TCSC in a power system and also to broaden the capacities of transmission lines.

The Phase [A] design of TCSC [thyristor controlled series compensation] is shown in figure.2.The inductive reactance is defined by the firing angle of thyristor.TCSC usually linked in series with line and allows change in impedance of the transmission lines, so this change in impedance influences power flow control fast and efficient [6-8].TCSC operates in three different modes as follows:

Mode1 [Blocking mode]: Thyristor valve is always off, opening inductive branch and effectively causing the Thyristor controlled series compensation to operate as fixed series compensation.
Mode2 [By pass mode]: Thyristor valve is always on, causing Thyristor controlled series compensation to operate as capacitor and inductor in parallel, reducing current through Thyristor controlled series compensation.
Mode3 [Capacitive boost mode]: Forward voltage thyristor valve is triggered slightly before to allow current to flow through inductive branch, adding to capacitive current. This in fact increases the observed capacitance of the Thyristor controlled series compensation without requiring a large capacitance within the Thyristor controlled series compensation.

Thyristor controlled series compensation allows improved compensation simply by means of the above modes of operation and also in limiting line current during the event of faults.

Advantage of using Thyristor controlled series compensation is the damping's of sub synchronous resonance caused by torsion oscillation and inter area oscillation. This results in capability to transfer more power.

1. **Procedure to build up a test system**

Step 1: Design a Test system and create three phase faults near infinite bus as shown in figure 3.
Step 2: Measure the generator voltage, generator current, Bus voltage, Bus current and generator load angle.
Step 3: Design a Thyristor controlled series compensation (Figure.2) and connect to the test system as shown in figure.4.
Step 4: Measure the generator voltage, generator current, Bus voltage, Bus current and generator load angle.
Step 5: Compare both the result of test system as shown in table.2.

IV. SIMULATION MODEL OF TEST SYSTEM

1. Test system with three phase fault

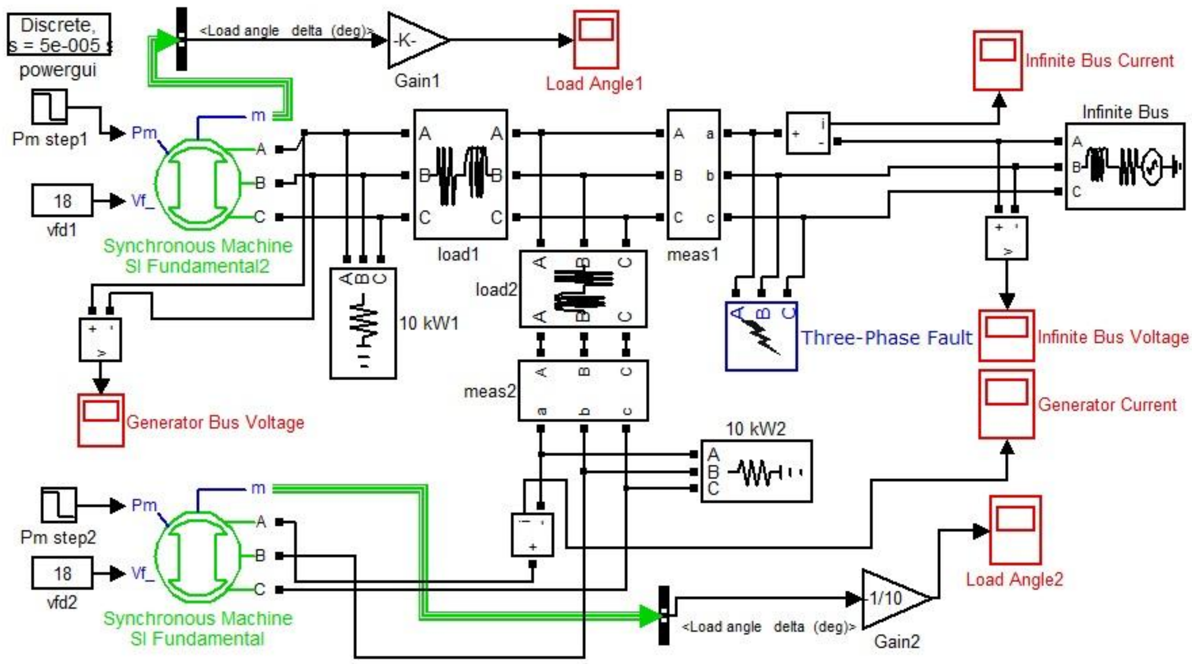

Figure.3.Test system with three phase fault

2. Test system with Thyristor controlled series compensation

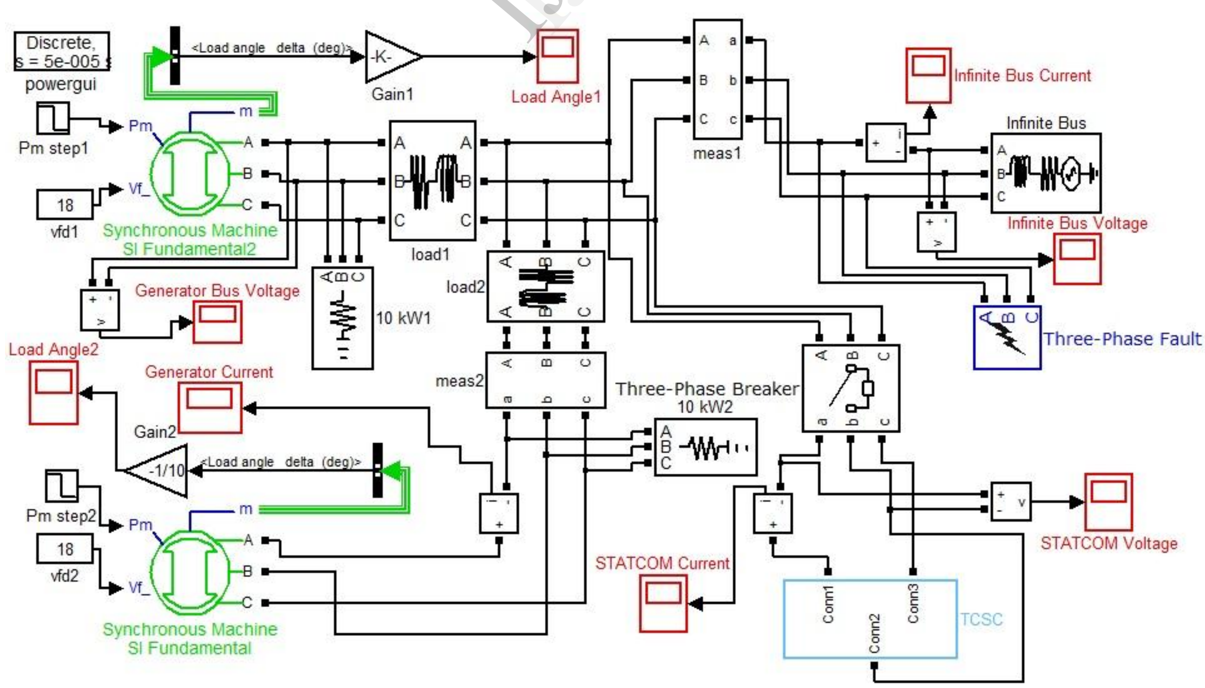

Figure.4. Test system with Thyristor controlled series compensation

V. SIMULATION RESULTS

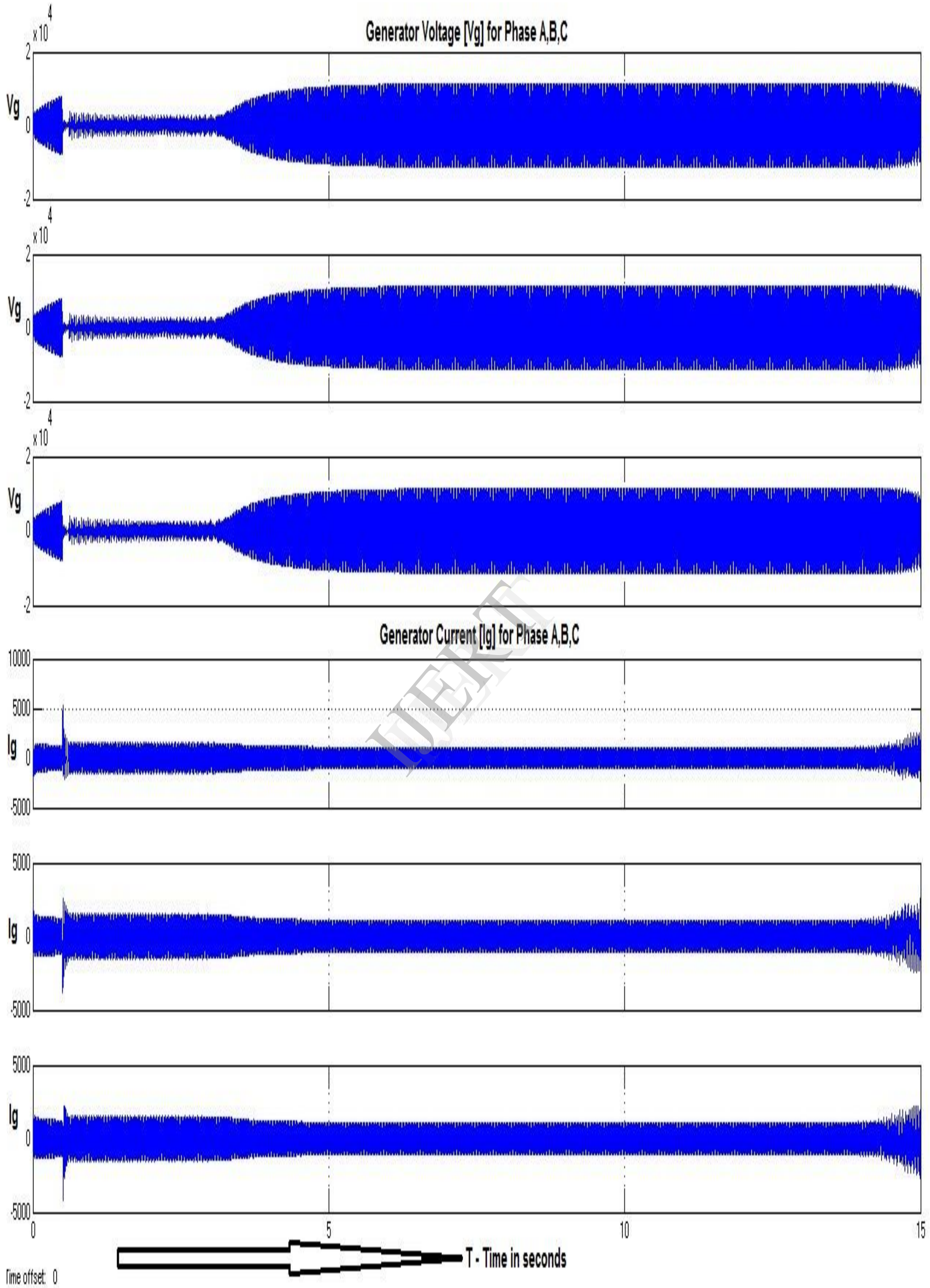

Figure.5.Represents generator voltage and current of test system with three phase fault

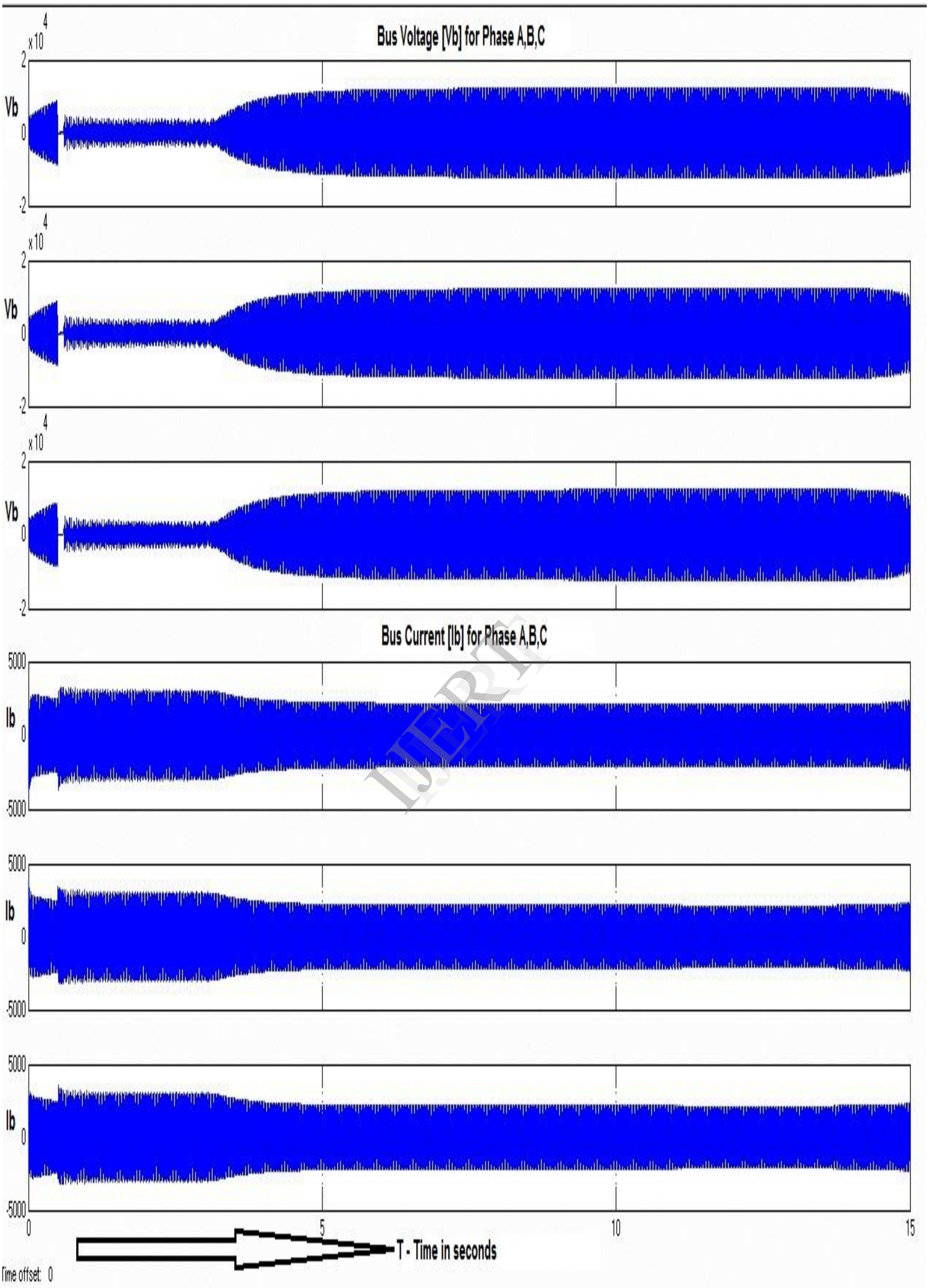

Figure.6.Represents bus voltage and current of test system with three phase fault

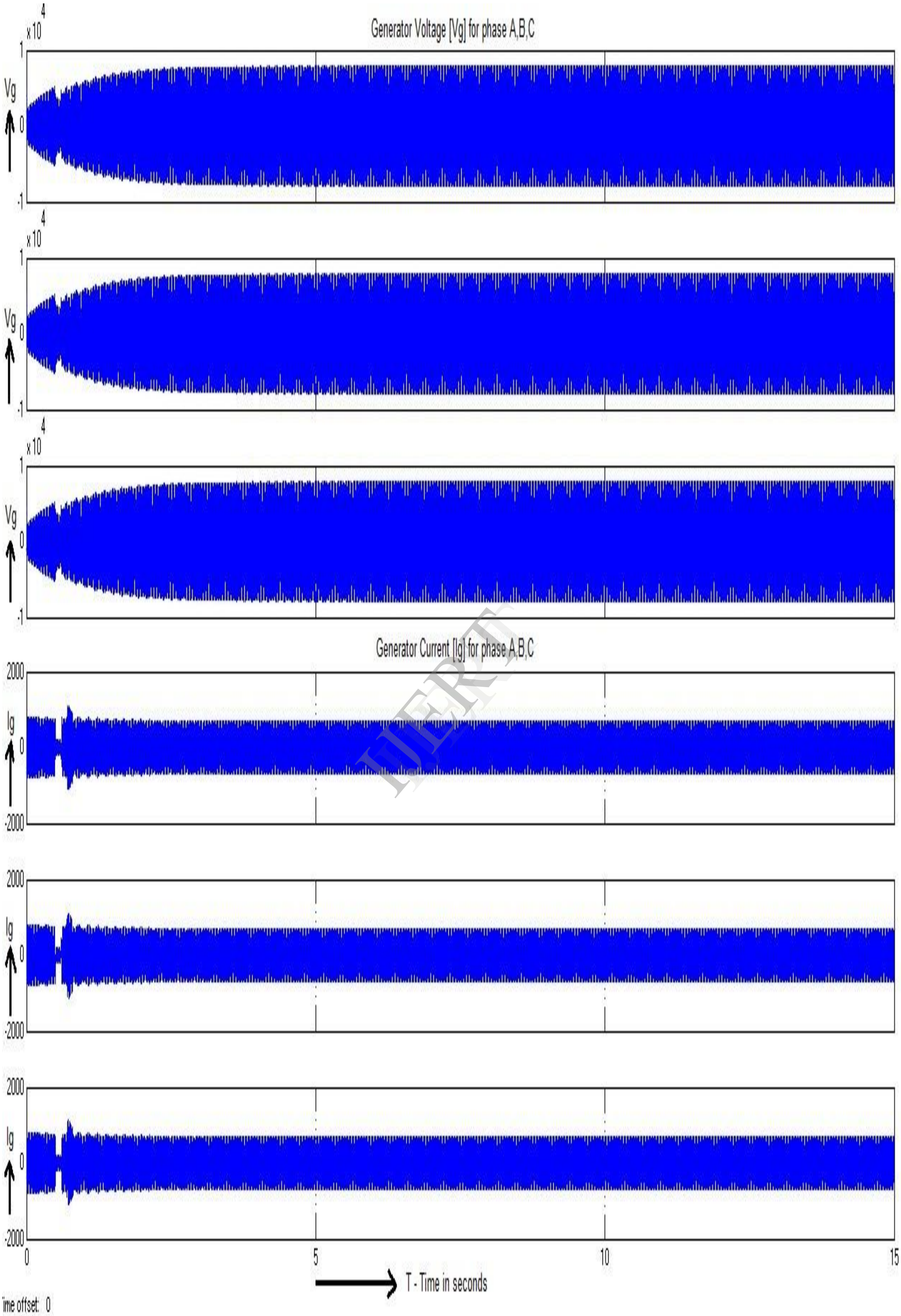

Figure.7. Represents generator voltage and current of test system with TCSC

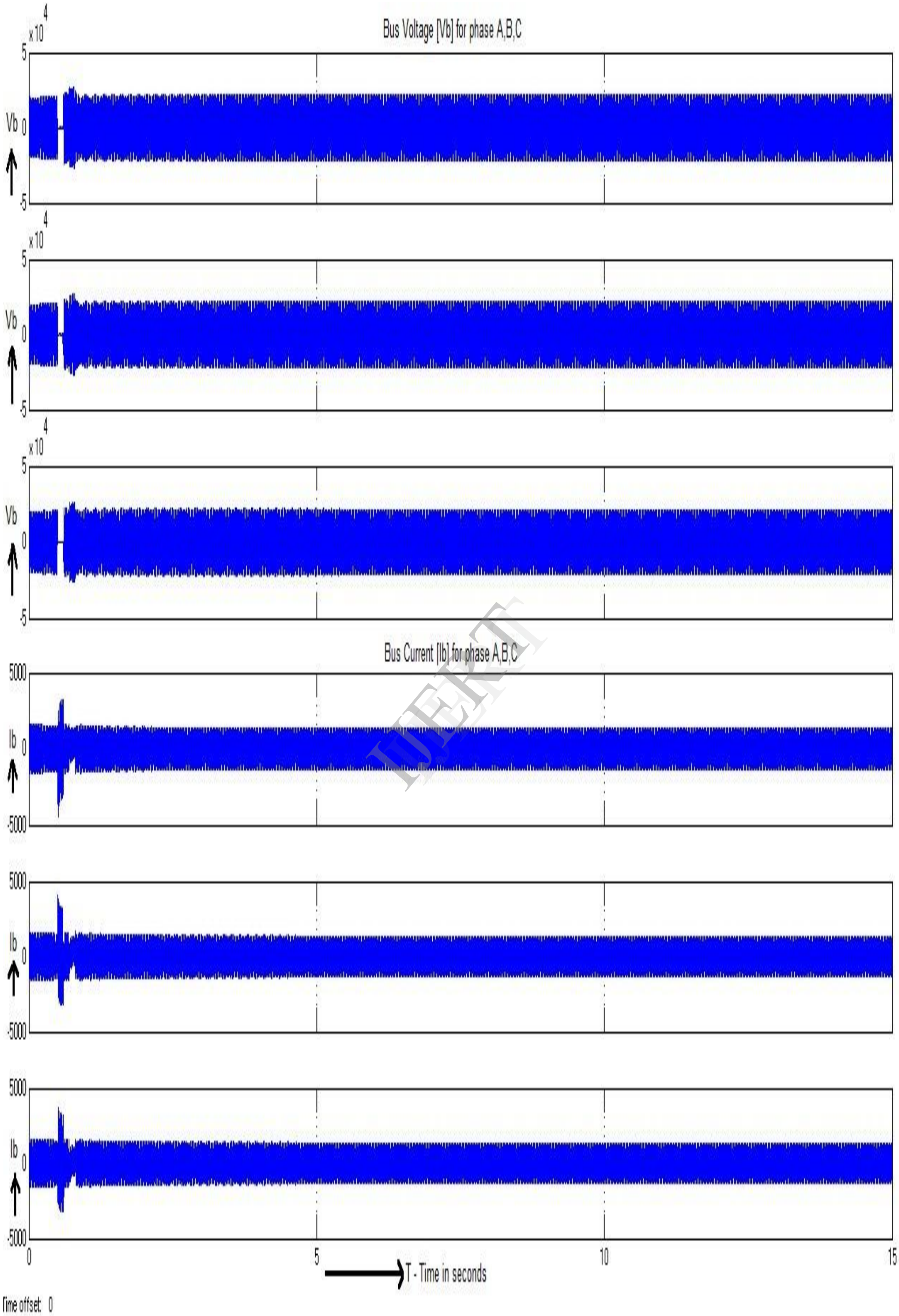

Figure.8. Represents bus voltage and current of test system with TCSC

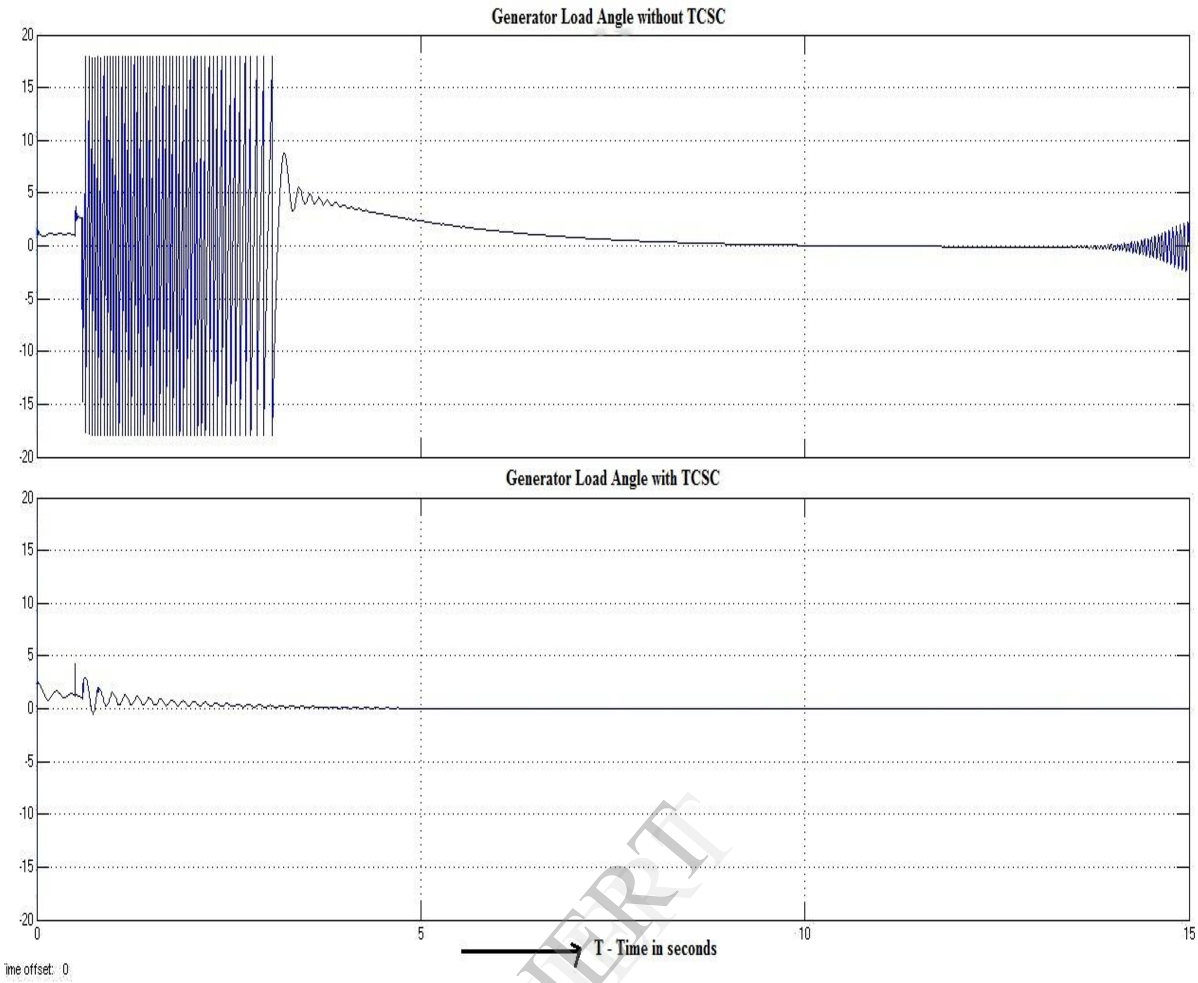

Figure.9.Represents Generator load angle of test system with and without TCSC

Parameters	Settling Time T_s	
	Without FACTS devices	**Thyristor controlled series compensation**
Generator voltage	4.3 Seconds	2.3 Seconds
Bus voltage	5.3 Seconds	0.3 Seconds
Generator current	4.3 Seconds	2.3 Seconds
Bus current	3.3 Seconds	0.3Seconds
Generator load angle	7.3 Seconds	4.1 Seconds

Table.2.Test system settling time comparisons

From Figure 5, 6, 7 and 8 we can observe that the generator voltage and current settling time is highly reduced from 4.3 seconds to 2.3 seconds and from 4.3 seconds to 2.3 seconds respectively. Likewise the Bus voltage and current settling time is highly reduced from 5.3 seconds to 0.3 seconds and from 3.3 seconds to 0.3 seconds respectively. So the power system stability is achieved moderately better with thyristor controlled series compensation under three phase fault in the test system.

VI. CONCLUSION

In this research paper the test system is designed with three phase fault using thyristor controlled series compensation. By using the thyristor controlled series compensation in the test system the bus voltage are controlled and voltage fluctuation is reduced. Generator voltage is stabilized at 2.3 seconds. Likewise the generator current is stabilized at 2.3 seconds. But without FACTS device generator voltage and generator current reaches stabilization at 4.3 and 4.3 seconds respectively. From the table.2 we infer that the test system with TCSC is much better in stabilization of generator load angle, Infinite Bus voltage and current than without FACTS device.

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BIOGRAPHIE

Mr.J.Vikramarajan received his Master degree in Power Electronics and Drives and Bachelor degree in Electrical and Electronics Engineering from VIT University, India. His research interests are power electronic applications, power quality, power electronic converters and power electronic controllers for renewable energy systems.