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Dynamic Performance of UPFC Integrated with a Voltage Source for Controlling the Real and Reactive Power of Transmission Line

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Abstract:
UPFC is the best featured device among FACTS devices for different applications in power systems. The main problem with UPFC is the voltage across the dc link varies according to the variation of parameters in the transmission line. This paper proposes a new model of UPFC integrated with a DC source instead of dc link capacitor. Hysterisis current control methods is used for switching the voltage source converters. Model is simulated in SIMULINK MATLAB platform to show the effectiveness of result. The results show that UPFC integrated with the voltage source can reduce the oscillations and transients. Proposed model can control the real and reactive power flow to the power system.

Keywords: *UPFC, STATCOM, SSSC, power system.*

1. Introduction

UPFC is the best featured and flexible FACTS device. It can control parameters like voltage, the real power and reactive power flow to the power system. UPFC has the applications such as damping of oscillations and harmonic mitigation etc. UPFC is mainly used for regulating the voltage and power of the system. UPFC has the ability to track the power variations in the line and can control it by controlling the real power and reactive power flow through the transmission line. UPFC Controls the voltage magnitude and phase angle to control the real power and reactive power flow with the transmission line. UPFC provides two types of compensation i.e. series compensation and shunt compensation. Series compensation is provided by injecting a voltage in series with the line at the point of connection. Power flow in the system is mainly controlled by controlling the voltage and phase angle and the reactance. Series injection of voltage is provided by the series compensator.

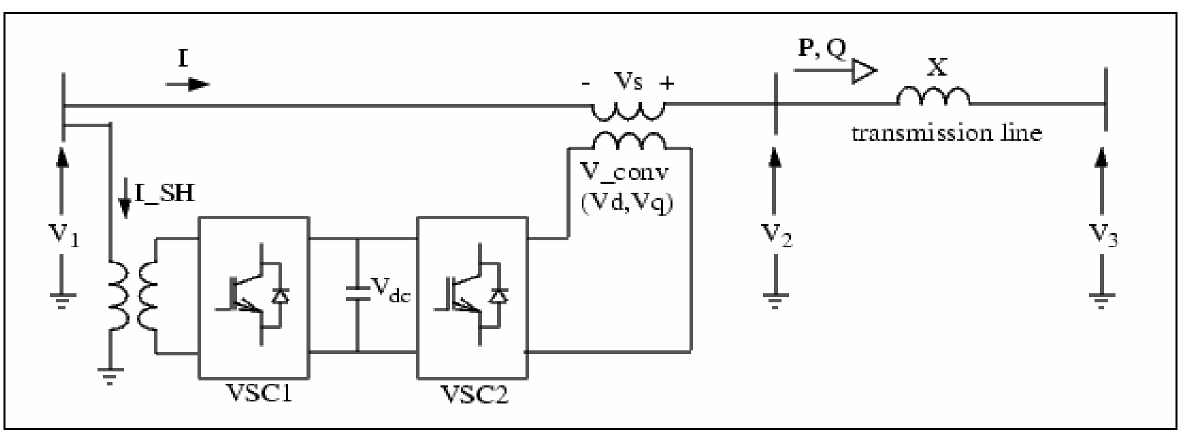

Figure 1: Basic configuration of conventional UPFC

2. Operating Principle of UPFC

Conventional UPFC consists of two voltage source converters. VSC 1 is a shunt converter and VSC2 is the series converter. The two voltage source converters, VSC1 and VSC2 are connected back to back with a dc link capacitor. Shunt converter can operate as

STATCOM which generates or consumes the reactive power. DC capacitor gets charged through STATCOM. Series converter can operate as SSSC provides series compensation with the transmission line. The two voltage source converters can exchange the real power and reactive power independently with the power system. The real power flows through the system can control the losses of voltage source converters. The shunt converter is connected in shunt with the transmission line through a transformer. The series converter connected in series with the boosting transformer.

3. Simulink Model of UPFC with Voltage Source

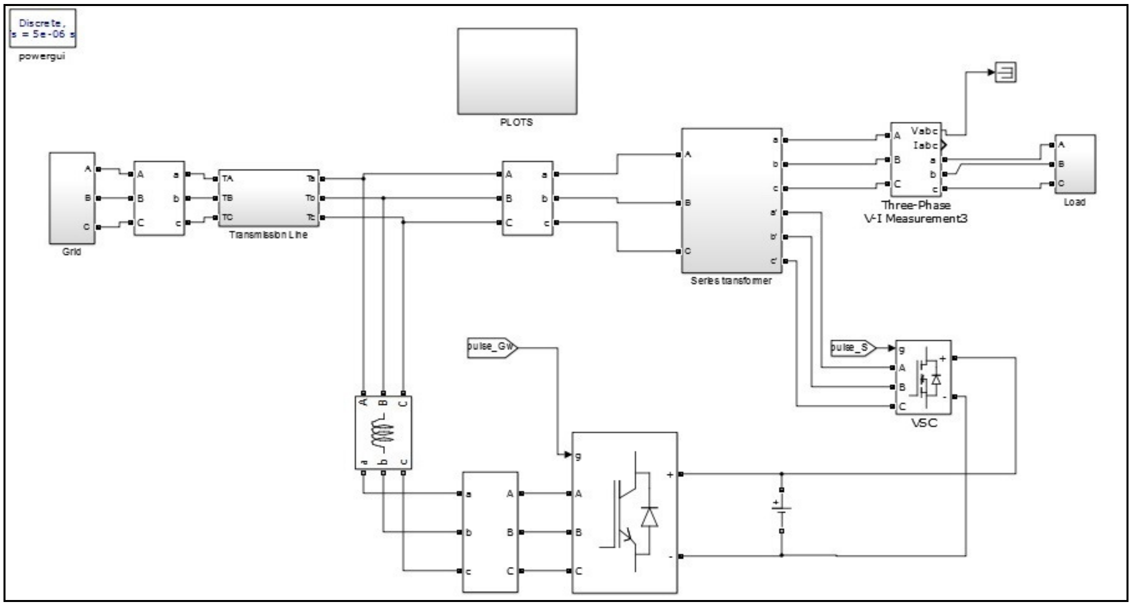

Figure 2: Proposed SIMULINK model of UPFC with active Voltage source

The Proposed system is connected to a 400 KV transmission line. It controls the real and reactive power flow through the system. Voltage source is a DC source acts as an energy storage system. When the power is positive the source gets charged then current flows from grid to source. when power is negative the source gets discharged then current flow reverses. Thus power is maintained by the voltage source with the transmission line.

3.1. Series Controller

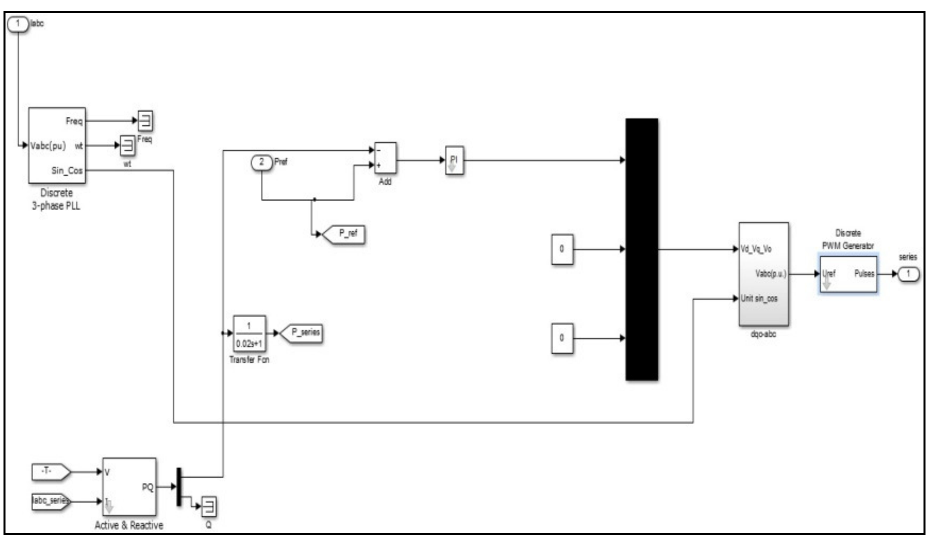

Figure 3: SIMULINK Model of series Controller

Series controller is used to control the injection of voltage in series with the transmission line. Series controller provides series compensation with the line. It injects the three phase voltage at the point of connection.PWM technique is used for controlling the power. Error value is obtained from the PI controller. Decoupled control scheme is used. The voltage given to the voltage source converters are based on the reference value.

3.2. Shunt Controller

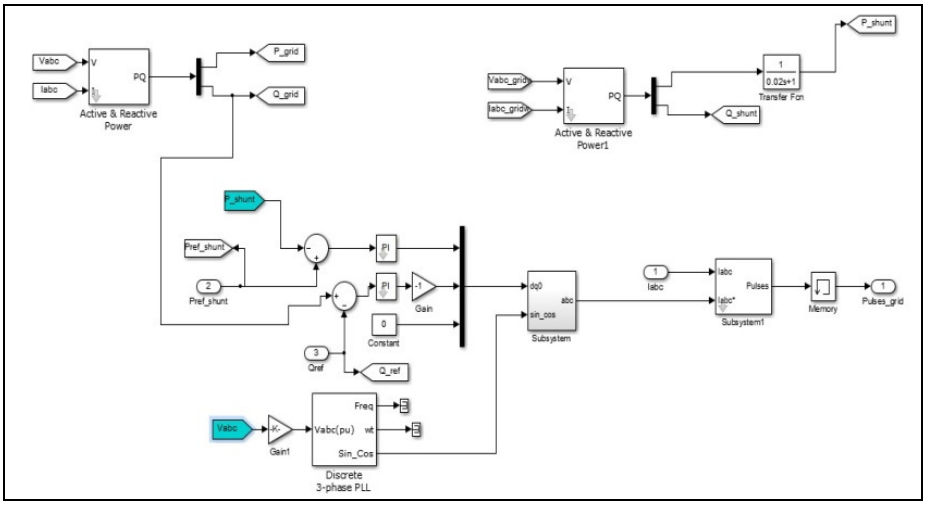

Figure 4: SIMULINK model of Shunt controller

In the shunt controller the currents are compared. Controller which creates a pulse signal to control the power flow through the transmission line.

4. Parameters of UPFC

Rated capacity of series Transformer	10 KVA
Rated capacity of shunt Transformer	10 KVA
Proportional integral Gain K_{p1}	.05
Proportional integral Gain K_{p2}	1
DC voltage	1000V
Switching Frequency of series converter and shunt converter.	5600 Hz,1650Hz

Table 1: Parameters of UPFC

5. Simulation Results

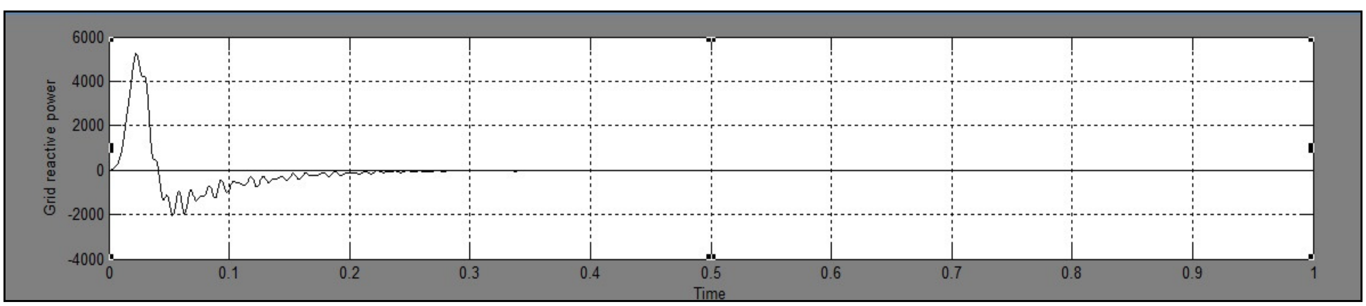

Figure 5: Grid reactive power of conventional UPFC

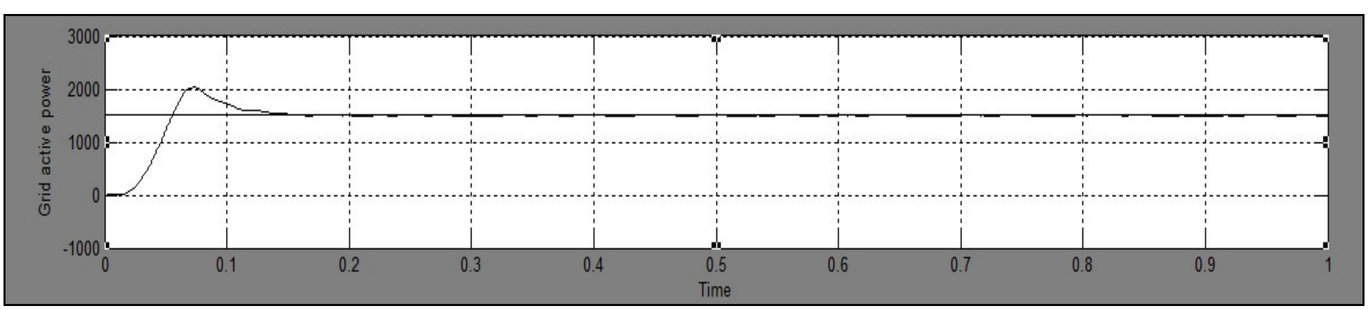

Figure 6: Grid active power of conventional UPFC

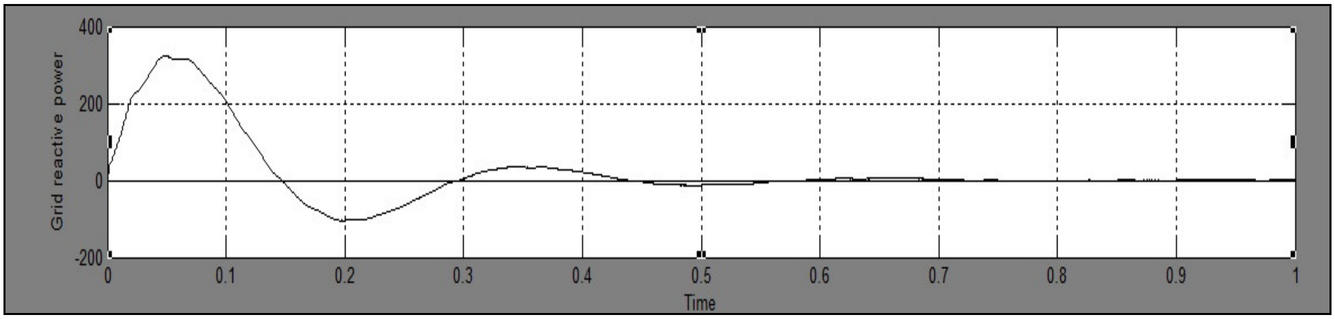

Figure 7: Grid reactive power of proposed system

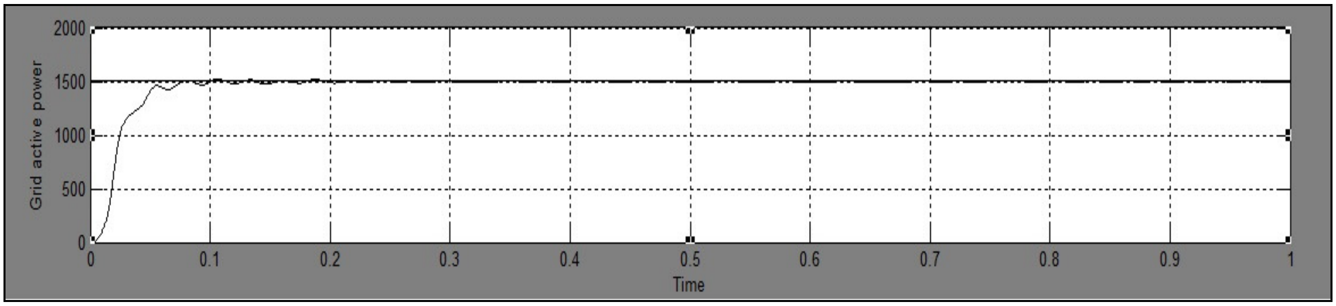

Figure 8: Grid active power of proposed system

The simulation results show that the proposed system is better when compared it with conventional system. Hence UPFC with voltage source can reduce the oscillations and transients in the system. The proposed system acts simultaneously and independently for controlling the power flow in transmission line.

6. Conclusion

In the proposed system dc link is replaced by a voltage source. UPFC with DC source devices independently generate and consumes reactive power. Every mode of existing UPFC voltage and phase angle will be controlled. They cannot be modified because of insufficient active power flow in conventional UPFC but this real power can be supplied by a DC source by connecting with UPFC. Hence the integrated system of UPFC with DC source can improve power transferability and it can also control the real and reactive power flow through the transmission line.

7. References

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