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Impact of UPFC on power system behaviour during different fault locations

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Abstract

In this paper, we emphasize the performance & effect of the UPFC on the power system behaviour during different fault conditions. A transmission line with UPFC & different fault locations such as at sending end, receiving end & at midpoint of the transmission line is considered for the study. As we know UPFC can handle all the three parameters-voltage, impedance & phase angle simultaneously & can also control both real and reactive power flows, hence the idea is taken to observe the capability of the UPFC under various fault conditions. Simulation results show the improvement in the behaviour of the system with the UPFC even under fault conditions by appropriate injection of series voltage into the transmission line at the point of connection.

1. Introduction

Unified power flow controller (upfc) is the most versatile controller for controlling the AC transmission systems. It is different from other devices in such a manner that it gives independent control of real & reactive power in the transmission line. UPFC has the ability to control the power flows under fault conditions, not only in the line where it is installed but also in the adjacent parallel line.Fig (1) shows a two machine-double line power system with UPFC and fault at different locations. Single line to ground fault and three phase fault with fault occurring at sending end & receiving end describe by Kumara Deepak, G.Saravana Ilango, C.Nagamani and K. Shanti Swarup is given in the reference [8]. In our study we take case of LLLG fault only and the location of fault is at sending end, receiving end & also at the midpoint of the system.

2. Control Strategy

In this paper we have taken two different systems-system A and system B. Both the systems are two machine-double line power systems. In this study we consider the different location of UPFC with LLLG fault. The possible cases for investigation are listed below-

Case-1: Two machine-double line power system with LLLG fault at receiving end without UPFC

Case-2: Two machine-double line power system with LLLG fault at receiving end with UPFC

Case-3: Two machine-double line power system with LLLG fault at mid point without UPFC

Case-4: Two machine-double line power system with LLLG fault at mid point with UPFC

Case-5: Two machine-double line power system with LLLG fault at sending end without UPFC

Case-6: Two machine-double line power system with LLLG fault at sending end with UPFC

The fault affected line has three faults- F_1 occur at the sending end, F_2 occur at the receiving end and F_3 occur at the midpoint. The transmission lines have also breakers at either side so that if there is a fault in the system then it activates the UPFC to remove the fault.

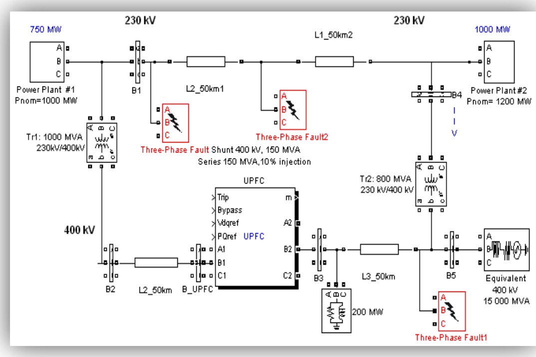
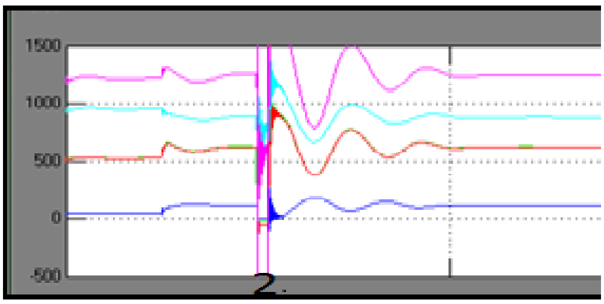


Figure 1 power system with UPFC

3. Simulation results & Discussion

In all the four cases of simulation, fault is considered at load point, midpoint, and sending end. Fault F_1 is considered to occur at sending end for time 2 to 2.1sec and after the fault is cleared the steady state condition is achieved. Another fault F_2 occur for time 10 to 10.1 sec at load point and after clearing of this fault, fault F_3 occur for time 15 to 15.1 sec at mid point.

3.1. Three phase fault- As in our study, we take the three situation of fault in the transmission line-at sending end, receiving end and at midpoint. As we see from the table that for the duration of 0 to1sec bypass breaker is closed, it means UPFC is not in active mode. The power flow in duration 0 to 1sec at different buses is shown in the table. From the table we can see that power in the bus B_4 is 950mw and since the transformer connected to bus B_4 is of the rating of only 800mva, hence it become overloaded. After/at 1sec bypass breaker is open and UPFC come into the active mode. We can see from the graph or from the table, there is increase in the power flow after the working of UPFC. But power at bus B_4 becomes 886mw which make the transformer to work in the healthy mode. After/at 2sec fault F_1 that connects at the sending end is energized for the duration of .1sec. From the graph, for the duration of 2 to 2.1sec there is random change in the power and voltage. During these periods power goes to maximum value of 175mw and minimum value of -300mw at bus B_1. Since UPFC is in active mode, it tries to remove the fault as soon as possible. We can see that UPFC take only .05sec to remove the fault and make the system in stable condition. After the removal of fault, power is maintain in the system as maximum value becomes 150mw and minimum value becomes -145mw at bus B_1. Same case we can see in the voltage and reactive power at all the buses.



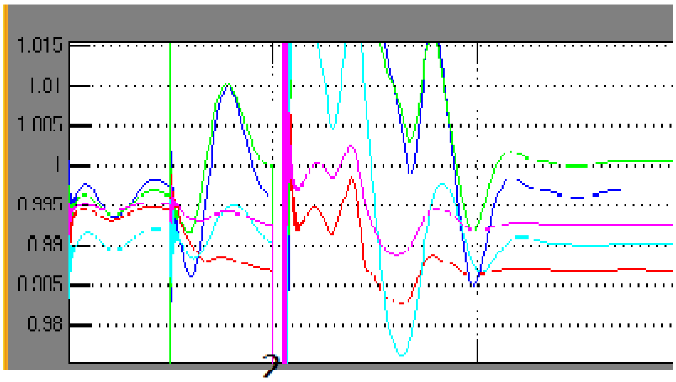
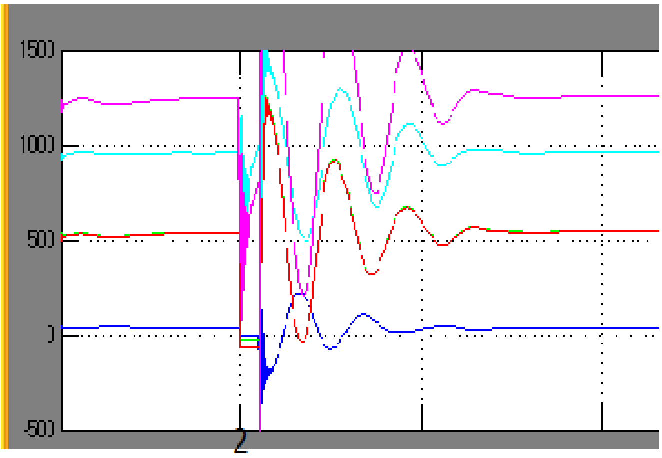


Figure 2 power & voltage on different buses at time fault f_1 with UPFC



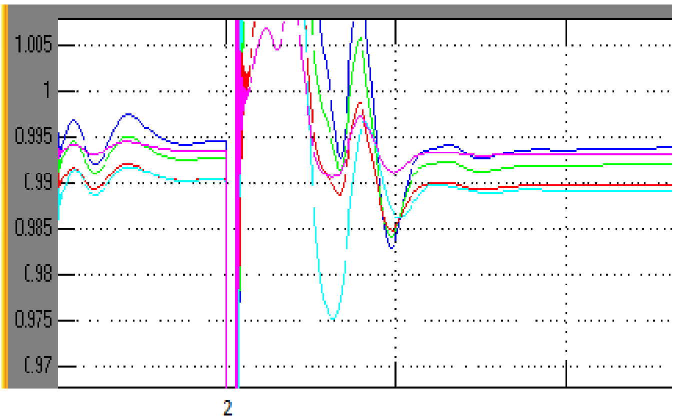


Figure 3 power & voltage at different buses at time fault f_1 without UPFC

Table 1 value of voltage & power with UPFC

Bus	Power with UPFC(mw) at fault f_1	Voltage with UPFC(pu)	Time (sec)
B_1	150 to -145	1.001	2-2.1
B_2		.998	
B_3		.987	
B_4	230 to -450	.991	2-2.1
B_5	950 to 200	.993	

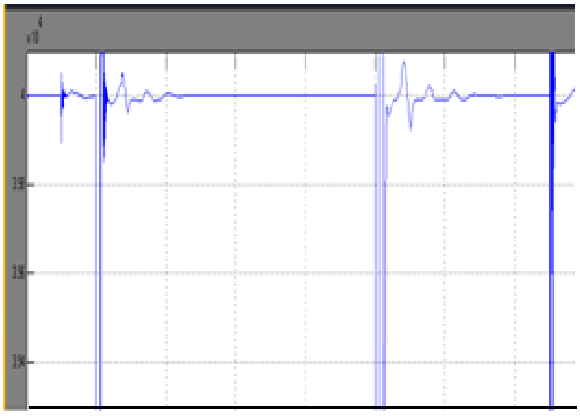


Figure 3 D.C link voltage

We have seen from the graph of dc link voltage that there is suddenly increase & decrease in the dc link voltage due to the charging & discharging of the capacitor. During the fault condition, capacitor is discharge to allow the continuous flow of power so that maintaining the $V_{p.u}$ in the power system and reduces the losses.

Table 2 value of voltage & power without UPFC

Bus	Power without UPFC(mw)	Voltage without UPFC(pu)	Time (sec)
B_1	50	.998	0-1
B_2	530	.997	
B_3	525	.994	
B_4	950	.992	
B_5	1210	.995	

4. Conclusion

The performance of UPFC on the power system behaviour is studied under LLLG fault condition and four different cases are considered for analysis purpose. From the result we conclude that UPFC improve the system performance by the way of maintaining voltage, power and current under fault conditions.

5. References

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