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Transmission line Three-Phase Fault Analysis Using Matlab Simulink

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Abstract: The Electric Power System has many different sections, transmission system is one of. Where power is transmitted from generating stations and substations via transmission lines into consumers. In the Power System causes of faults are many, they include lighting, wind damage, trees falling across transmission lines, vehicles or aircraft colliding with the transmission towers or poles, birds shorting lines. The fault occurring in power system can be broadly classified into symmetrical and unsymmetrical fault.

Generally these faults are occurred in the long transmission line system such as single line - ground fault (L-G), double line - ground (2L-G), triple line - ground fault (3LG) and Line - line fault (L-L). The transmission line fault analysis helps to select and develop a better for protection purpose.

This paper ways to deal with the MATLAB programming in which transmission line model is composed and different issues has been reenacted utilizing tool compartment. Fault Analysis for different sorts of faults has been done and it impacts are appeared in simulation output, for example, voltage, current, control alongside the positive, negative and zero grouping segments of voltage and current output as far as waveforms.

Keywords: Thyristor controlled series capacitor (TCSC), Power quality issues, MATLAB simulation

I. INTRODUCTION

The main objective of this dissertation is to analyze the fault and improve the voltage stability and power flow control in power system network using Thyristor controlled series capacitor (TCSC).

When different types of fault occurs in power system then in the process of transmission line fault analysis, determination of bus voltage and the rms line current are possible. While consulting with the power system the terms bus voltage and rms current of line are very important.

In case of three phase power system mainly two faults occurs, three phase balance fault and unbalance fault on transmission line of power system, such LG (Line to Ground), LL (Line to Line), 3L (Three lines) in the supply systems.

The transmission line fault analysis helps to select and develop a better for protection Purpose. For the protection of transmission line we place

The circuit breakers and its rating is depends on triple line fault. The reason behind is that the triple line fault current is very high as compare to other fault current. Hence by using MATLAB simulation in computer, the analysis of transmission line fault can be easily carried out. The main purpose of this paper is to study the general fault type which is Unbalance faults of transmission line in the power system.

Also to perform the analysis and obtain the Result of various parameters (voltage, current, power etc) from simulation on those types of fault Using MATLAB. A new modeling framework for analysis and simulation of unbalance fault in power system on IEEE 14 bus system is Procedure includes the frequency information in dynamical models and produces approximate nonlinear Models that are well adopted for analysis and simulation. The transformer model includes Saturation. The parameters have been obtained from practical or experimental measurement. Due to fault all phases voltage magnitude decreases this can be improved using proposed Facts Devices TCSC.

A. DVR

DVR is a recently proposed series connected solid state device that injects voltage into the system in order to regulate the load side voltage. It is normally installed in a distribution system between the supply and the critical loadfeeder at the point of common coupling

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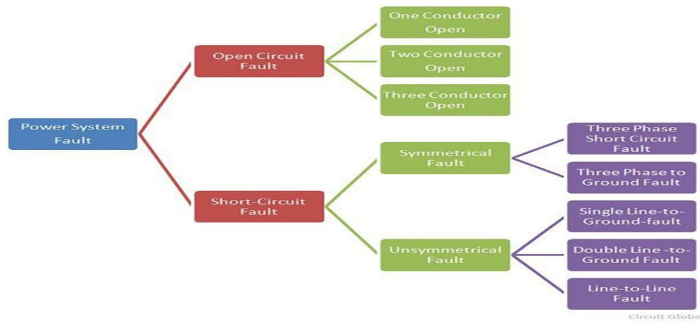
B. Types Of Fault

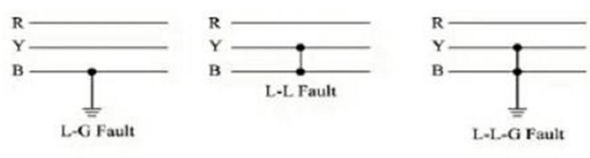


Normally, a power system operates under balanced conditions. When the system becomes unbalanced due to the failures of insulation at any point or due to the contact of live wires, a short circuit or fault is said to occur in the line. Faults may occur in the power system due to the number of reasons like natural disturbances (lightning, high-speed winds, earthquakes), insulation breakdown, falling of a tree, bird shorting, etc. Faults that occur in transmission lines are broadly classified as:

1) Shunt faults
a) Single line-to-ground faults
b) Line-to-line faults
c) Double line-to-ground faults
d) Balanced or symmetrical three phase faults

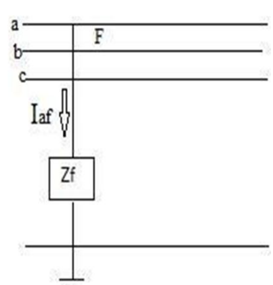
2) Series fault
a) One line open
b) Two line open

C. Unsymmetrical Faults



As discussed above in three-phase transmission line of power system mainly two types of fault occurs, balance fault which is also called symmetrical fault and unbalance fault called as unsymmetrical fault. But this paper only deals with the
Unsymmetrical faults are the faults which leads unequal currents with unequal phase shifts in a three phase system. The unsymmetrical fault occurs in a system due to presence of an open circuit or short circuit of transmission or distribution line. It can occur either by natural disturbances or by manual errors. The natural disturbances are heavy wind speed, ice loading on the lines, lightening strokes and other natural disasters. The open circuit or short circuits of transmission or distribution lines will lead to unsymmetrical or symmetrical faults in the system. In case of tree branches falling on lines, a short circuit of transmission lines will occur. These line faults are classified as:

D. Single Line To Ground Faults (Lg Fault)



Single line to ground fault is the most frequently occurring fault (60 to 75% of occurrence). This fault will occur when any one line is in contact with the ground. Double line fault occurs when two lines are short circuited. This type of fault occurrence ranges from 5 to 15%. Double line to ground fault occurs when two lines are short circuited and is in contact with the ground. This type of fault occurrence ranges from 15 to 25% of occurrence

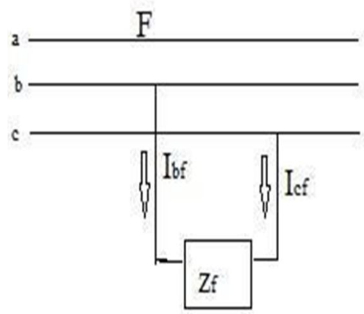
There are three phases that is phase –a, phase–b and phase – c, during single–line –ground fault it is assumed that phase – a shorted to ground directly. The condition at that fault are represented by the following terminal conditions.

$V_a = 0$

$I_b = 0$

$I_c = 0$

E. Line To Line Fault (Ll Fault)



Here we assumed that the fault takes place in phases b and c, this phases shorted ground directly. The condition at that fault are represented by the following terminal conditions.

$V_b = 0$

$V_c = 0$

$I_a= 0$

The fault current occurred during double – line – ground fault can calculated by using below formula

$I_f = - 3\ I_{a1}\ (Z_2/\ Z_1+Z_2)$

F. Double Line To Ground Fault (Llg Fault)

Here three phases are shorted ground directly. The condition at that fault are represented by following terminal conditions.

$I_a + I_b + I_c = 0\ V_a= V_b= V_c$

The fault current occurred during three – line – ground fault can calculated by using below formula

$I_f = E_a / Z$

G. Causes Of Electrical Faults

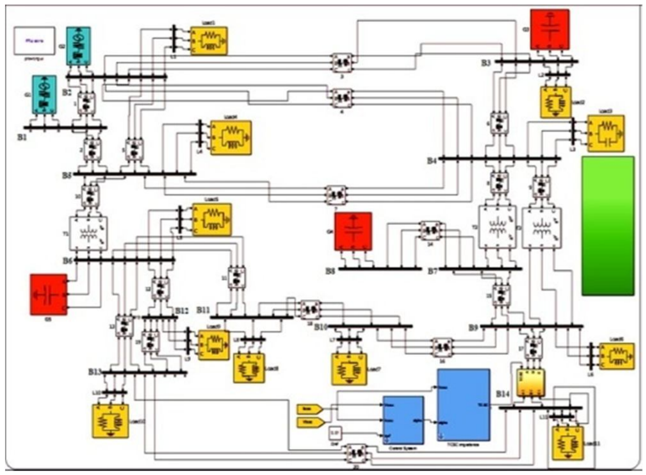
1) *Climate Conditions:* It consists of heavy amount of rain, lighting strokes, deposition of salt on the overhead transmission line conductor, accumulation of snow or ice on the transmission lines etc. these conditions of environment disturb the power supply and causes the damage to the electrical equipment.
2) *Equipment Failure:*
   Electrical equipment like electrical generator, motor, transformer, reactor, switching devices etc causes short circuit faults due to their failure of insulation of cables, ageing, malfunctioning operations of the relay [5]. These types of failure in the power system cause high amount of currents to flow through the equipment which results in the future damage to the equipment.
3) *Human Errors:*Human errors also a reason to create the electrical faults in the system. The errors are the selections of the improper ratings of the equipment and devices, forgetting metallic and electrical conducting parts after switching circuits or after maintenance while it goes in to services.

Fire due to smoke particles, ionization of air surrounding the transmission lines causes the spark between the conductor and the insulation. The insulator loses the insulating property due to flashover.

II. METHODOLOGY

Project we were perform on IEEE 14 bus system TCSC observe the voltage, active power and reactive power waveform. Connect the TCSC with IEEE 14 bus system and observe the voltage, active, and reactive waveform. Create the Three phase fault on IEEE 14 bus system and observe the effect of fault on 14 bus voltage waveform.

IEEE 14 bus system with three phase fault and TCSC connected it is observed that simulation result output TCSC improve the voltage stability and power flow control in power system network.



IEEE 14 bus system with TCSC

Show the Simulink model of IEEE 14 bus system with TCSC. TCSC connected to bus 14 . When TCSC operates in the constant impedance mode it uses voltage and current feedback for calculating the TCSC impedance. The reference impedance indirectly determines the power level, although an automatic power control mode could also be introduced.

III. OBJECTIVE

1) Optimal placement of custom power devices in power system to mitigate voltage sag under fault.
2) Voltage stability improvement using Thyristor controlled series capacitor (TCSC) based on Lmn and VCPI stability indices.
3) Comparison of thyristor controlled series capacitor and discrete PWM generator e reduction of voltage sag.
4) Power flow control using TCSC Facts controller.
5) Analytical Modeling of TCSC Dynamics

IV. PROBLEM FORMULATION

On the basis of literature survey, it has been analyze that instead of various advantages of TCSC has offers power flow and voltage stability. So in this work, the effort has been made to improve power flow control as well as voltage stability of the power system during fault. In recent years, along with the rapid increasing electric power requirement, the reconstruction of India’s urban and rural power network is more and more urgent. There will be huge demand for reactive power compensation to improve the efficiency and stability of AC transmission systems during transmission upgrade process. Given a profit-driven, deregulated electric power industry coupled with increased load growth, the power transmission infrastructure is being stressed to its upper operating limits to achieve maximum economic returns to both generator and transmission system owners. In such an environment, system stability problems such as inadequate voltage control and fast regulation must be resolved in the cost- effective manner to improve overall grid security and reliability.

With the increasing demand of power the power system network are becoming more complex from the point of view of operation and control. The existing network are mostly mechanically controlled. Microelectronics computers and high speed communication are widely used for protection and control of transmission system However when operating signal are sent to power circuit n where final control action take place switching devices are mechanical. These devices are slow in operation. Another problem associated mechanical switching devices is that control cannot be initiated frequently .This is due to fact that mechanical devices is that wear out quickly as compared to static devices. Consequently both steady state and dynamic operation of the system are practically uncontrolled.

V. BASIC CONTROL SCHEME OF TCSC

The main consideration for the structure of the internal control operating the power circuit of the TCSC is to ensure immunity to sub synchronous resonance. Present approaches follow two basic control philosophies. One isotope rate the basic phase locked-loop (PLL)from the fundamental component of the line current. In order to achieve this, it is necessary to provide substantial filtering to remove the super and, in particular, the sub synchronous components from the line current and, at the same time, maintain correct phase relationship for proper synchronization. A possible internal control scheme of this type is shown in Figure 4.2. In this arrangement the conventional technique of converting the demanded TCR current into the corresponding delay angle, which is measured from the peak (or, with a fixed 90 degree shift, from the zero crossing) of the fundamental line current, is used. The reference for the demanded TCR current is; as illustrated in figure usually provided by a regulation loop of the external control, which compares the actual capacitive impedance or compensating voltage to the reference given for the desired system operation.
A functional internal control scheme for the TCSC based on the synchronization to the fundamental component of the line current. The second approach also employs a PLL, synchronized to the line current, for the generation of the basic timing reference. However, in this method the actual zero crossing of the capacitor voltage is estimated from the prevailing capacitor voltage and line current by an angle correction circuit.

VI. ADVANTAGES OF THE TCSC

1) Power flow control dynamically
2) Power oscillation
3) Load sharing improved
4) System losses are minimizing.
5) Rapid continuous control of the transmission line series - compensation level.
6) Dynamic control of power flow in selected transmission line within the network to enable optimal power flow condition and prevent the loop flow of power.
7) Damping of the power swings from local and inter area oscillation.

VII. SIMULATION RESULTS

Simulation Result for IEEE 14 bus system without TCSC

Figure: Simulation Result of IEEE 14 bus voltage

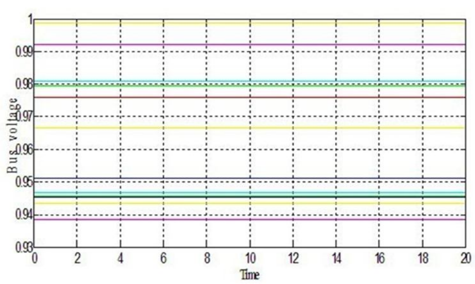


Figure: Simulation Result of Active power

Table: Bus voltage and power flow in IEEE 14 bus system without TCSC.

BUS	Voltage	Active power	Reactive power
1	0.9999	3.792e+07	2.239e+07
2	0.9937	1.799e+08	1.525e+08
3	0.5895	4.361e+07	2.382e+07
4	0.6437	3.921e+07	2.541e+07

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Simulation Result For IEEE 14 bus system with TCSC

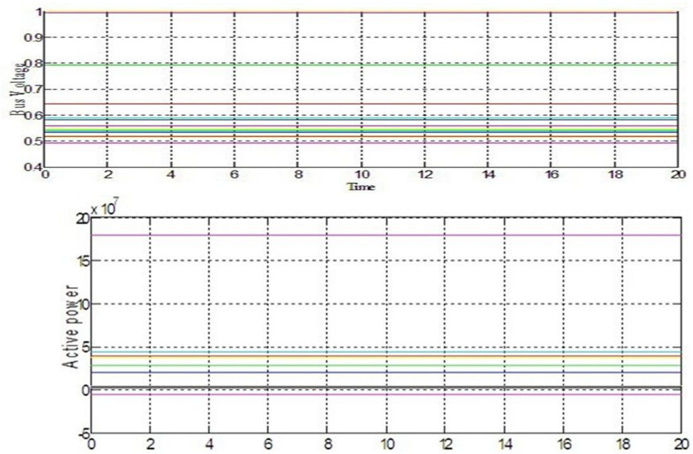

Figure : Simulation Result of IEEE 14 bus voltage

Table : Bus voltage and power flow in IEEE 14 bus system with TCSC.

BUS	Voltage	Active power	Reactive power
1	0.9989	1.142e+08	1.019e+08
2	0.9922	2.116e+08	1.844e+08
3	0.9809	1.062e+08	5.938e+07
4	0.9761	8.372e+07	5.814e+07

VIII. CONCLUSION

In this dissertation, IEEE 14 bus system with 3 phase fault observe and TCSC FACTS controller is use to limit the fault and improve the voltage stability and power flow control in power system network. We reach at the conclusion that TCSC is one of the fast acting power electronic controller which can provide a smoothly variable series capacitive reactance. This is a new approach 14 bus system with TCSC to improve the voltage stability, limit fault and power flow control in power system network. IEEE 14 bus system with and without TCSC, comparative result and simulation result waveform show that, using TCSC we can improve the voltage stability and power flow control in power system network and also limit the three phase fault.

IX. FUTURE SCOPE

In this dissertation work, 14 bus systems with 3 phase fault analyse and it is use with TCSC. This work can further be extended to:
Number of buses is use with TCSC.
All L-G, LL-G, LLL-G Fault use with TCSC.
Other FACTS controller is use rather than TCSC.

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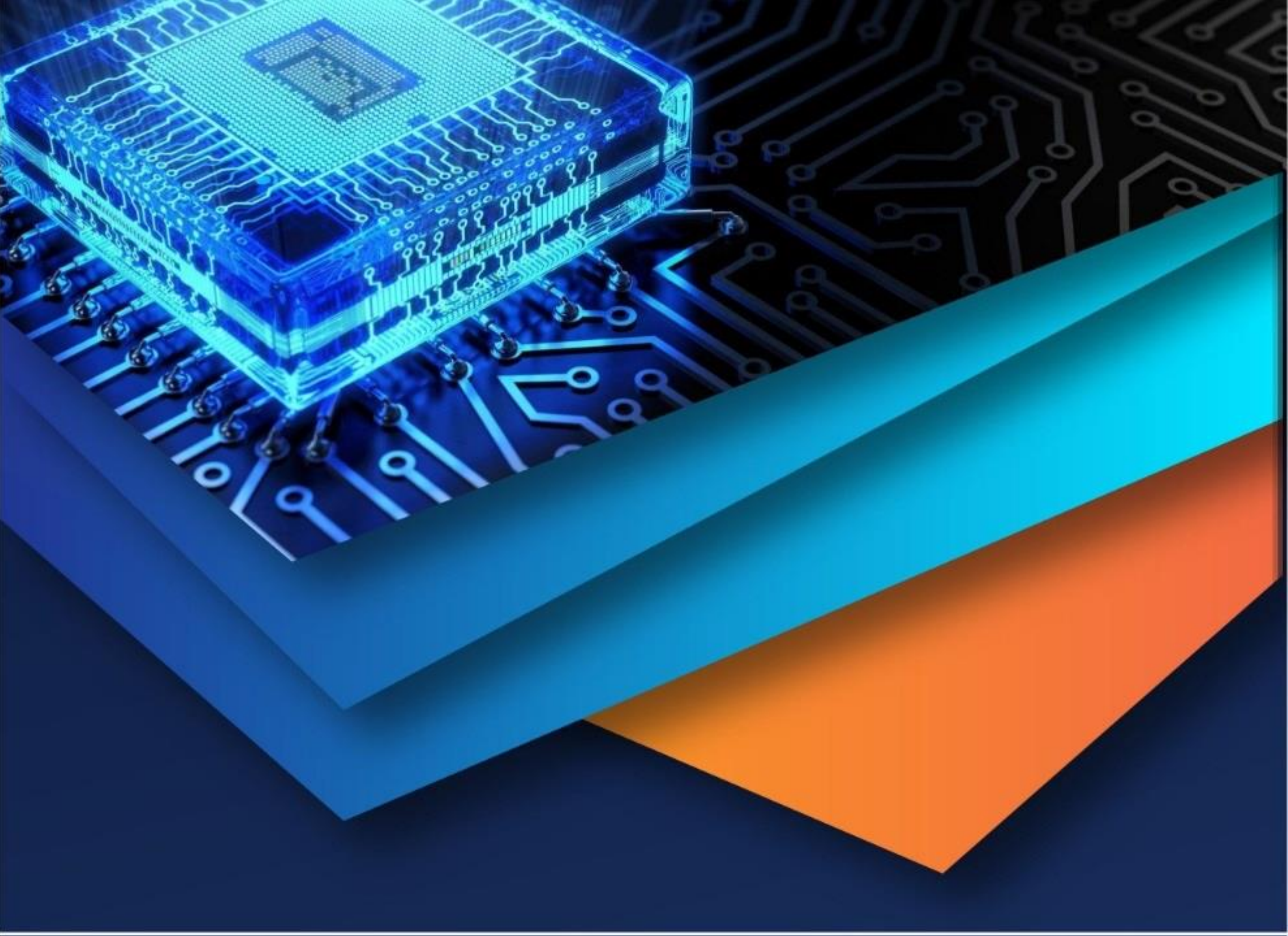

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