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Experimental study of Thyristor Switched Series Capacitor (TSSC)

[1]Ms. Nayana G. Hinge [2] Prof. Shradha Umathe
[1][2] Department of Electrical Engineering,
G H Raisoni college of Engineering
Nagpur
[1] hinge_nayan.ghrcemtechips@raisoni.net [2] shradha.umathe@raisoni.net

Abstract- **An Experimental Model is Available in FACTS Laboratory in Department. The Experimental Model Consist of Variable Impedance Type FACTS Devices. The General Types of Variable Impedance type FACTS Devices are TSC, TCR, GCSC, TSSC. The Main Objective of this Project is to study the Variable Impedance Type FACTS Device i.e. TSSC theoretically and obtained the different types of Operational and Control Characteristics of the Same Variable Impedance Type FACTS Device. MATLAB or Other Appropriate Software will be used in this Project to Support the Findings.**

Index Terms: **FACTS, Thyristor switched series capacitor (TSSC).**

I. INTRODUCTION

This paper describes operation of TSSC for improvement of power transfer and also for stabilizing system. The concept of FACTS able to boost ac system controllability and stability. The main types of FACTS devices are TCR, TSC, GCSC and TSSC.

Flexible ac transmission systems devices (FACTS) have occur as an option for improvement of stability. Experimental studies can help in understanding the VI characteristics of the TSSC and also DSO results i.e. voltage & current waveforms are presented.

II. BASIC OPERATION OF TSSC

TSSC consist of a capacitor in parallel with thyristor switches which are connected in anti-parallel direction. It is similar to circuit of GCSC but its operation is different conventional thyristor valve.

As the inserted capacitor is zero i.e. the voltage across load is DC voltage which is equivalent to AC capacitor voltage.
Maximum series compensation at rated current is given by;
4Xc = Vcmax / Imax

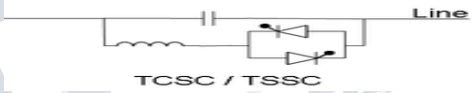


Fig.1 General Diagram of TSSC

This device permits variation in equivalent series compensating impedance by varying the firing angle of thyristor. TSSC does not permit an accurate compensation control, only a variation in degree

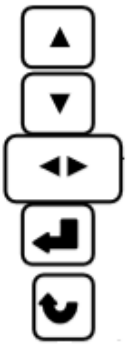
III. EXPERIMENTAL RESULTS

A. Front panel description of Single phase power line analyser

Single phase power line analyser have possess AC source, transmission line, TSC, TCR, TSSC, GCSC and display meter section.

SVC model have provided the variac for controlling the voltage of the thyristorized controller.

The variac output voltage can be adjusted by changing the increment and decrement switch which is given to the thyristorised and GTO controller. The keys of digital pulse controller are shown below.



-Selection and increment function

-Selection and decrement function

-cursor movement

-Enter key

-Reset

According to the digital pulse controller selected function based 9 pin pulse connector should be connected static var compensator configuration. As per the requirement based we can connected the display meters for the analyser of the power line analyser which function is selected in the power line analyser for the appropriate controller for their corresponding terminals should be connected as per the connection diagram. Fig 2 showing the experimental setup of thyristor switched series capacitor (TSSC).

Figure 2. Experimental setup of TSSC

Figure 3. Single phase power line analyser

B. Front panel diagram of TSSC

Fig. 3 showing the front view of single phase power line analyser and the results i.e. voltage and current waveform at α=120 deg which is shown below in fig. 4a & 4b.

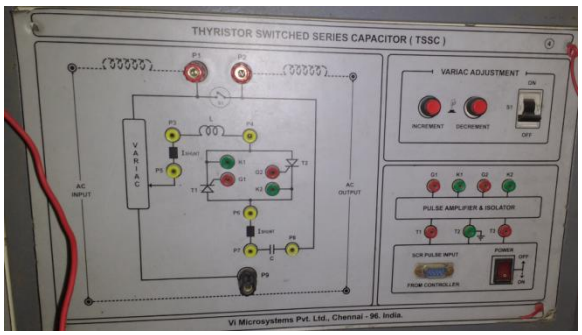


Figure 4. Experimental Panel of TSSC

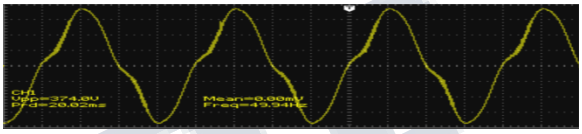


Fig. 4a waveform of voltage in TSSC with α=120

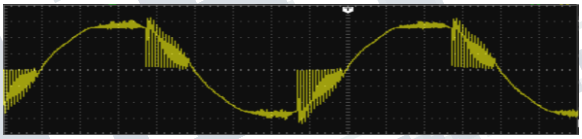
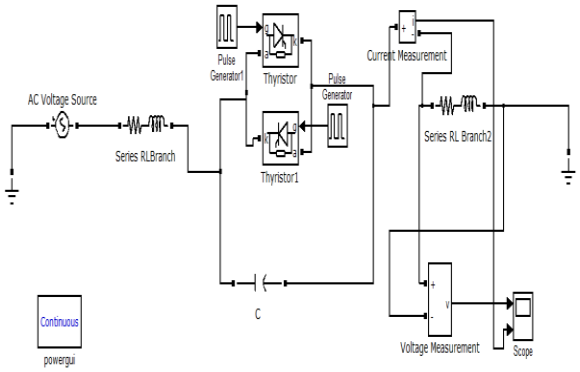


Fig.4b waveform of current in TSSC with α=120

IV. SIMULATION RESULTS



The above system is the simple system consist of single phase ac source, transmission line, single phase load, TSSC device connected at mid point of transmission

line. 120° phase delay for thyristor 2 and 0° phase delay for thyristor 1.The simulation results which are shown below in fig 5;

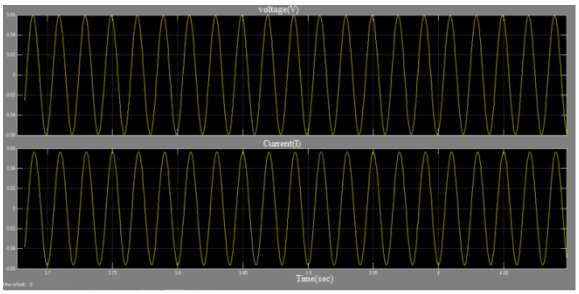


Fig.5 waveform of voltage and current

V. CHARACTERISTICS

- Input voltage or sending end voltage V (volt)=94v
- Output voltage across load,V=41v
- Power factor ,cosα=0.75 0r 0.8
- Power ,P=VICosα

Test results for TSSC shows that, as firing angle (α) increases from 20 deg to 150 deg, the corresponding current(I) decreases from 0.69 to 0.60 and the calculated reactive power at different firing angles are also decreases. The VI characteristic of TSSC for four series compensated module and for single series connected modules are shown in fig. 6a & 6b.

Table I: Test Results

Sr. no.	Firing angle(α)	Current I(amp)	Power P(watt)
1	20	0.69	26.5839
2	30	0.69	24.4998
3	40	0.69	21.6713
4	50	0.68	17.9209
5	60	0.67	13.735
6	70	0.67	9.3952
7	80	0.66	4.6989
8	90	0.64	0
9	100	0.63	-4.4853
10	110	0.62	-8.694
11	120	0.61	-12.505
12	130	0.60	-15.8125
13	140	0.60	-18.84
14	150	0.60	-21.3042

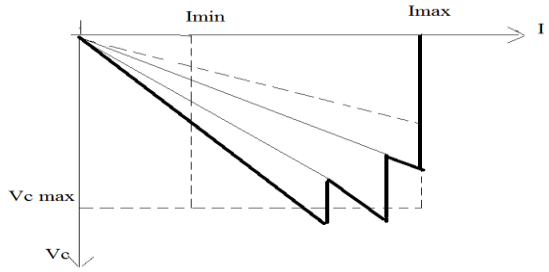


Figure A1: for four series compensated module

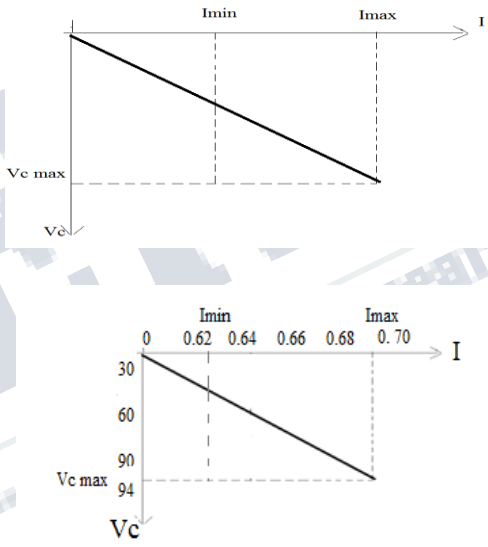


Figure B1: for single series compensated module

Imin < I< Imax
0.62<I<0.69amp

VI. CONCLUSION

The VI characteristic of TSSC has been studied. The reactive power is dependent on fixed input voltage .The waveform obtained on DSO and on scope gives same response i.e. sinusoidal current voltage waveform without creating any single phase fault. This project can be implemented to higher voltage rating and also can gives more accurate results with more compensation.

REFERENCES:-

[1]Nicklas Johansson, Lennart Ängquist, and Hans-Peter Nee, "An Adaptive Controller for Power

System Stability Improvement and Power Flow Control by Means of a Thyristor Switched Series Capacitor (TSSC)," *IEEE Transactions on power systems, vol. 25, no. 1, february 2010*

[2] Nicklas Johansson, Lennart Ängquist and Hans-Peter Nee, "Preliminary Design of Power Controller Devices Using the Power-Flow Control and the Ideal Phase-Shifter Methods " *IEEE Ttransactions on Power Delivery, vol. 27, no. 3, july 2012*

[3] Nicklas P. Johansson, Lennart Angquist, Hans-Peter Nee, "Adaptive Control of Controlled Series Compensators for Power System Stability Improvement," *IEEE 2007*

[4] Jyoti Govind Agrawal , K.D.Joshi, "Experimental Study of Some Variable Impedance Type FACTS Devices," *2011 Fourth International Conference on Emerging Trends in Engineering & Technology*.

[5] N.G. Hingorani and L Gyugyi, Understanding FACTS - Concepts and Technology of Flexible AC Transmission Systems, *IEEE Press, New York, 2000*.

[6] R.M. Mathur and R.K. Varma, Thyristor-Based FACTS Controller for Electrical Transmission Systems, *IEEE Press and Wiley Inter science, New York, 2002*.

[7] Brian K. Johnson, "Simulation of TSC and TSSC",*IEEE 2001*.

[8] Farag Ali El-Sheikhi, Yousef Mabruk Saad, Saleh Omar Osman, and Khalil M. El-Arroudi,"Voltage Stability Assessment Using Modal Analysis of Power Systems including Flexible AC Transmission System (FACTS) " *IEEE 2013.*

[9] Eugen Neagu and Rodica Neagu," New Results Concerning Thermally Stimulated Discharge Current Peak Above Room Temperature" *IEEE 1994.*