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Power System Transient Improvement using PI Controller based UPFC

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***Abstract*— With increased power transfer, transient stability is more and more vital for secure operation. Transient stability analysis of huge scale power systems is a particularly labyrinthine and extremely non-linear downside. a crucial perform of transient analysis is to appraise the aptitude of the power system to face up to serious contingency in time, so some emergencies or preventive management are often dole out to stop system breakdown. In practical real time operations correct assessment of transient stability for given operative states is important and valuable for power system operation.**

Flexible AC Transmission Systems (FACTS) technology is that the most advanced tool for power flow management in electrical network. Unified Power Flow Controller (UPFC) is that the most versatile FACTS device for optimization and management of power flow in power transmission line system. It's a voltage source converter based device primarily based FACTS controller for series and shunt compensation of the transmission line that controls the important and reactive power severally. This system deals with PI controller is employed because the controlling technique for UPFC. The controller are designed and tested for controlling active and reactive power flow of UPFC. Simulation by MATLAB/SIMULINK has been wont to verify proposed system.

***Keywords*—UPFC, FACTS, PI Controller.**

I. INTRODUCTION

Now recent years, the power system style, high potency operation and dependableness of the power systems are thought-about quite before. As a result of the expansion in intense voltage, the most capability of the transmission lines ought to be inflated. So in a very traditional condition additionally the soundness in addition because the security is that the major a part of discussion. many years the power system stabilizer act as a standard management approach to damp the system oscillations [1-2].

However, in some in operation conditions, the PSS might fail to stabilize the power system, particularly in low frequency oscillations [3]. As a result, different alternatives are instructed to stabilize the system accurately. it's proven that the FACTS devices are a great deal effective in power flow management furthermore as damping out the swing of the system throughout fault. Recent years countless management devices are enforced below the FACTS technology. By implementing the FACTS devices offers the pliability for voltage stability and regulation conjointly the steadiness of the system by obtaining correct management signal [4].The FACTS devices don't seem to be one however conjointly assortment of controllers that are expeditiously not solely work below the rated power, voltage, impedance, point in time frequency however conjointly below the rated frequency.

Among all FACTS devices the UPFC most well liked management attributable to its wide space control over power each active and reactive power, it additionally provides the system to be used for its most thermal limit. It's primarily duty to manage each the powers severally. It's been shown that each one 3 parameters which will have an effect on the important power and reactive power within the power grid are often at the same time and severally management simply by dynamical the control schemes from one kind to different in UPFC. Moreover, the UPFC is dead for voltage provision and transient stability improvement by suppressing the sub-synchronous resonance (SSR) or LFO [5].

For example, in it's been shown that the UPFC is capable of inter-area oscillation damping by means that of straight dominant the UPFC's causing and receiving bus voltages. Therefore, the most aim of the UPFC is to regulate the active and reactive power flow through the conductor with emulated electrical phenomenon. It's wide accepted that the UPFC isn't capable of damping the oscillations with its traditional controller. As a result, the auxiliary damping management ought to be supplemented to the conventional control of UPFC so as to retrieve the oscillations and improve the system stability.

II. PROPOSED APPROCH

A. Block diagram

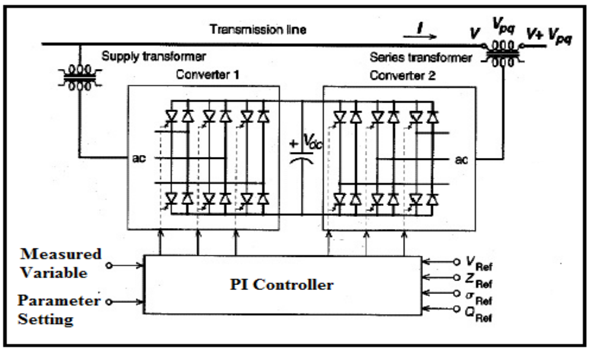

Fig.2. Block diagram of proposed approach

This work aims at to achieve transient improvement algorithm using UPFC FACTS controller for power system. The main objectives of this project are:

Design of power system for analysis of power system oscillation during abnormal condition using MATLAB simulink. Design UPFC controller for design power system model. Design transient conditions for designed power system model for analysis of UPFC controller response. Suggest best UPFC controller parameter for different types of transmission line like long, short and medium based on distance of line. Suggest best UPFC controller parameter for different types of transmission line like Low voltage, High voltage, extra high voltage, Ultra high voltage etc depends on voltage rating of line.

In this approach PI controller control the firing pulses of power electronics switch of UPFC controller. PI controller process the input of active power and reactive power of bus bar at which UPFC controller are connected.

III. IMPLEMENTED SYSTEM

A. Simulation model

The proposed system implemented using MATLAB digital simulink software 2009 package. The complete simulation model shown in figure 5.

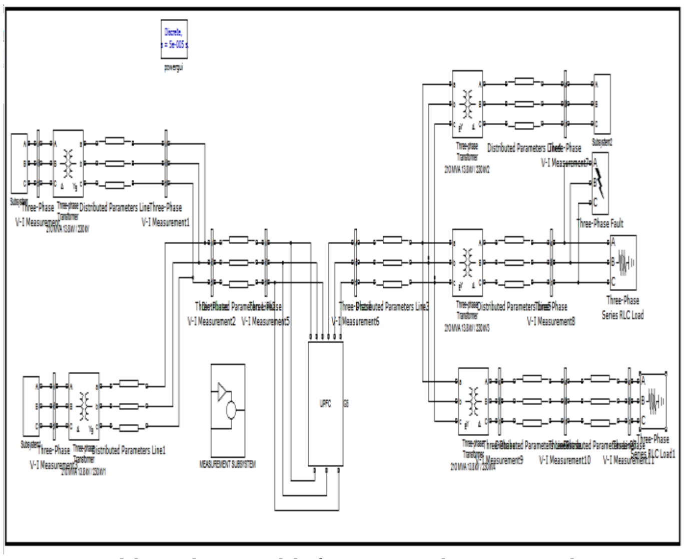

Fig.5. Matlab simulation model of transmission line system with UPFC controller.

The transmission line system of 13.5 KV, 200MVA, 60Hz model simulate using MATLAB 2009 power system toolbox. In simulation model UPFC controller connected in between bus bar 5 and bus bar 6 of transmission line for maintain power quality and reduce power system oscillation which improves the transient response of power system. Each distributed transmission line model of simulink model of length is 40km.

B. Measurement subsystem simulink model

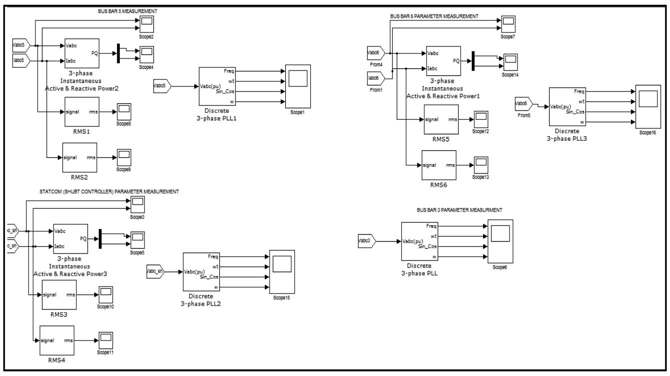

Fig.6. Measurement subsystem simulink model for bus bar 5 and bus bar 6 parameter measurement.

In this subsystem (figure 6), measure transmission line bus bar parameter in which UPFC controller connected. This subsystem measure the transmission line bus bar voltage, current, active power, reactive power, frequency, RMS voltage, RMS current and shunt controller in UPFC parameters also analysis.

C. UPFC controller susbsystem

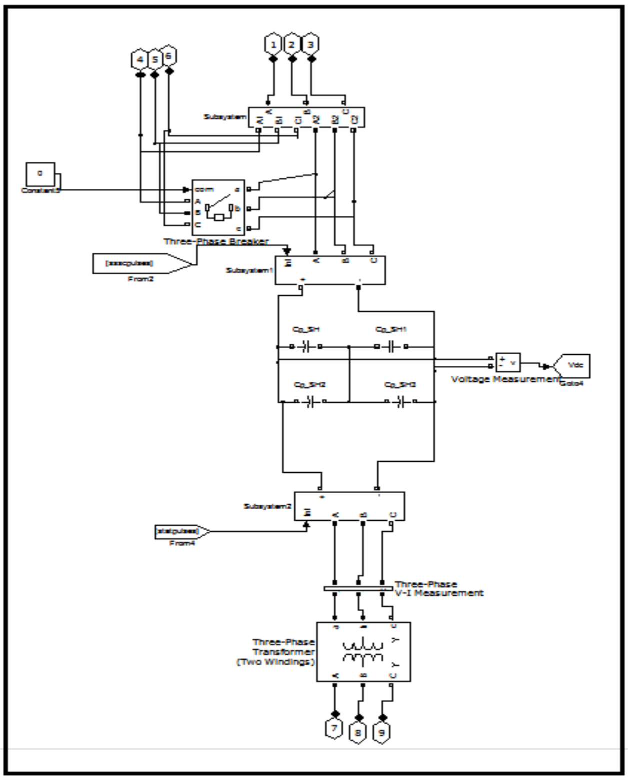

Fig.7. UPFC controller in matlab simulink

Figure 7 shows the UPFC controller which consist of STATCOM shunt controller and SSSC series controller with coupling capacitor and bypass switch (circuit breaker).

D. UPFC Control system

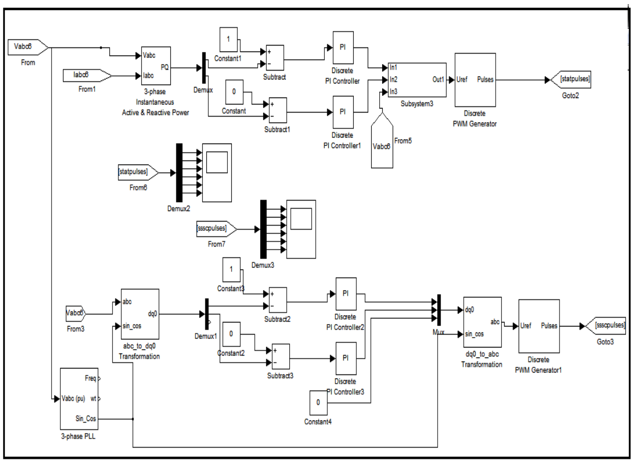

Fig.8. UPFC Control system using PI controller

Figure 8 shows PI controller for controlling the firing pulse of thyristor based shunt controller (STATCOM) and series controller (SSSC). The input of PI controller is voltage and current of bus bar 5 and bus bar 6 for generation of logic. That logic send to discrete pulse width modulation block for generation of firing pulse based on input parameter of PI controller.

IV. SIMULATION RESULTS

Simulation model shown in figure 5 simulate and run for 10 second of time duration. The three phase fault simulate at receving end of transmission line for 2.6 to 2.8 second time slot out of 10 second of simulation time. The result of simulation model for different cases are observe in this section. The different types of cases are (a) UPFC controller with PI controller in bypass switch open condition (b) UPFC controller with PI controller in bypass switch closed condition (c) Transmission line system without UPFC controller.

A. Result when UPFC bypass switch open

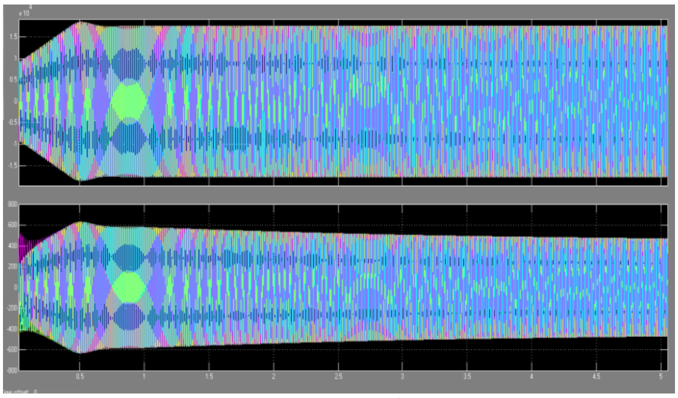

Fig.9. Three phase voltage and current waveform at bus bar 5 when bypass switch open.

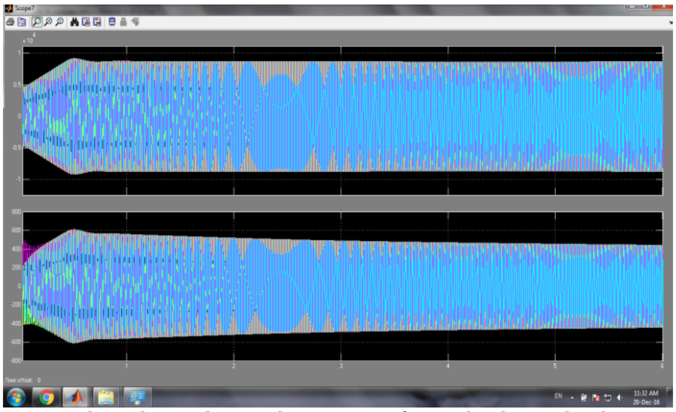

Fig.10. Three phase voltage and current waveform at bus bar 6 when bypass switch open.

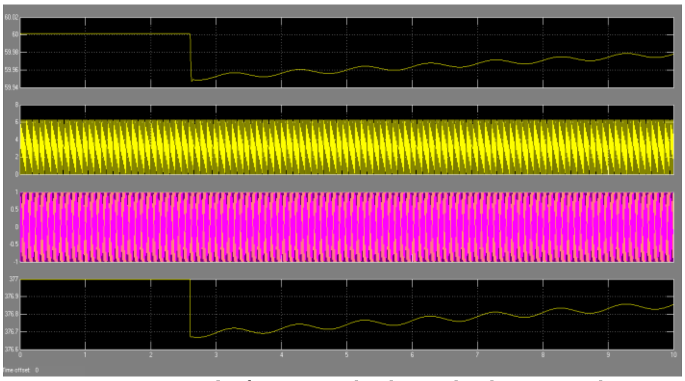

Fig.11. Frequency, angular frequency at bus bar 5 when bypass switch open.

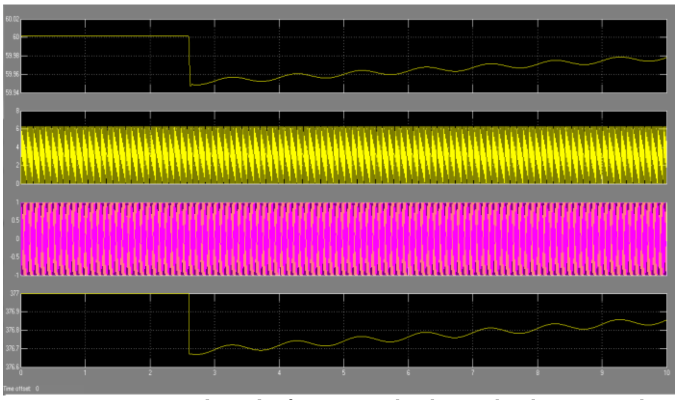

Fig.12. Frequency and angular frequency at bus bar 6 when bypass switch open.

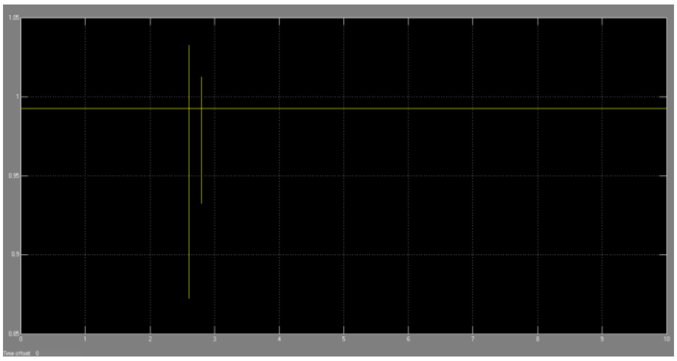

Fig.13. RMS three phase current (p.u.) at bus bar 5 when bypass switch open.

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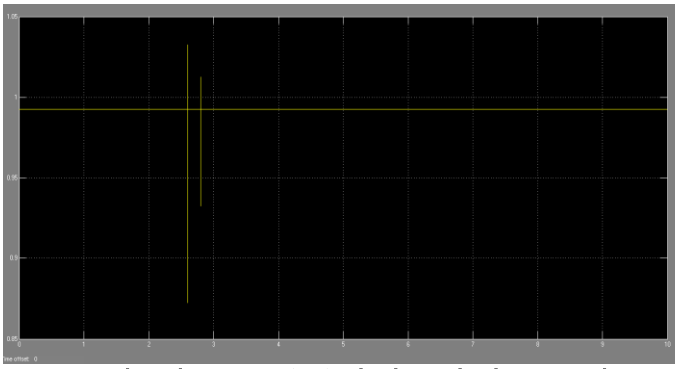

Fig.14. RMS three phase current (p.u.) at bus bar 6 when bypass switch open.

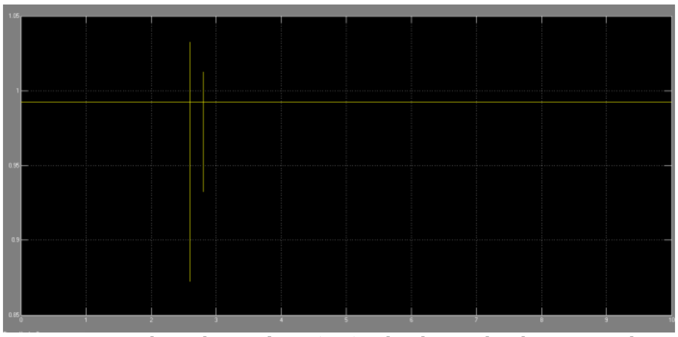

Fig.15. RMS three phase voltage (p.u.) at bus bar 5 when bypass switch open.

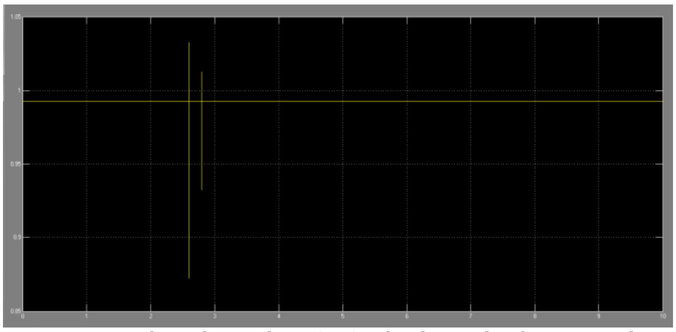

Fig.16. RMS three phase voltage (p.u.) at bus bar 5 when bypass switch open.

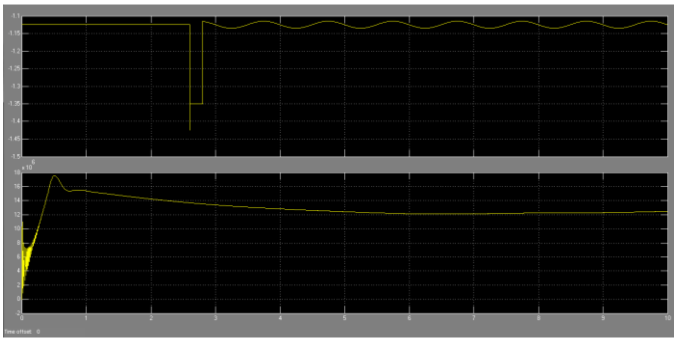

Fig.17. Active and reactive power at bus bar 5 when bypass switch open.

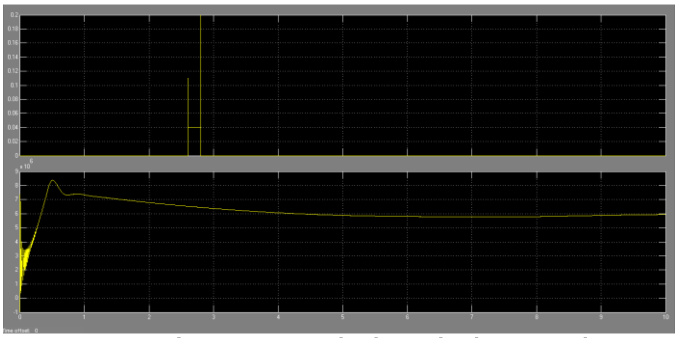

Fig.18. Active and reactive power at bus bar 6 when bypass switch open.

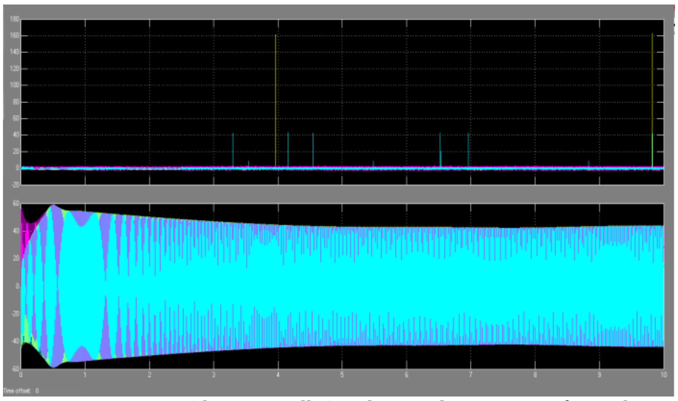

Fig.19. STATCOM (shunt controller) Voltage and current waveform when bypass switch open.

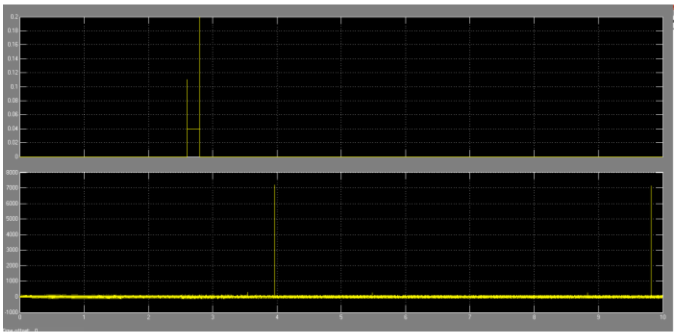

Fig.20. STATCOM active and reactive power response when bypass switch open.

B. Result when UPFC bypass switch open

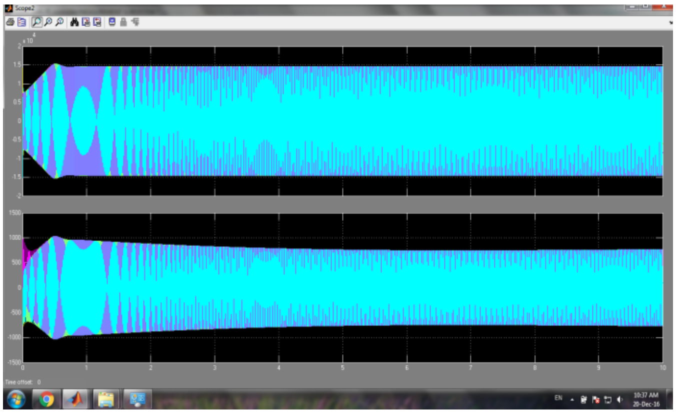

Fig.21. Three phase voltage and current waveform at bus bar 5 when bypass switch closed.

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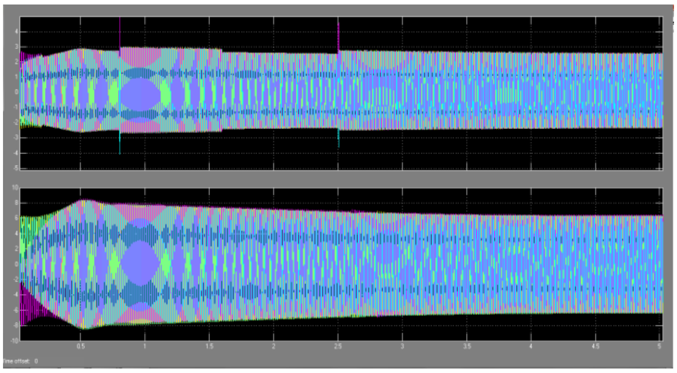


Fig.22. Three phase voltage and current waveform at bus bar 6 when bypass switch closed.

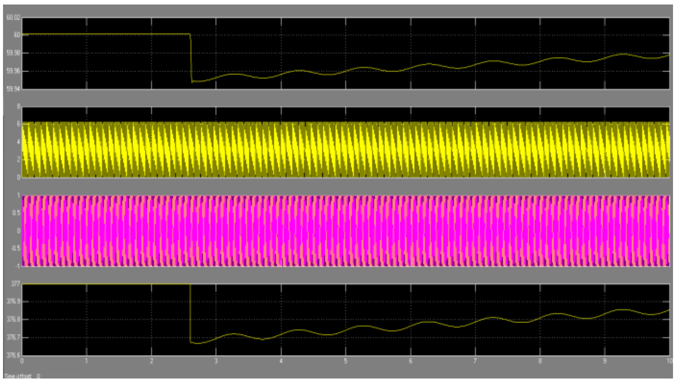


Fig.23. Frequency, angular frequency at bus bar 5 when bypass switch closed.

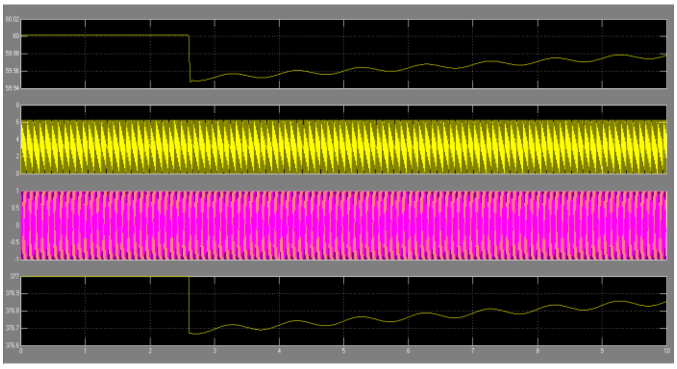


Fig.24. Frequency, angular frequency at bus bar 6 when bypass switch closed.

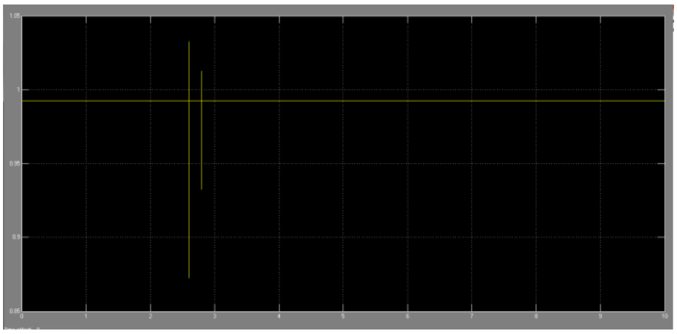


Fig.25. RMS three phase current (p.u.) at bus bar 5 when bypass switch closed.

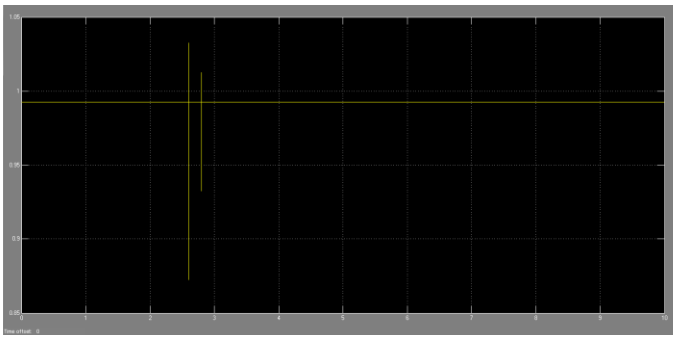


Fig.26. RMS three phase current (p.u.) at bus bar 6 when bypass switch closed.

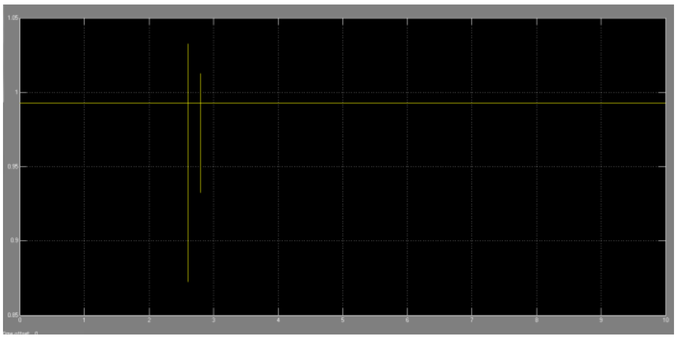


Fig.27. RMS three phase voltage (p.u.) at bus bar 5 when bypass switch closed.

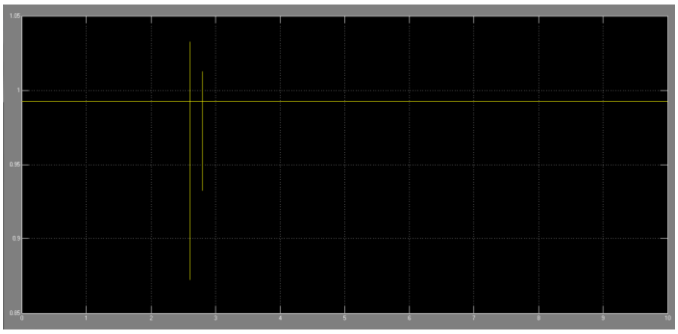


Fig.28. RMS three phase voltage (p.u.) at bus bar 6 when bypass switch closed.

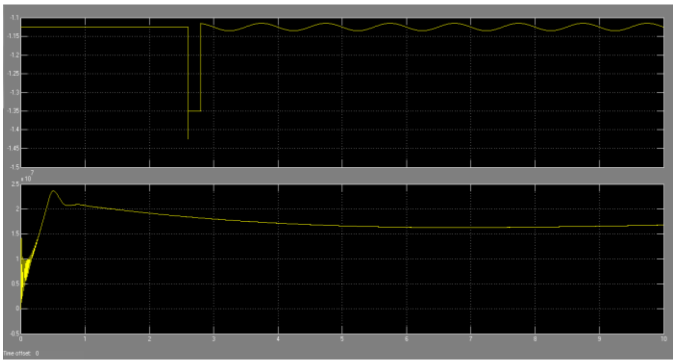


Fig.29. Active and reactive power at bus bar 5 when bypass switch closed.

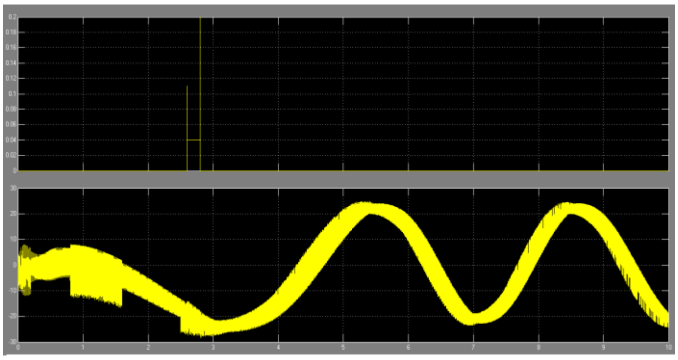


Fig.30. Active and reactive power at bus bar 6 when bypass switch closed.

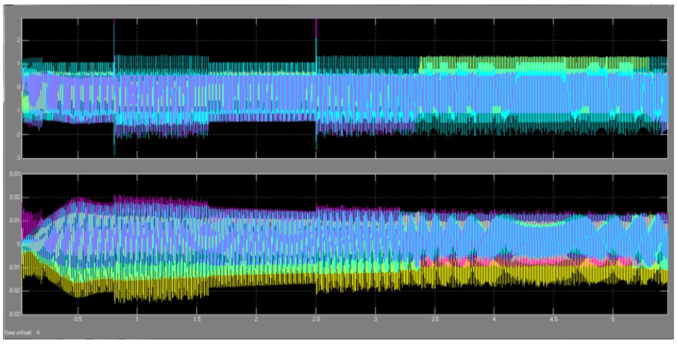


Fig.31. STATCOM (shunt controller) Voltage and current waveform when bypass switch closed.

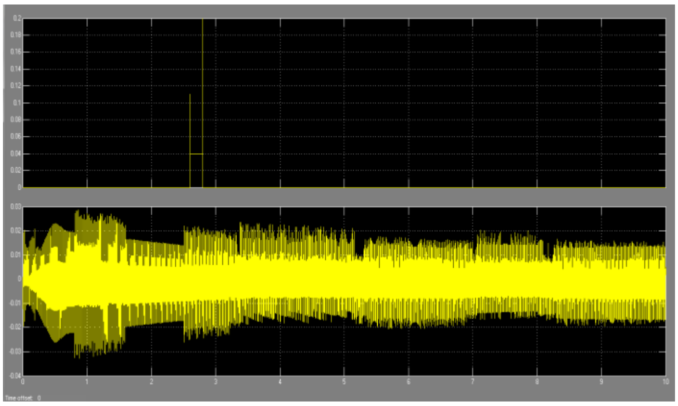


Fig.32. STATCOM active and reactive power response when bypass switch closed.

C. *When UPFC controller not connected*

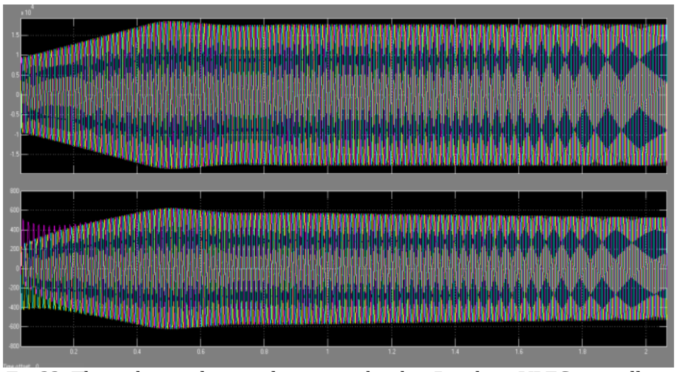


Fig.33. Three phase voltage and current at bus bar 5 without UPFC controller.

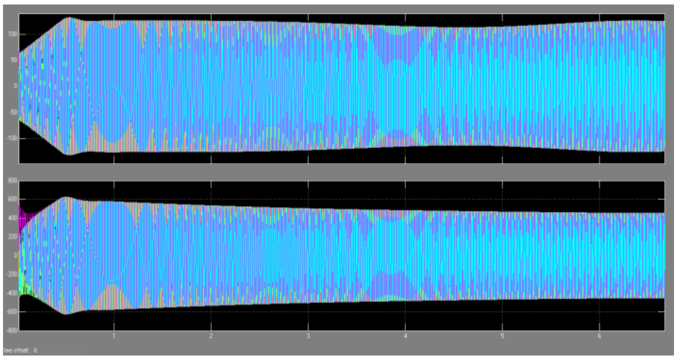


Fig.34. Three phase voltage and current at bus bar 6 without UPFC controller

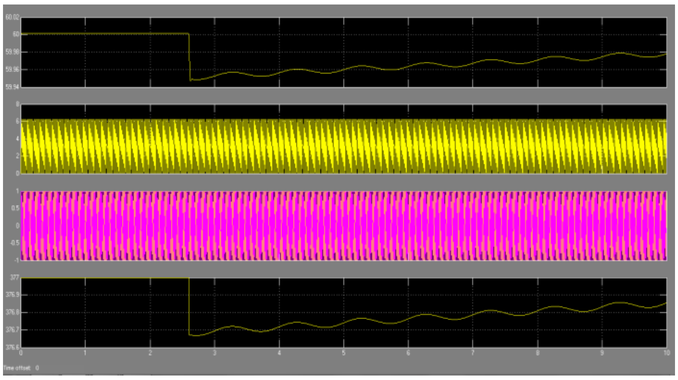


Fig.35. Frequency and angular frequency at bus bar 5 without UPFC controller.

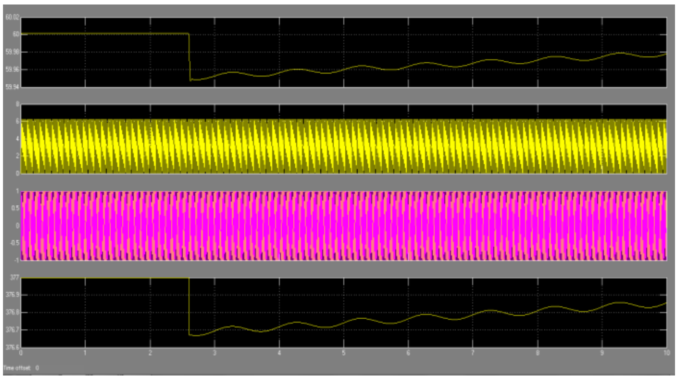
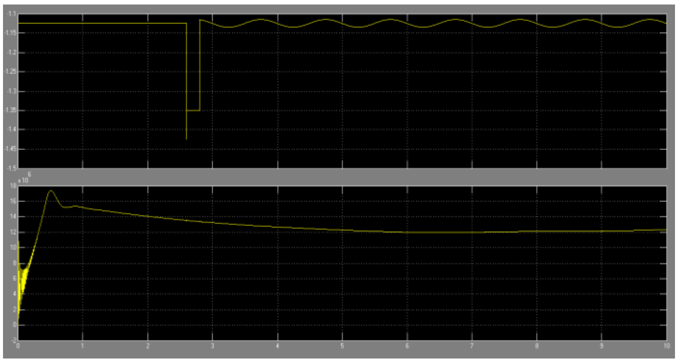
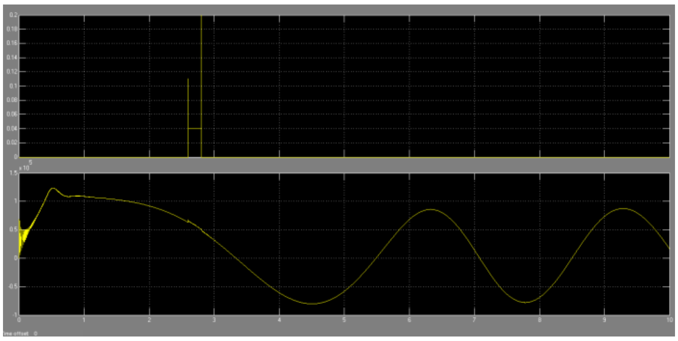


Fig.36. Frequency and angular frequency at bus bar 5 without UPFC controller.



Fg.37. Active and reactive power at bus bar 5 without UPFC controller.



Fg.38. Active and reactive power at bus bar 6 without UPFC controller.

V. CONCLUSION

In this work proposed PI controller based UPFC controller for improve the transient stability of 13.5 KV transmission system. The entire system design using matlab simulink 2009 and simulate for observation. The result from MATLAB simulink shows that UPFC controller maintain the voltage and current profile during transient or fault condition and minimize the fault current magnitude. Parallel it tries to maintain the frequency of transmission system. The comparative study of transmission line with and without UPFC controller shows that active and reactive power control by UPFC maintain the voltage profile of transmission line with short duration of response time.

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