CHAPTER 5

EIGHT BUS SYSTEM

5.1 Introduction

Standard eight bus system is considered for simulation studies. Eight bus system with and without UPQC are studied and the corresponding results are discussed in this chapter. Eight Bus System with and without UPQC is modeled and simulated using the blocks of Simulink. There are three generator buses and five load buses.

In this chapter Eight bus system is modeled using the blocks of simulink. The UPQC system is connected in a Eight bus system to control the real power, reactive power and voltage. The real power, reactive power and voltage is observed without connecting the UPQC in a Eight bus system and connecting the UPQC system. The readings are tabulated.

5.2 Model of Eight Bus System using UPQC in power systems to improve power quality

Simulink model of 8 bus system is shown in Figure 5.1. Eight Bus System is modeled using the elements of Matlab Simulink and the simulation results are presented in this section. The specifications are as follows.

L & C are designed by assuming \( \Delta I = 0.4A, f = 3 \text{ kHz} \) & \( R = 1K \Omega \).
L & C for boost converter works out to be \( 7.5mH \) & \( 12\mu F; T_{\text{ON}} = 0.25\text{ms}; T_{\text{OFF}} = 0.08\text{ms} \).

Scopes are connected to measure receiving end voltage, receiving end current, real power and reactive power. The generator is represented as series combination of R,L&E. Line is represented by series impedance. The load at the
receiving end is series combination of resistance 200Ω and inductance of 100 mH. The parameters of the additional load are 50Ω and 50mH. DC required by UPQC is applied from a photo cell. The output of UPQC is injected using a series transformer.

The inverter of DVR used in the UPQC is triggered at 50 Hz. All the switches are operated with pulses of 10ms width. The pulses given to the other two switches are delayed by 10ms. The output of inverter is filtered by using LC filter. This will reduce heating since harmonics are reduced. The inverter switches of active filter are triggered at 250Hz.

Fig. 5.1. Eight Bus System without UPQC

8 bus system is modeled using the elements of Matlab simulink and the simulation results are presented in this section. The line impedances are shown as series combination of resistance and inductance. There are three generator buses and five load buses. The load at each bus is represented as series combination of load resistance and inductance. The circuit of eight bus system without UPQC is shown in Fig. 5.1. Additional load is applied by closing the breaker at t = 0.2 sec.
Fig. 5.2. Real And Reactive Power at Bus-7

Fig. 5.3. Real And Reactive Power at Bus-3

Fig. 5.3(a). Voltage across Load-1 And Load-2
In Figure 5.2, the real and reactive powers at bus 7 is drawn with time on x-axis and watts on y-axis. The real and reactive power increased at $t = 0.2$ sec, since the current drawn is increased.

In Figure 5.3, the real and reactive powers at bus 3 is drawn with time on x-axis and watts on y-axis. The real and reactive power increased at $t = 0.2$ sec, since the current drawn is increased.

In Figure 5.3(a), voltage across load 1 and 2 is drawn with time on x-axis and voltage on y-axis. At $t = 0.2$ sec the voltage across loads 1 and 2 decreases due to the addition of heavy load. The circuit of eight bus system with UPQC is shown in Fig. 5.4. The network of 8 bus system is represented as the sub-system here.

Fig. 5.4. Eight Bus System with UPQC
The circuit model of UPQC Eight Bus is shown in figure. The UPQC is connected near bus three.

**Fig. 5.5. Real And Reactive Power Across Bus-1**

Figure 5.5 represents, the real and reactive power at bus 1 is drawn with time on x-axis and watts on y-axis. The load is applied at $t = 0.2$ sec. The DVR part of UPQC injects voltage at $t = 0.3$ sec. The real and reactive power at bus 1 decreases.

**Fig. 5.6. Real And Reactive Power Across Bus-3**

Figure 5.6 represents, the real and reactive power at bus 3 is drawn with time on x-axis and watts on y-axis. The load is applied at $t = 0.2$ sec. The DVR part of UPQC injects voltage at $t = 0.3$ sec. The real and reactive power at bus 1 decreases, and that of bus 3 increases due to the transfer of power from bus 1 to 3.

Figure 5.7 represents, the voltage across load 1 and 2 are drawn with time on x-axis and volts on y-axis. The voltage decreases at $t = 0.2$ sec. and
resumes its normal value at $t = 0.3$ sec. This is due to the voltage injected by the UPQC.

![Fig. 5.7. Voltage Across Load-1 And Load-2](image.png)

The summary of real and reactive powers at various buses are shown in Table 5.1.

**Table 5.1 Summary of Real and Reactive Power of 8 Bus System**

<table>
<thead>
<tr>
<th>BUS NO</th>
<th>REAL POWER WITHOUT UPQC (MW)</th>
<th>REAL POWER WITH UPQC (MW)</th>
<th>REACTIVE POWER WITHOUT UPQC (MVAR)</th>
<th>REACTIVE POWER WITH UPQC (MVAR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUS-7</td>
<td>0.041</td>
<td>0.0277</td>
<td>0.0981</td>
<td>0.0208</td>
</tr>
<tr>
<td>BUS-1</td>
<td>0.823</td>
<td>0.778</td>
<td>1.572</td>
<td>1.76</td>
</tr>
<tr>
<td><strong>BUS-3</strong></td>
<td><strong>0.0307</strong></td>
<td><strong>0.208</strong></td>
<td><strong>0.059</strong></td>
<td><strong>0.156</strong></td>
</tr>
<tr>
<td>BUS-8</td>
<td>0.456</td>
<td>0.574</td>
<td>1.432</td>
<td>1.86</td>
</tr>
</tbody>
</table>
5.3 Results and Discussions

It can be seen that the reactive power increases with the increase in the injected voltage. The increase in real power, reactive power and the voltage is higher near bus three than the other buses due the presence of UPQC. The real and reactive powers can be increased by connecting UPQC and they can be controlled by using the UPQC. Hence the desired power flow can be made in a bus by providing suitable control to the UPQC.

5.4 Conclusion

Modeling and simulation of eight bus system with and without UPQC are presented in this chapter. The real and reactive powers increase due to the addition of UPQC.