

# Transient Stability of Power System using Facts Device-UPFC

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**Abstract**— This paper is based on Occurrence of a fault in a power system causes transients. To stabilize the system, The Flexible Alternating Current Transmission (FACTS) devices such as UPFC are becoming important in suppressing power system oscillations and improving system damping. The UPFC is a solid-state device, which can be used to control the active and reactive power.. By using a UPFC the oscillation introduced by the faults, the rotor angle and speed deviations can be damped out quickly than a system without a UPFC. The effectiveness of UPFC in suppressing power system oscillation is investigated by analyzing their oscillation in rotor angle and change in speed occurred in the two machine system considered in this work. A proportional integral (PI) controller has been employed for the UPFC. It is also shown that a UPFC can control independently the real and reactive power flow in a transmission line. A MATLAB simulation has been carried out to demonstrate the performance of the UPFC in achieving transient stability of the two-machine five-bus system.

## I. INTRODUCTION

The UPFC is the most versatile of the FACTS devices. The main function of the UPFC is to control the flow of real and reactive power by injection of a voltage in series with the transmission line. Both the magnitude and the phase angle of the voltage can be varied independently. Real and reactive power flow control can allow for power flow in prescribed routes, loading of transmission lines closer to their thermal limits and can be utilized for improving transient and small signal stability of the power system.

The schematic of the UPFC is shown in Fig. 1

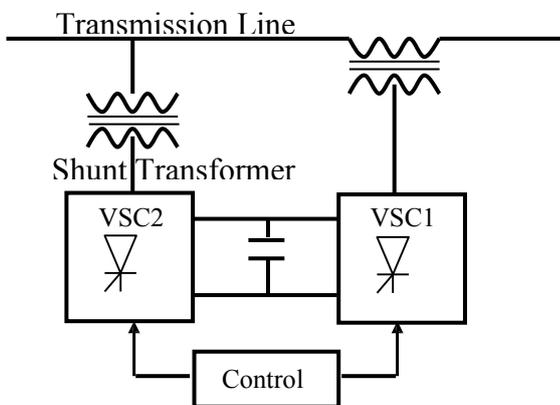


Fig. 1: Schematic diagram of UPFC

The UPFC consists of two branches. The series branch consists of a voltage source converter, which injects a voltage in series through a transformer. The inverter at the input end of the UPFC is connected in shunt to the AC power system and the inverter at the input end of the UPFC is connected in series with the AC transmission circuit. Since the series branch of the UPFC can inject a voltage with variable magnitude and phase angle it can exchange real power with the transmission line. However the UPFC as a whole cannot supply or absorb real power in steady state (except for the power drawn to compensate for the losses) unless it has a power source at its DC terminals.

## II. PRINCIPLE OF OPERATION OF UPFC

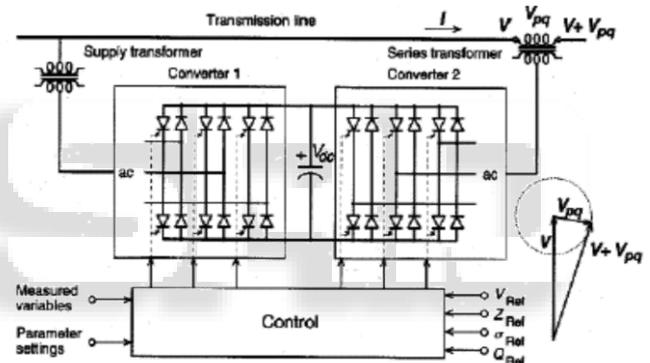


Fig. 2: Basic circuit arrangement of the Unified Power Flow Controller

The Unified Power Flow Controller (UPFC) was proposed for real time control and dynamic compensation of ac transmission systems, providing the necessary functional flexibility required to solve many of the problems facing the utility industry. The Unified Power Flow Controller consists of two switching converters, which in the implementations considered are voltage sourced inverters using gate thyristors valves, as illustrated in Fig. These inverters, labeled "Inverter1" and "Inverter 2" in the figure, are operated from a common dc link provided by a dc storage capacitor. This arrangement functions as an ideal auto ac power converter in which the real power can freely flow in either direction between the ac terminals of the two inverters and each inverter can independently generate (or absorb) reactive power at its own ac output terminal since the series branch of the UPFC can inject a voltage with variable magnitude and phase angle it can exchange real power with the transmission line. However a UPFC as a whole cannot supply or absorb real power in steady state (except for the power drawn to compensate for the losses). Unless it has a power source at its DC terminals. Thus the shunt branch is required to

compensate (from the system for any real power drawn/supplied by the series branch and the losses. if the power balance is not maintained, the capacitor cannot remain at a constant voltage. Shunt branch can independently exchange reactive power with the system.

The basic function of Inverter 1 is to supply or absorb the real power demanded by Inverter 2 at the common dc link. This dc link power is converted back to ac and coupled to the transmission line via a shunt-connected transformer. Inverter 1 can also generate or absorb controllable reactive power, if it is desired, and thereby it can provide independent shunt reactive compensation for the line. It is important to note that whereas there is a closed "direct" path for the real power negotiated by the action of series voltage injection through Inverters 1 and 2 back to the line, the corresponding reactive power exchanged is supplied or absorbed locally by Inverter 2 and therefore it does not flow through the line. Thus, Inverter 1 can be operated at a unity power factor or be controlled to have a reactive power exchange with the line independently of the reactive power exchanged by Inverter 2. This means that there is no continuous reactive power flow through the UPFC.

A. Basic UPFC control Function

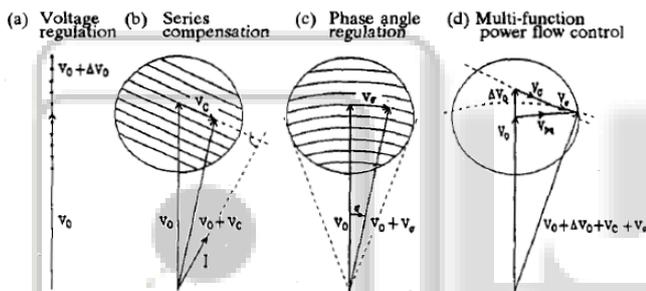


Fig. 3 : Basic UPFC control function. (a) Voltage Regulation (b) Series compensation (c) Angle regulation (d) Multifunction power flow controller

B. ONE LINE DIAGRAM FOR Case study

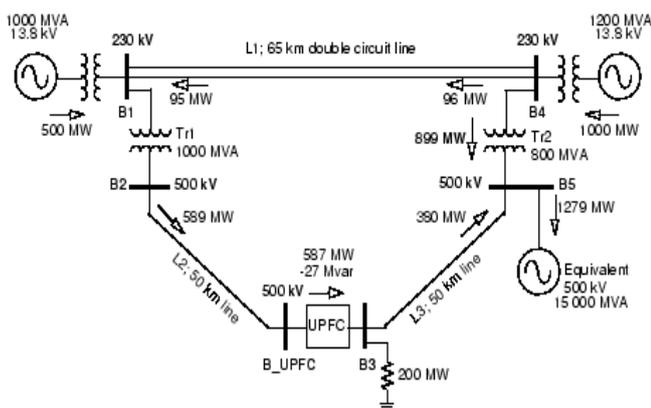


Fig. 4 : Circuit diagram for UPFC

C. Circuit Description

UPFC is used to control the power flow in a 500 kV /230 kV transmission systems. The system, connected in a loop configuration, consists essentially of five buses (B1 to B5) interconnected through transmission lines (L1, L2, L3) and two 500 kV/230 kV transformer banks Tr1 and Tr2. Two

power plants located on the 230-kV system generate a total of 1500 MW which is transmitted to a 500-kV 15000-MVA equivalent and to a 200-MW load connected at bus B3. The plant models include a speed regulator, an excitation system as well as a power system stabilizer (PSS). In normal operation, most of the 1200-MW generation capacity of power plant #2 is exported to the 500-kV equivalent through three 400-MVA transformers connected between buses B4 and B5. For this circuit we are considering a contingency case where only two transformers out of three are available ( $Tr2 = 2 \times 400 \text{ MVA} = 800 \text{ MVA}$ ).

Using the load flow option of the powgui block, the model has been initialized with plants #1 and #2 generating respectively 500 MW and 1000 MW and the UPFC out of service (Bypass breaker closed). The resulting power flow obtained at buses B1 to B5 is indicated by numbers on the circuit diagram. The load flow shows that most of the power generated by plant #2 is transmitted through the 800-MVA transformer bank (899 MW out of 1000 MW), the rest (101 MW), circulating in the loop. Transformer Tr2 is therefore overloaded by 99 MVA. The circuit will illustrates how the UPFC can relieve this power congestion.

The UPFC located at the right end of line L2 is used to control the active and reactive powers at the 500-kV bus B3, as well as the voltage at bus B\_UPFC. It consists of a phasor model of two 100-MVA, IGBT-based, converters (one connected in shunt and one connected in series and both interconnected through a DC bus on the DC side and to the AC power system, through coupling reactors and transformers). Parameters of the UPFC power components are given in the dialog box. The series converter can inject a maximum of 10% of nominal line-to-ground voltage (28.87 kV) in series with line L2. The b numbers on the diagram show the power flow with the UPFC in service and controlling the B3 active and reactive powers respectively at 687 MW and -27 Mvar.

D. Matlab File without UPFC

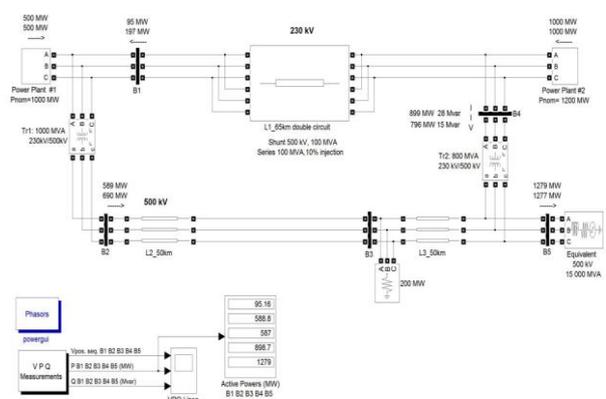


Fig. 5: MATLAB diagram for UPFC

### III. SIMULATION RESULT

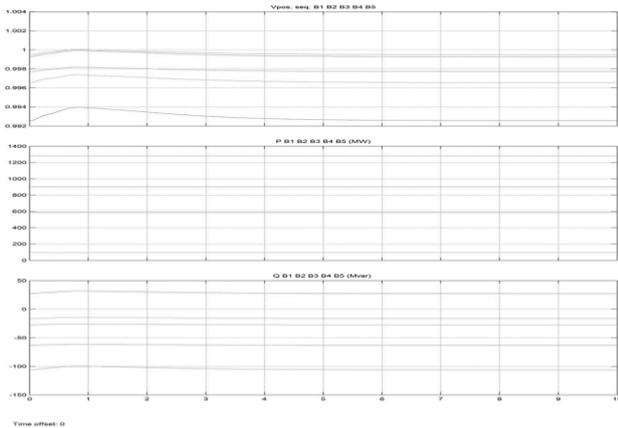


Fig. 6 :System with UPFC

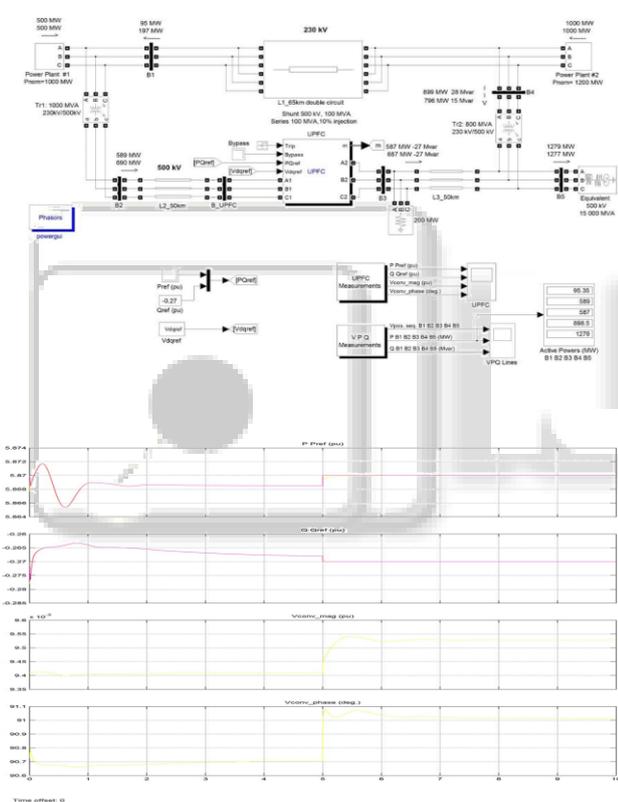


Fig. 6 : Without UPFC when Fault is created

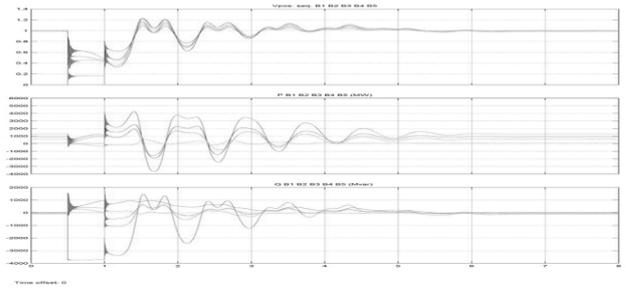


Fig. 7 : Result when fault is created.

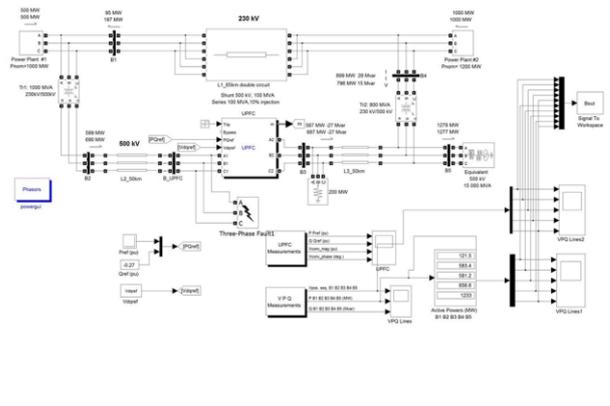


Fig. 8: MATLAB file with UPFC when fault is created

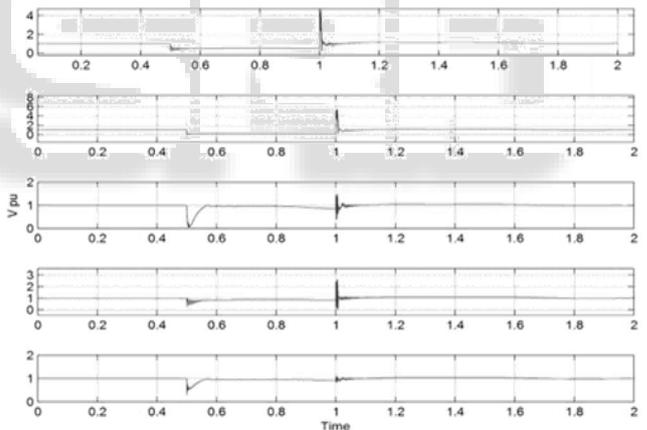


Fig. 9: Result when Fault is created with UPFC

### IV. CONCLUSION

After this analysis in Research paper I conclude that transient stability of power system will improve by using UPFC. UPFC is most versatile device than other facts devices. The Dynamic response of UPFC is better than other device. It can control three parameter of power system.

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