Controlling of Reactive Power in Transmission Line using Facts Technology with Closed Loop Controller

S.D.Sundarsingh Jebaseelan, D.Godwin Immanuel, M.Kavitha, S.M. Shyni, D.N.S.Ravikumar

Abstract: The paper proposes the power flow control in the transmission line using FACTS devices. In the existing system the power flow in the line system is controlled by using STATCOM. In the proposed system we are going to implement the Combined FACTS device. Which is a combination of series and shunt controller like HPFC (Hybrid power flow controller). Comparison of open loop and closed loop are analyzed for fourteen bus system. In the closed loop PI and FOPID are analyzed for both FACTS Devices. The simulation of both open loop and closed loop are done in the Matlab software.

Index Terms: FACTS, STATCOM, HPFC, FOPID

I. INTRODUCTION

A lot of energy is being consumed for the consumer needs and household usages and many industrial purposes due to this high usage there is a lot of drop in the voltage and causes fault in the transmission lines and to avoid that condition we are going to introduce the FACTS devices that will control the reactive power and stores the reactive power and helps in emitting that same reactive power whenever there is a drop in the transmission line and as the reactive power is directly proportional to the voltage as the control of the voltage in the transmission line will be difficult so by controlling the reactive power we can control the voltage this is the main principle behind the usage of FACTS devices. They are different types of the FACTS devices static shunt compensator SVC, TCR, TSC, STATCOM and combined compensators IPFC, UPFC, HPFC. STATCOM [8] is a device which can supply the required reactive power at low values of bus voltage and can also supply active power if it has large energy storage. STATCOM is a shunt connected reactive power compensation device it is capable of generating and absorbing the reactive power. [2-3]

HPFC is combined compensators where the device is the combination of both series and shunt compensators. HPFC is used to deal with the above problems namely high cost efficiency and also if focuses on grid connection and operating performance. [1]

II. METHODOLOGY

A. Existing Method

Fig 1: Existing method of block diagram

The above block diagram shows the Generator supply is given to the transformer and the Crystal oscillator to the Micro Controller which consists a supply of +5v and the micro controller is connected to Driver Unit the driver unit consists of a supply of +12v and thus the driver unit is connected to the STATCOM and STATCOM is been connected to the Transformer to the Load. [4,5]
A. Proposed Method

The above block diagram shows the Generator supply is given to the Transformer and the Crystal Oscillator is to the Micro Controller which consists of a supply of +5v and the micro controller is connected to the Driver Unit and thus a supply of +12v is given to the driver unit and the driver unit is connected to the STATCOM and HPFC [3,6] and thus from the HPFC to the Transformer also from STATCOM to the Transformer and thus both is being connected to the Load.

III. SIMULATION RESULTS

A. 14 bus system with open loop

The above graph explains about the voltage across the loads one and two across the bus -3 in 14 bus system without any FACTS devices as the x axis is time and y axis is voltage.

The above graph explains about the real and reactive power across the bus 3 in 14 bus system without any FACTS devices.

B. 14 bus system with STATCOM open loop

The graph mentioned above explains about the real and reactive power across the bus 6 in 14 bus system after compensation without any FACTS devices.

The above graph explains about the voltage across the load 1 and load 2 at bus 3 in 14 bus system using STATCOM.
Fig 9: Real and Reactive power at bus-3

The above graph explains about the real and reactive power across the bus 3 in the 14-bus line system with the FACTS device with STATCOM as there is a drop in the voltage then the real and reactive power will increase in the transmission line.

Fig 10: Real and Reactive power at bus-6

The above graph explains about the real and reactive power across the bus 6 using STATCOM in the 14-line bus system after compensation.

C. 14 bus system using combined FACTS Device with open loop

Fig 11: simulation circuit diagram using STATCOM and HPFC

Fig 12: Voltage across Load-1 and load-2 at bus-3

The above graph explains about the voltage across the load 1 and load 2 at the bus 3 with the combined FACTS devices called STATCOM and HPFC in the 14-line bus system.

Fig 13: Real and Reactive power at bus-3

Fig 14 Real and Reactive power at bus-6

D. PI Controller with Combined FACTS

Fig 15: simulation circuit diagram in closed loop using PI controller

Fig 16 Real and reactive power at bus3 using PI controller
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The above graph explains about the real and reactive power across the bus 3 in the 14-bus line system by closed loop using PI controller using combined FACTS devices STATCOM and HPFC.

E. FOPID Controller with Combined FACTS

The above graph explains about the real and reactive power across the bus 3 in the 14-bus line system in the closed loop using FOPID controller with the help of combined FACTS devices STATCOM and HPFC.

Table 1: Comparison of Real Power at Bus 3 and 6

<table>
<thead>
<tr>
<th>Bus No</th>
<th>Without FACTS devices</th>
<th>With STATCOM (open loop)</th>
<th>With STATCOM (Closed loop)</th>
<th>With combined STATCOM &amp; HPFC (open loop)</th>
<th>With combined STATCOM &amp; HPFC (Closed loop)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0.0603</td>
<td>0.0755</td>
<td>0.0790</td>
<td>0.0825</td>
<td>0.0963</td>
</tr>
<tr>
<td>6</td>
<td>0.6155</td>
<td>0.0233</td>
<td>0.0294</td>
<td>0.0354</td>
<td>0.0396</td>
</tr>
</tbody>
</table>

Table 2: Comparison of Reactive Power at Bus 3 and 6

<table>
<thead>
<tr>
<th>Bus No</th>
<th>Without FACTS devices</th>
<th>With STATCOM (open loop)</th>
<th>With STATCOM (Closed loop)</th>
<th>With combined STATCOM &amp; HPFC (open loop)</th>
<th>With combined STATCOM &amp; HPFC (Closed loop)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0.0156</td>
<td>0.1981</td>
<td>0.2014</td>
<td>0.2563</td>
<td>0.2409</td>
</tr>
<tr>
<td>6</td>
<td>0.0164</td>
<td>0.1223</td>
<td>0.2297</td>
<td>0.2352</td>
<td>0.3108</td>
</tr>
</tbody>
</table>

Table 3: Comparison of Time Domain Parameters

<table>
<thead>
<tr>
<th>Controllers</th>
<th>Tr</th>
<th>Ts</th>
<th>Tp</th>
<th>Ess</th>
</tr>
</thead>
<tbody>
<tr>
<td>PI</td>
<td>0.33</td>
<td>0.42</td>
<td>0.57</td>
<td>9.8</td>
</tr>
<tr>
<td>FOPID</td>
<td>0.32</td>
<td>0.36</td>
<td>0.34</td>
<td>2.2</td>
</tr>
</tbody>
</table>
IV. RESULTS AND DISCUSSION

The performance of the proposed scheme is higher when compared to the present system the real power across the bus 3 is 0.063 and at bus 6 is 0.0155 without using any FACTS devices. By using the STATCOM open loop across bus 3 and bus 6 real power increase of value to 0.075 and at bus 6 to 0.0223. By using the STATCOM and HPFC in open loop across bus 3 and bus 6 real power increase of value to 0.0825 at bus 3 and bus 6 to 0.0354.

By using the STATCOM in PI Controller in bus 3 and bus 6 real power increase of value to 0.0798 at bus 3 and bus 6 to 0.0294.

By using the STATCOM and HPFC in FOPID controller across bus 3 and bus 6 there is an increase of value to 0.0963 at bus 3 and 0.0396 at bus 6. From we can find that real power has been compensated by 73%.

The reactive power values across the bus 3 and bus 6 without FACTS devices are 0.0156 at bus 3 and 0.0164 at bus 6. By using the STATCOM across bus 3 and bus 6 there is an increase of value to 0.1981 at bus 3 and 0.1223 at bus 6. By using the STATCOM and HPFC across bus 3 and bus 6 there is an increase of value to 0.2363 at bus 3 and 0.2352 at bus 6.

V. CONCLUSION

In the proposed work, FOPID controllers have been implemented for combined FACTS devices. After the implementation of FOPID in STATCOM across bus 3 and bus 6 there is an increase of value to 0.2014 at bus 3 and 0.2297 at bus 6. By using the STATCOM and HFPC (FOPID) across bus 3 and bus 6 there is an increase of value to 0.2409 at bus 3 and 0.3108 at bus 6. Using FOPID Combined FACTS devices reactive power is compensated to 88%. By using this controller, the reactive power is improved so the stability of the system is maintained.

REFERENCES


AUTHORS PROFILE

Dr.S.D.Sundarsingh Jebaseelan received his Bachelor of Engineering degree in Electrical and Electronics Engineering in the year 2002 from the Bharathiyar University, Coimbatore, Tamilnadu and Master of Engineering degree in Power Systems in the year 2005 from Annamalai University, Chidambaram, Tamilnadu and also he received his Doctor of Philosophy in the year 2014 from Sathyabama University,Chennai. He is currently working as an Associate Professor in the Department of Electrical and Electronics Engineering, Sathyabama Institute of Science and Technology, Chennai. He has published four Book Series, Twelve International Journal papers, Ten National Journal and Ten papers in National Conferences and Six papers in International Conferences. He is Life Member of International Association of computer science and Information Technology

D. Godwin Immanuel was born in Nagercoil, Tamilnadu. He completed his B.E degree in Electrical and Electronics Engineering in Manonmaniam Sundaramar University, Tirunelveli. He later completed his Masters in Power system Engineering in Annamalai University and completed his Phd in Sathyabama University. He has published more than 40 papers in various Journals and Conferences. His research interest includes Power System Optimization problems.
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M.Kavitha has received her B.E degree in Electrical and Electronics Engineering from Bharathiyar University, Tamilnadu, India in 2000 and M.E degree in Power Systems Engineering from Anna University, Tamilnadu, India in 2012. She is pursuing her Ph.D under the faculty of Electrical and Electronics Engineering at Sathyabama Institute of Science and Technology from 2014. Her research interest includes Renewable Energy sources, Energy storage system, Fuzzy logic controller, Artificial Neural network and Power Electronic Converters.

S.M.Shyni, received her M.E Applied Electronics in the year 2012. Currently, she is working as an Assistant Professor in the Department of Electrical and Electronics Engineering, Sathyabama Institute of Science and Technology, Chennai. She has more than 8 years of experience in teaching field. She is undergoing her research in Utilization of Renewable energy in the department of Electronics Engineering, Sathyabama Institute of Science and Technology, Chennai. Her current research area focuses on Soft Computing Techniques.

D.N.S Ravi Kumar has completed his M.Sc.(Applied Electronics ) in the year 2003 from Bharathiyar University Coimbatore, India and M.E Applied Electronics in the year 2006 from Sathyabama Institute of Science & Technology Chennai, India. He is pursuing PhD in the field of Vehicular Communication (Distributed Embedded Systems) from Sathyabama Institute of Science and Technology since 2015, Chennai, India. His field of interests includes Embedded Systems, Vehicular Communication and Robotics. He is currently working on Smart car Technology (V2V). Apart from research an innovator to spark startups from ideas to implementation.