REACTIVE POWER FLOW CONTROL USING STATIC VAR COMPENSATOR TO REDUCE HARMONIC AND TO IMPROVE POWER STABILITY IN TRANSMISSION SYSTEM

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ABSTRACT

As one of the traditional solutions, the flexible systems of current transmission systems (FACTS) are designed to make power systems more efficient, improve stability and energy quality, and these systems are used in different parts of the world including our country. In general, FACTS can be defined as systems that provide voltage, impedance and phase angle to AC systems. With recent studies, the use of modern technology devices such as static VAr compensator and static synchronous compensator is becoming increasingly common to ensure energy quality in energy systems. In addition, due to advances in semiconductor technology, static VAr compensation systems have been introduced for use on the middle and upper power side. The most important feature of these systems is that they can compensate without requiring active power from the grid. In this study, the required operating power is required by a system provided using a fixed VAr compressor consisting of a thyristor-controlled responder and the properties of a thyristor switch capacitor. In simulation studies, active energy is provided by a static compensator instead of a power source. In this way, unnecessary use of power in the system was prevented. It is recommended that static VAr solutions be used especially when there is unbalanced load and fast operating power required.

Keyword: - *SVC, TCR, TSC, FACTS, Power System Stability*

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1. INTRODUCTION

In recent years, due to the high rate of switching, electronic power components have been used in compensation systems for power systems. Therefore, it is predicted that power outages can be prevented and stability will be increased. Advances in the construction of electronic power systems have had a profound effect on the transformation of energy systems around the world. The use of thyristors in power control and switching power systems has led to new-generation thyristor-based devices. These new devices, based on electronic power, enable the power to control, stabilize and transfer power to the current transmission systems, called flexible alternating current transmission systems (FACTS). FACTS devices are installed to improve the stability of the power system. Strength of the power system is a major part of electrical engineering work. Basically, it depends on the minimum amount of electricity losses and the transfer from the end of the shipment to the end of the receipt as per the consumer's requirement. The power at the end of the buyer is often attributed to changes due to changes in load or disruption to the transmission line. Therefore, the stability of the energy system is very important and is used to describe the ability of the reinforcement system to function as quickly as possible after a certain type of temporary disruption.

Adjustment of the power factor of fast and unbalanced loads with traditional electro-mechanical compensation methods is problematic to ensure the stability of the electrical system. One reason for this is that conventional compensation methods (with active energy control and contactor) are not able to respond quickly to active energy loads and that the required capacitive power cannot be compensated for by the compensation system. On the other hand, in the case of unequal loading, there are no three-way approaches to responding to the needs of each category. With static VAr compensation systems, rapid compensation for unstable loads can be done quickly, such as a vacuum cleaner, arc furnace, port cranes used in sectors such as automobiles, glass, cement, steel and steel, where the power factor can always show and major changes.

2. BASIC PRINCIPLES OF STATIC VAR COMPENSATOR SYSTEMS

SVC is one of the FACTS devices, connected in the same way as the power system, which generates or absorbs active energy from the system to control the parameters of electrical systems such as power. They are safe and flexible, capable of producing or using continuous working capacity, operating at unlimited speeds, and high response times [5]. SVCs are widely used in energy systems to improve power management and system stability. In recent years, many researchers have proposed the process of improving stability with SVC to eliminate electromechanical flexibility in electrical systems [6 - 7 - 7]. The SVC structure typically consists of a combination of thyristor-controlled reactor (TCR) and / or thyristor switched capacitor (TSC) structures. Figure 1 shows a typical block diagram of SVC control systems. In this study, a static VAR model developed by TCR and TSC structures is modeled.

The problem of energy fluctuations caused by arc corks during steel production has always been a major concern for energy quality worldwide. SVC systems are widely used today, especially in facilities such as the arc center and rolling mills where rapidly changing loads are available. The active energy consumption of arc fish becomes very strong due to the random variation of the arc length during the melting of the stain. In addition the use of SVC improves the temporal stability of the transmission line and the thesis in which it is used [9 - 10].

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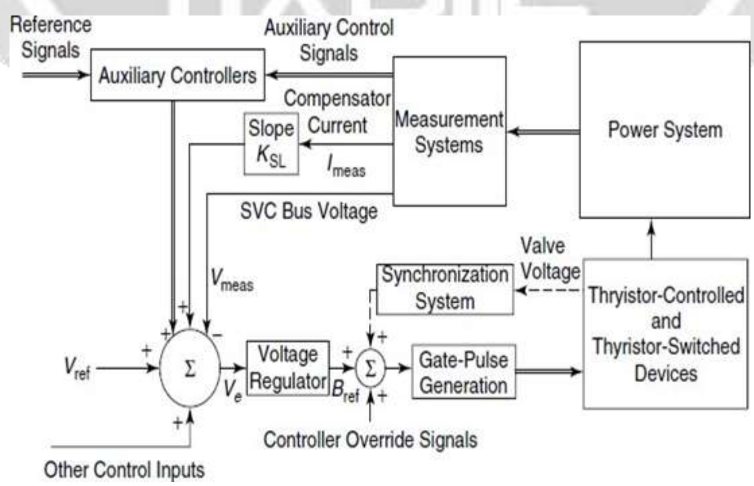

Fig -1 General schematic block diagram of SVC control systems

In voltage control cycles, the SVC can effectively switch off power system surges and improve the stability of power systems. An ideal SVC is defined as a controller that does not have an active and reactive power loss, the voltage is equal to the reference voltage, it cannot be changed and can respond very quickly.

2.1 V-I Characteristic of the SVC

The variation of SVC bus voltage and SVC current or reactive power is defined by the steady state and dynamic properties of SVC. Figure 2 shows the voltage–current characteristic of the SVC.

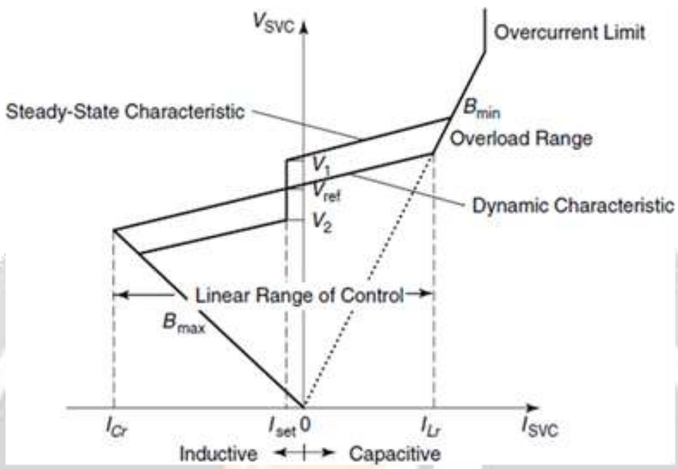

Fig -2 The voltage–current characteristic of the SVC

At the reference voltage Vref, the voltage is regulated while the SVC susceptance (B) continues among the maximum and minimum susceptance values enforced by the total reactive power of capacitor banks ($Bcmax$) and reactor banks ($Blmax$) [12].

3. TCR and TSC Structures

3.1 TCR Structure

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As shown in Figure 3, one basic TCR phase consists of thyristor anti-parallel valves connected in series with an air-core reactor such as and1 and -2. The attitude of the thyristor pair is connected in parallel-like by switching to both bids. In good cycles half of the thyristor valve $T1$ operates and in negative circuits the power of the thyristor valve $T2$ operates. Estimation of the shooting angle of thyristors can be made from the force of zero falling across all of their terminals.

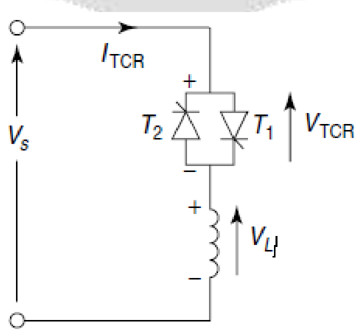

Fig -3 Basic structure of a TCR

For in-system thyristors that typically form a Vatic static control system, it is very important to know what intervals will start. In the first part of the exchange, i.e. for the causes to be made below 90º, the converted thyristor groups produce a DC current, so that the thyristors connected to each other are disturbed. Also, a change in trigger angle after the thyristor is transferred is only possible at a later time. This is called the time of thyristor.

Control characteristics of the TCR susceptance, is shown in Figure 4.

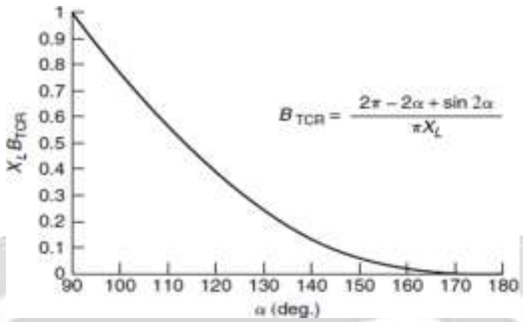

Fig -4 Control characteristics of the TCR susceptance, $BTCR$

3.2 TSC Structure

Thyristor switched capacitors (TSC) are generally used instead of constant capacity thyristor controlled reactor (FC-TCR). TSC is also a subset of SVC, where thyristor-based ac switches are used to turn on and off the shunt capacitor units (without firing angle control), unlike shunt reactors, to provide the necessary step change in the reactive power supplied to the system. The shunt capacitors cannot be changed continuously with variable firing angle control. Basic structure of a TSC is shown in Figure 5.

Generally single or more than one TSC structure is connected to the same load bus in parallel (the reactive power values of TCS are chosen approximately equal to each other). As the demand for reactive power increases, the thyristors are triggered and the required number of TSCs are activated. We can say that TSCs are commissioned in sequence step by step.

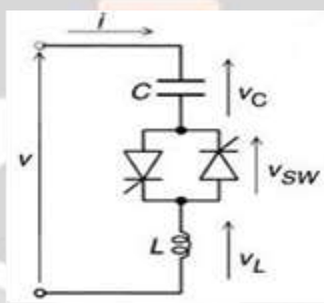

Fig -5 Basic structure of a TSC

The operating logic of the TSC is done by switching on and off the capacitor, which is pre-charged to the peak value of the source voltage [14]. Under steady-state conditions, when the TSC branch is connected to a sinusoidal AC voltage source $V(t)$=$Vsin\omega t$ and the thyristor valve is closed, the current in the branch.

4. WORK DONE

The proposed study has been carried out using the test system shown in Fig. 1. This system consists of a conventional generator (Gl) rated at 735 kV. There are four buses in the system designated as Bl to B4. The two loads Ll and L2 are connected on the buses Bl and B4 respectively as shown in Fig. 1. The loading status of these loads is given in Table 1. The data of transformer TRF is provided in Table 2. Thyristor switched capacitor (TSC) is connected to the bus B3.

The static VAR compensator (SVC) is consists of the one unit of thyristor controlled reactor (TCR) and three units of TSC. The TCSR consists of a bidirectional thyristor switch fixed with reactor a inductance L. The available power thyristors can block voltage up to 4000 to 9000 V and conduct current up to 3000 to 6000A. Hence, in a practical valve the many thyristors (ranging from 10 to 20) are connected in series to meet the required blocking voltage capability at a given power rating. A thyristor switch can be brought into conduction by simultaneous application of a gate pulse to all thyristors of the same polarity. The thyristor switch automatically blocks immediately after the ac current crosses zero, unless the gate signal is re-applied. The TCR inductance is IS.7e-3 henry and quality factor is 50. The thyristor snubber resistance and capacitance are respectively 500 ohm and 250e-9 F. The TCS consists of three parallel units each of capacity 94 MV AR. It consists of a fixed capacitor of capacitance C, and a bidirectional thyristor switch. The TSC capacitance in each unit is 30S.4e-6 F. Thyristor snubber resistance and capacitance are respectively 500 ohm and 250e-9F. The phase locked loop based control of the TSC and TCR are used in this study for reactive power flow control.

A SVC has been proposed for the improvement of voltage stability in the transmission network of the power system based on the reactive power flow control using the phase locked loop based control. Proposed SVC is capable to control the voltage variations in the power system events such as variations in the amplitude of voltage, switching of the large and small loads etc. The proposed SVC is capable to control the reactive power as per requirement of the system by automatically switching on the number of TSC in the circuit. The results have been validated in MATLAB/Simulink environment.

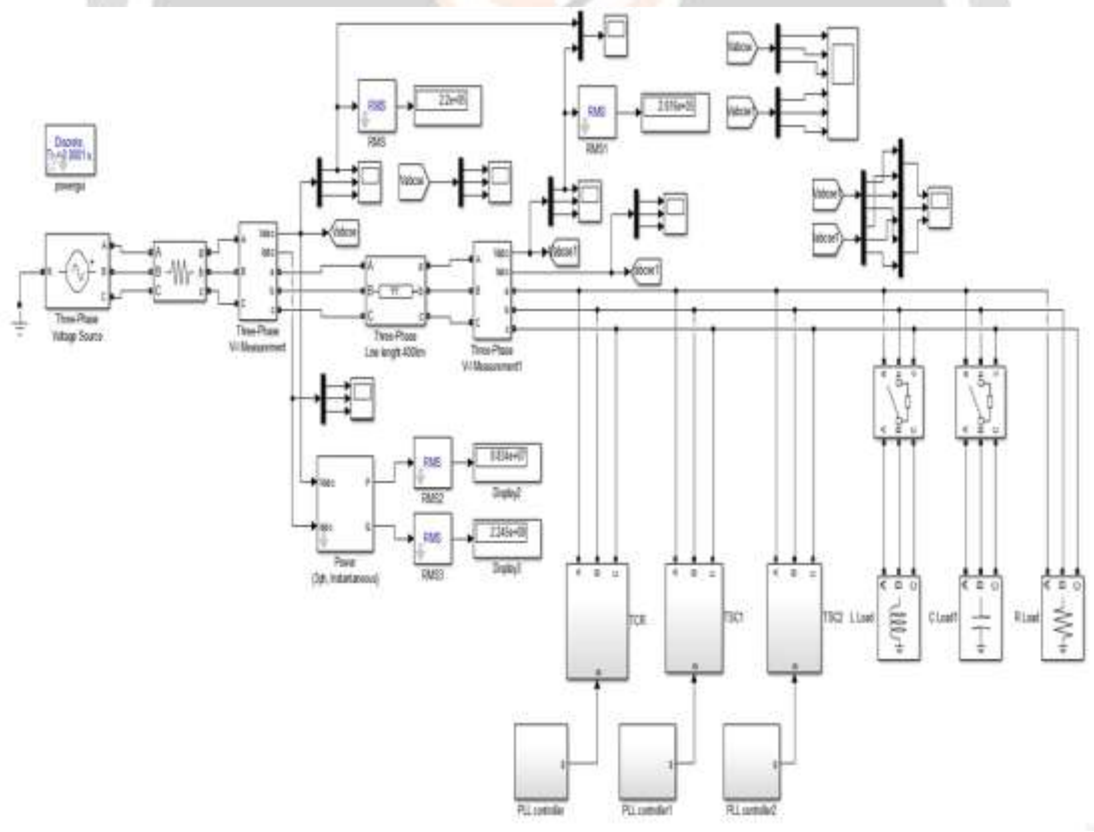

Fig-6 System Simulation Diagram

4. RESULT

The voltage stability of the power system network has been achieved by the control of reactive power using the SVc. The voltage stability during the power system operational events such as voltage variations and switching of the loads has been investigated. The study has been carried out using the MA TLAB simulations. The study has been carried out with the help of test system shown in Figure. Bus B-1 is selected as the test point and voltage and current signals are captured at this bus. The various case studies are detailed in the following subsections. The results have been plotted for 1 second.

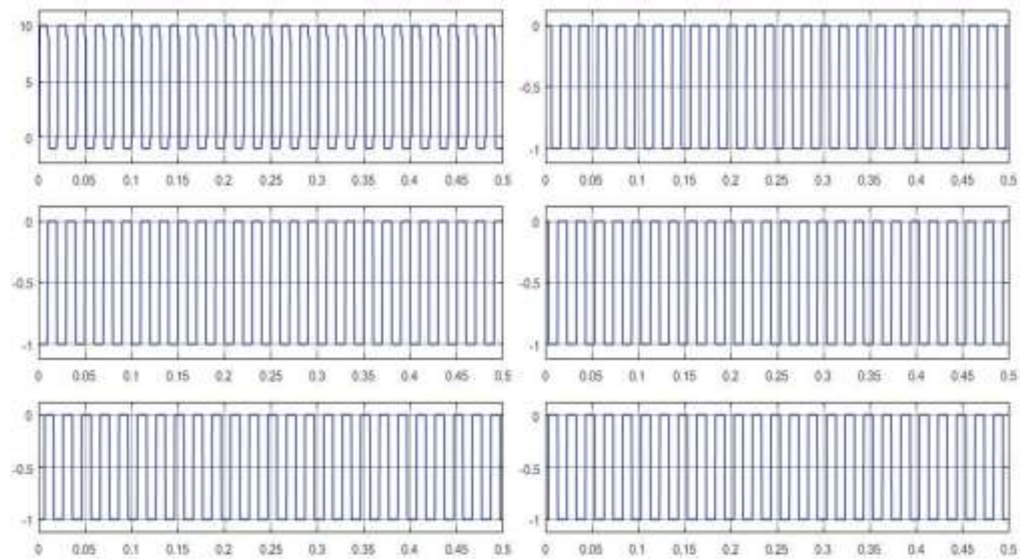

Fig-7 Gate pulses of TCR

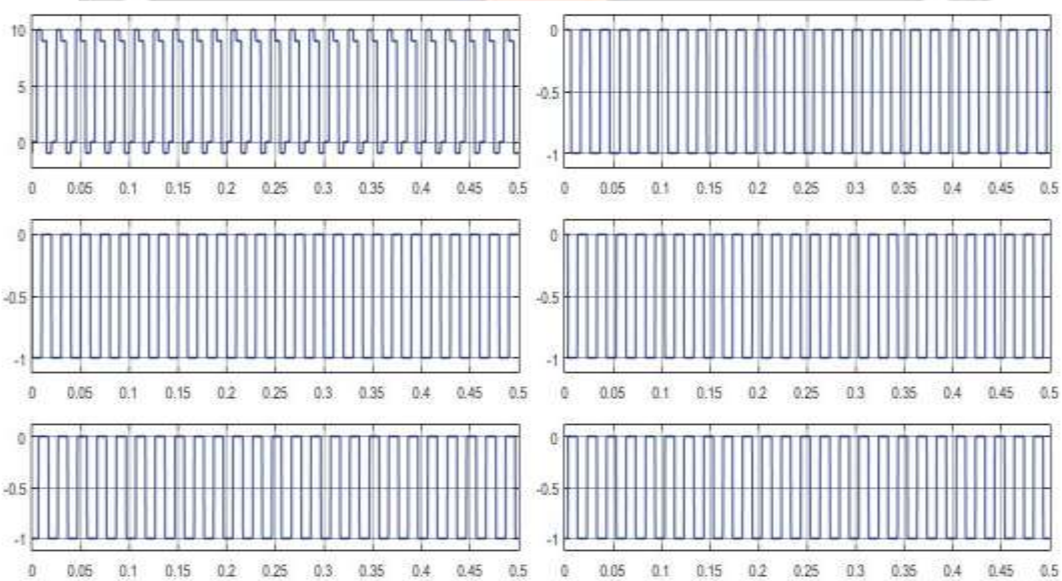

Fig-8 Gate pulses of TSC1

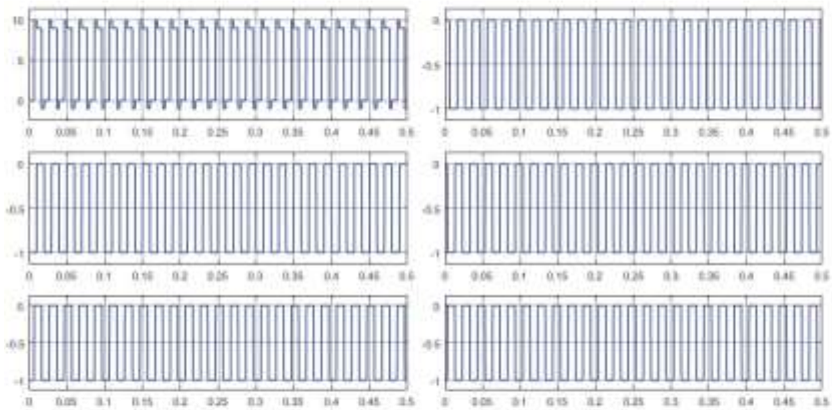

Fig-9 Gate pulses of TSC 2

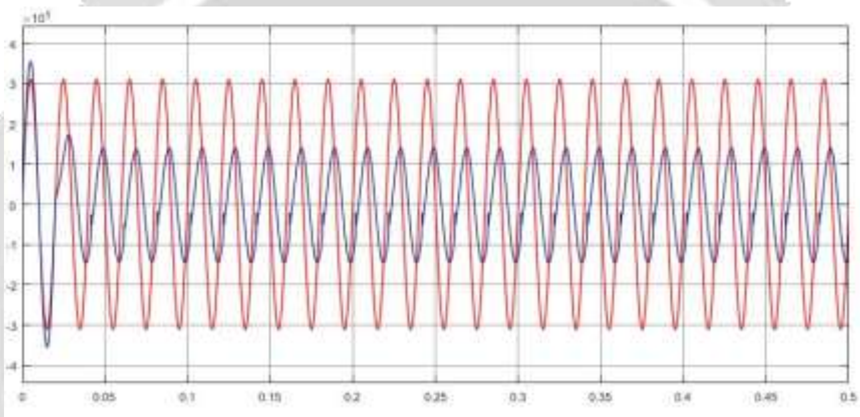

Fig-10 Input and output voltage source

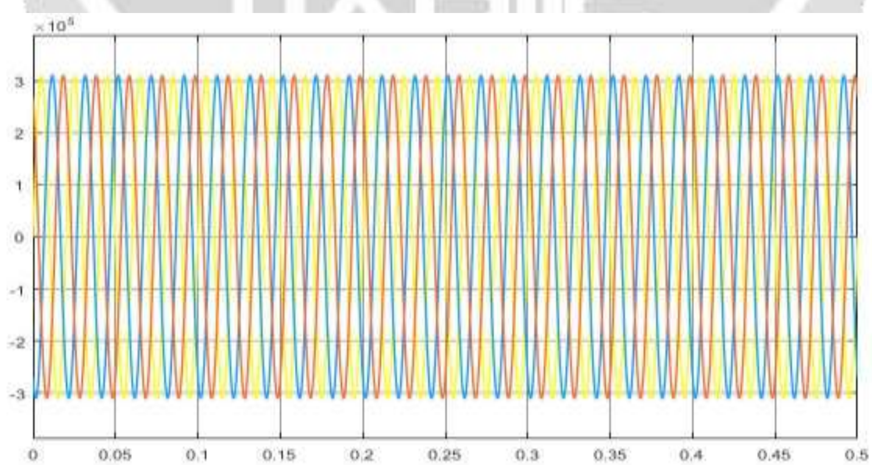

Fig-11 Input three phase supply

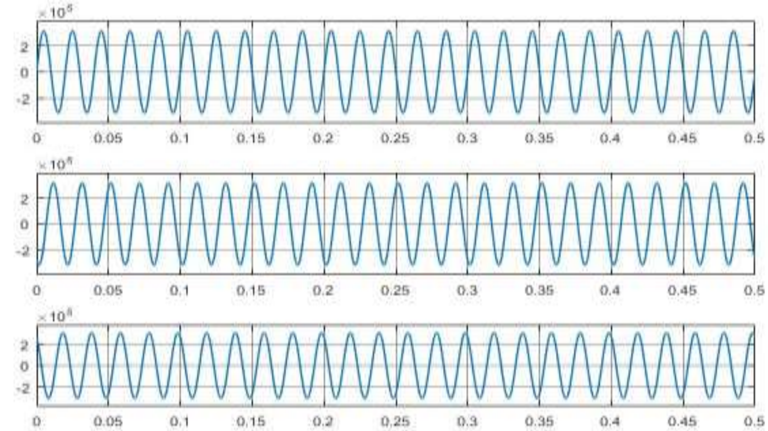

Fig-12 Input voltage source

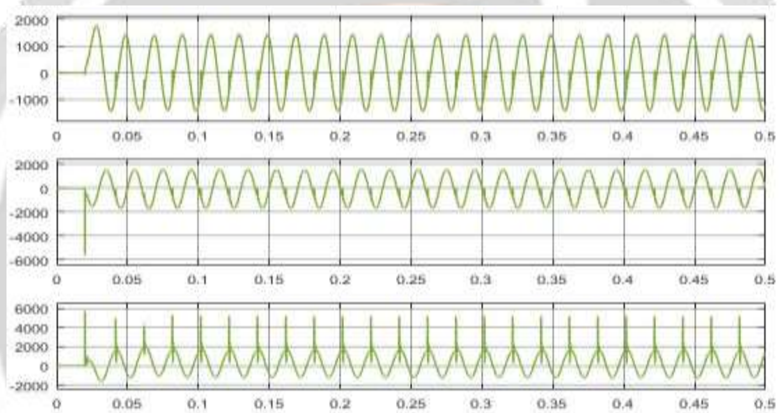

Fig-13 Output current source

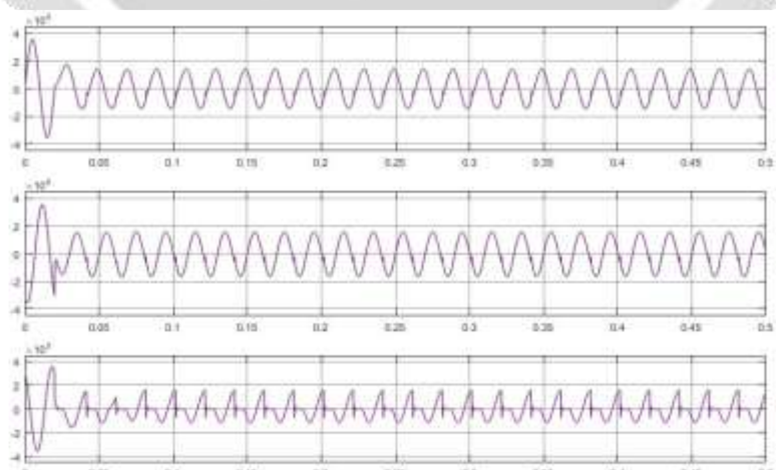

Fig-14 Output voltage source

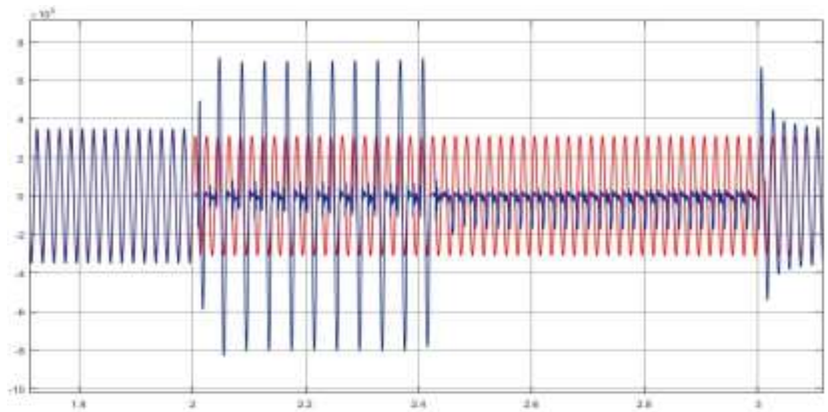

Fig-15 Single phase input output waveform with inductive load

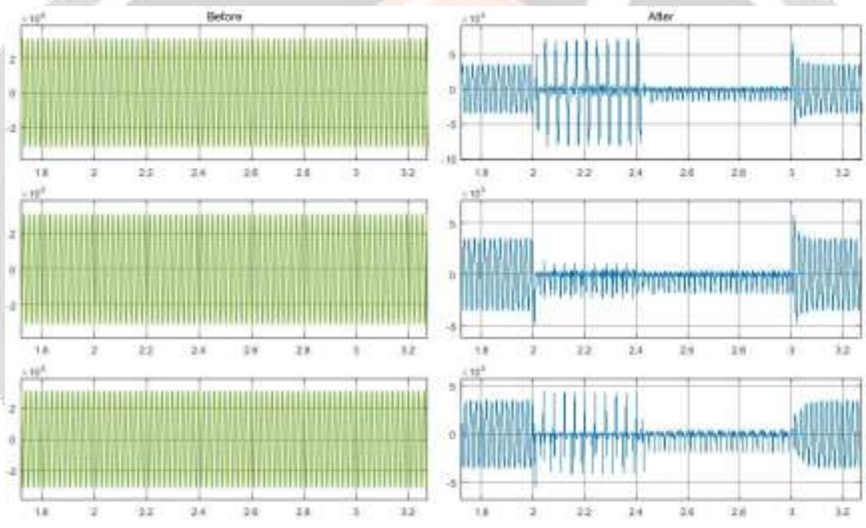

Fig-16 Before and after waveform connected in inductive load

5. CONCLUSIONS

To design three phase four wire transmission line with three phase voltage source and some resistance are connected on that time because of the physical transmission line present the same resistence and inductiance then measure the voltage and current measurement. This measurement is shows the three phase slop as well as display the RMS value of the single phase and voltage.

In the three phase transmission line the active and reactive power are generated because of the load. The load are present in the transmission line the load are inductance, capacitance and resistance are present in the transmission line shows the active and reactive power with RMS value in display.

The avc system are a FACT device like UPQC, DVR and many other, this system is improve the line of transmission l_in and reduced the harmonics. In SVC system TCR, TSC1 and TSC2system are present in SVC system. Internal present of TCR system six thyrisor are present each thyristor is operate on PWM signal and that

TCR system are connect to induction load and also available in the SVC system are TSC in that SVC system these are two two TSC are present like TSC1 and TSC2 both are the same, in TSC1system six thyristor are present and each are operational in PWM signal and TSC1 and TSC2 are also connected to the capacitor, and this capacitor are connected with ground.

In the given transmission system linear and non-linear load are connected to the system with switch breaker. This switch breaker automatically ON and OFF with some switching frequency and because of that switching frequency fault are automatically generated.

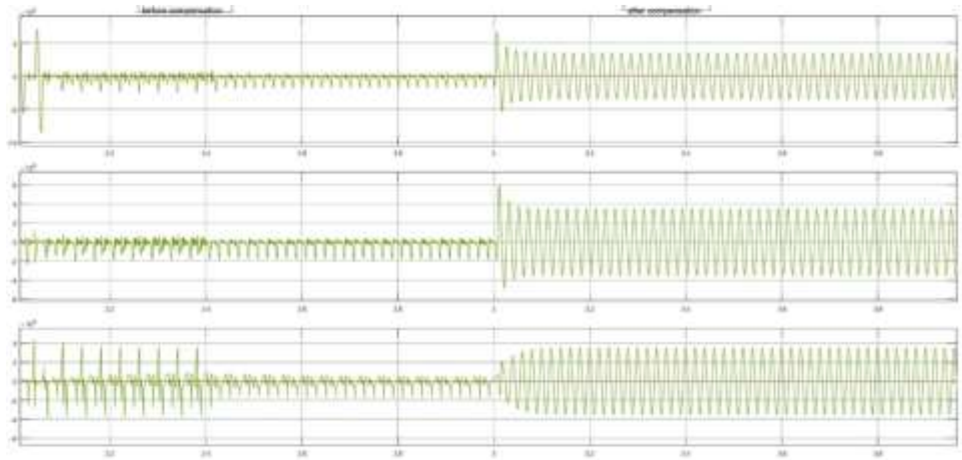

Fig-17 Before and after compensation

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