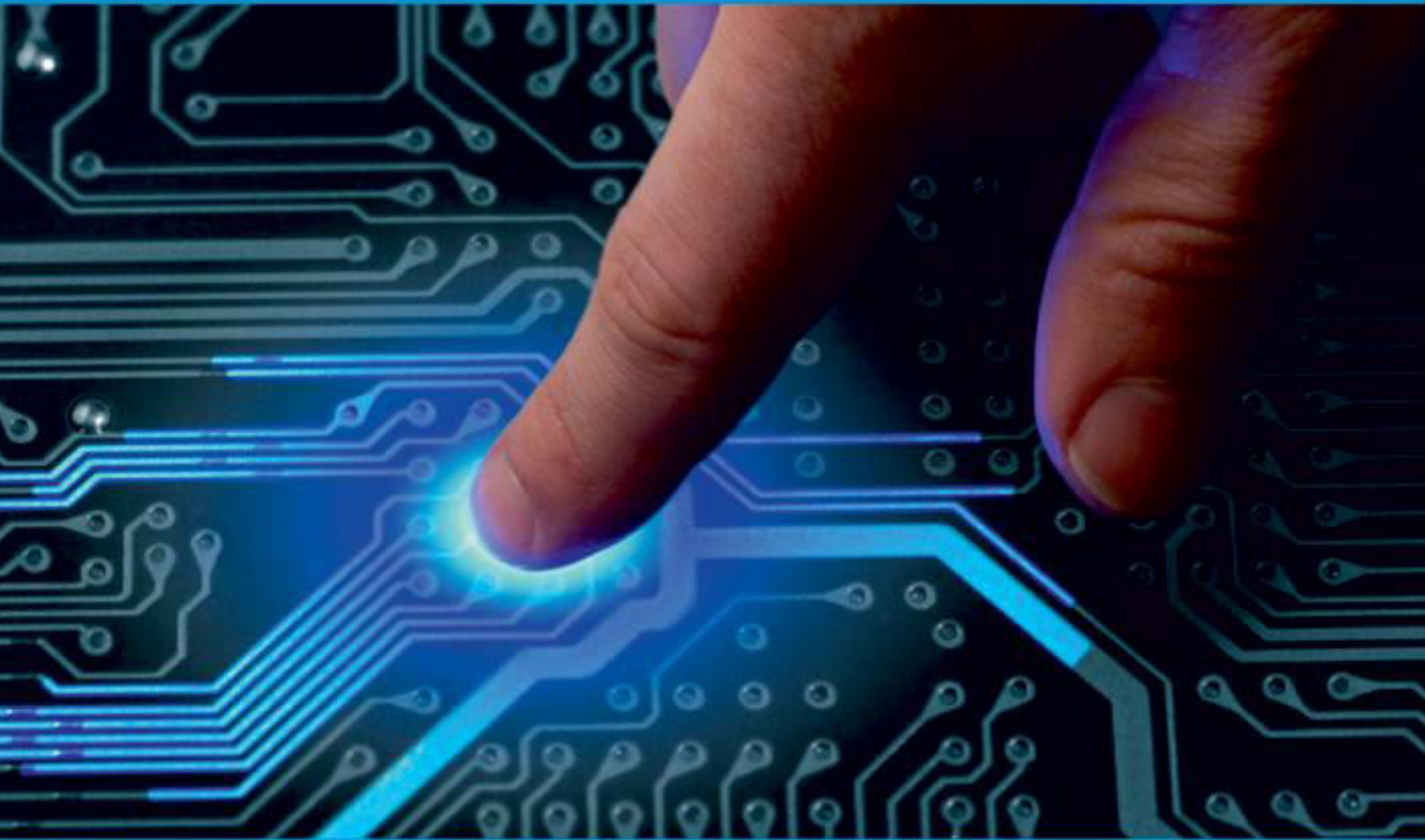
IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 9, Issue 12, December 2021

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.542

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.542

|| Volume 9, Issue 12, December 2021 ||

| DOI: 10.15680/IJIRCCE.2021.0912015 |

Analysis of Power System with Three - Phase Current Based Modeled FACTS Controllers

S. Tejaswa Kumar, N. Mahesh Babu

PG Student, Dept. of EEE., BITS, Adoni, Andhra Pradesh, India

Associate Professor, Dept. of EEE, BITS, Adoni, Andhra Pradesh, India

ABSTRACT: Nowadays the need of electricity demand increases, to meet the increasing load demand andsatisfy the quality and reliability criteria, either existing transmission or generation facilities mustbe utilized more efficiently, or new facilities should be added to the power system. By usingFACTS controllers we can utilize the generation andtransmission facilities more efficiently. Themain objectives of the FACTS controllers are enhancing the power system performance,improving the quality of supply and also providing an optimal utilization of the existingresources.It is also necessary to know the day to day analysis of power system, so perform load flow.Up to now this load flow is performed for a power system by treating the three phase lines arebalanced lines, so we are considering single line diagram for load flow calculation. Butpractically the loads are different, so it is necessary to develop a three phase load flow.So there is a necessity for modeling of three-phase FACTS controllers. But existed onemethod for modeling of three-phase FACTS controllers' i.e. voltage source based modeling. Ithas some disadvantage in the convergence point of view. Therefore, the previously developedcurrent based model seems to eliminate that problem. Comprehensive tests were carried outusing the one standard IEEE test systems.

KEYWORDS: FACTS controllers, Three phase load flow, Current based modeling, Voltage based modeling,UPFC.

I. INTRODUCTION

Nowadays the need of electricity demand increases, to meet the increasing load demand andsatisfy the quality and reliability criteria, either existing transmission or generation facilities mustbe utilized more efficiently, or new facilities should be added to the power system. By using FACTS controllers we can utilize the generation and transmission facilities more efficiently. Themain objectives of the FACTS controllers are enhancing the power system performance,improving the quality of supply and also providing an optimal utilization of the existing resources. The fallowing sections deals with modeling of FACTS controllers such as StaticSynchronous Series Compensator(SSSC),Static Synchronous Compensator(STATCOM),UnifiedPower Flow Controller(UPFC) by using Voltage Source Based (VSB) and Current Based model (CBM) and their incorporation in Newton-Raphson load flow.

The essential part of almost every planning procedure is a calculation of the steady-stateconditions applying load-flow (LF) procedures. Although in the past two decades modern powersystems, sometimes containing FACTS controllers [1,2].As already reported in [3–5], a new approach to the modeling of FACTS controllers, calledthe current-based approach, exhibits better convergence and robustness with respect to the initialconditions than the previously developed voltage injection models. A universal approach hasbeen developed, which is generally applicable for any kind or structure of electronicallycontrolled FACTS controllers, since it is ''branch oriented''. This means that various branches ofthe devices are modeled in a universal way, and the control mode and/or device-specificproperties are simply added in the form of simple equations.When talking about high-voltage applications the problem of the asymmetry of powersystems in steady-state conditions is mainly irrelevant, because with proper measures theunbalance of voltages and currents caused by the ''imperfection'' of electric machines and,primarily, by the geometry of the electric power lines, can be managed [6].

Nevertheless, there is a portion of unbalance that remains, which causes unwanted anomaliesin the electric power system. The consequences of unbalanced electric power lines are increasedpower losses, the heating of synchronous generators, the misfiring of power converters and theill-tripping of protective devices [7,8].The problem gets worse when we consider lower voltages (distribution systems) [9,10]. WithFACTS controllers, among others, it is possible to improve the quality of the electric powersupply, which also includes balancing of potentially unbalanced voltages [11]. In order to be ableto analyze such conditions the procedures for a three-phase, load-flow calculation have to beapplied. However, according to our investigations such procedures, which are also suitable foranalyses of power systems containing general FACTS controllers, are relatively rare [12,13].

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.542

|| Volume 9, Issue 12, December 2021 ||

| DOI: 10.15680/IJIRCCE.2021.0912015 |

II. RELATED WORK

In [2] authors used average residual battery level of the entire network and it was calculated by adding two fields to the RREQ packet header of a on-demand routing algorithm i) average residual battery energy of the nodes on the path ii) number of hops that the RREQ packet has passed through.According to their equation retransmission time is proportional to residual battery energy. Those nodes having more battery energy than the average energy will be selected because its retransmission time will be less. Small hop count is selected at the stage when most of the nodes have same retransmission time. Individual battery power of a node is considered as a metric to prolong the network lifetime in [3]. Authors used an optimization function which considers nature of the packet, size of the packet and distance between the nodes, number of hops and transmission time are also considered for optimization. In [4] initial population for Genetic Algorithm has been computed from the multicast group which has a set of paths from source to destination and the calculated lifetime of each path. Lifetime of the path is used as a fitness function. Fitness function will select the highest chromosomes which is having highest lifetime. Cross over and mutation operators are used to enhance the selection. In [5] authors improved AODV protocol by implementing a balanced energy consumption idea into route discovery process. RREQ message will be forwarded when the nodes have sufficient amount of energy to transmit the message otherwise message will be dropped. This condition will be checked with threshold value which is dynamically changing. It allows a node with over used battery to refuse to route the traffic in order to prolong the network life. In [6] Authors had modified the route table of AODV adding power factor field. Only active nodes can take part in rout selection and remaining nodes can be idle. The lifetime of a node is calculated and transmitted along with Hello packets. In [7] authors considered the individual battery power of the node and number of hops, as the large number of hops will help in reducing the range of the transmission power. Route discovery has been done in the same way as being done in on-demand routing algorithms. After packet has been reached to the destination, destination will wait for time δt and collects all the packets. After time δt it calls the optimization function to select the path and send RREP. Optimization function uses the individual node's battery energy; if node is having low energy level then optimization function will not use that node.

III. MATHEMATICAL MODELING AND INCORPORATION OF FACTS CONTROLLERS

A. *Static Synchronous Series Compensator*

A SSSC usually consists of a coupling transformer, an inverter and a capacitor. The SSSC isconnected in series with the transmission line by coupling transformer. In principle, The SSSCcan inject a series voltage which can be regulated to change the impedance (more precisely reactance) of transmission line. In this way, the power flow of the transmission line or voltage ofbus, which the SSSC is connected, can be controlled. The schematic diagram of SSSC can beshown in Figure.1, where k is the sending end and m is the receiving end buses of a transmission line with SSSC and j is the auxiliary bus formed in the transmission line by placingSSSC.

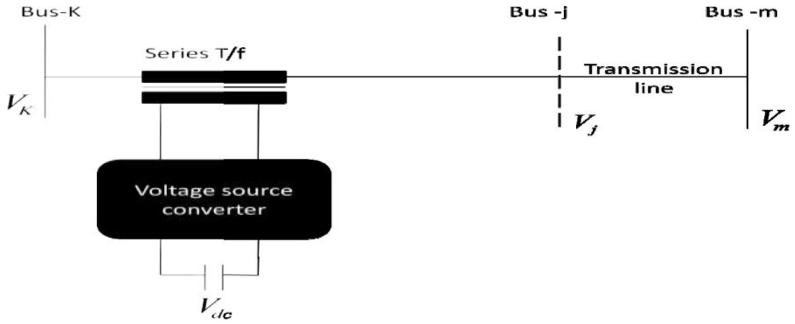
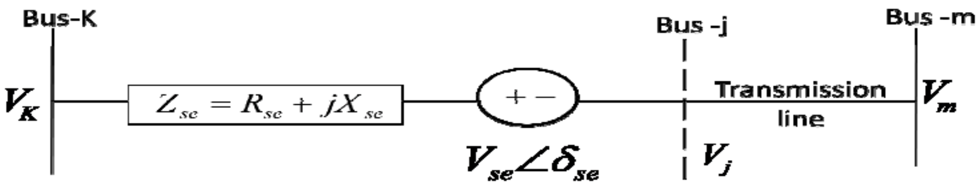


Figure. 1.Basic schematic diagram of SSSC

B. *Voltage Source Based (VSB) Modeling of SSSC*

VSB model is depends upon the injected voltage magnitude and voltage angle by the FACTScontrollers. By controlling those parameters the real and reactive flows in a transmission line and voltage magnitudes at the buses can be controlled. When the SSSC is placed in conventional load flow one auxiliary bus is formed, so the number of buses increased by one.The Voltage source based modeling of SSSC is shown in Figure.2.

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.542
|| Volume 9, Issue 12, December 2021 ||
| DOI: 10.15680/IJIRCCE.2021.0912015 |



The injected powers by the SSSC at Bus k

$$P_k = \frac{V_k V_j}{X_{se}} \sin(\delta_k - \delta_j) + \frac{V_k V_{se}}{X_{se}} \sin(\delta_k - \delta_{se}) \tag{2.1}$$

$$Q_k = \frac{V_k^2}{X_{se}} - \frac{V_k V_{se}}{X_{se}} \cos(\delta_k - \delta_{se}) - \frac{V_k V_j}{X_{se}} \cos(\delta_k - \delta_j) \tag{2.2}$$

The injected powers by the SSSC at Bus j

Since the active power absorbed by the SSSC is zero the power at the device receiving end is given by

$$P_j = -P_k$$

$$P_j = -\left(\frac{V_k V_j}{X_{se}} \sin(\delta_k - \delta_j) + \frac{V_k V_{se}}{X_{se}} \sin(\delta_k - \delta_{se})\right) \tag{2.3}$$

$$Q_j = \frac{V_j^2}{X_{se}} - \frac{V_j V_{se}}{X_{se}} \cos(\delta_j - \delta_{se}) - \frac{V_j V_k}{X_{se}} \cos(\delta_j - \delta_k) \tag{2.4}$$

C. *Current Based Modeling (CBM) of SSSC*

The current-based model is based on currents flowing via the branches of FACTS devices.These currents are multiplied by the terminal-bus voltages and thus result in active P and reactiveQ powers. In this way the equations for the powers are obtained, which are added to the classicset of power-balancing LF equations.

Injected powers by the SSSC

$$P_i = -V_i.(Re[I_s].\cos\delta_i + Im[I_s].\sin\delta_i)$$

$$Q_i = -V_i.(Re[I_s].\sin\delta_i - Im[I_s].\cos\delta_i)$$

$$P_j = V_j.(Re[I_s].\cos\delta_j + Im[I_s].\sin\delta_j)$$

$$Q_j = V_j.(Re[I_s].\sin\delta_j - Im[I_s].\cos\delta_j)$$

The injected powers by the SSSC at buses i and j are

$$P_{i\,sssc} = -P_i$$
$$P_{j sssc} = -P_j$$

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.542

|| Volume 9, Issue 12, December 2021 ||

| DOI: 10.15680/IJIRCCE.2021.0912015 |

IV. Computational Procedure with FACTS

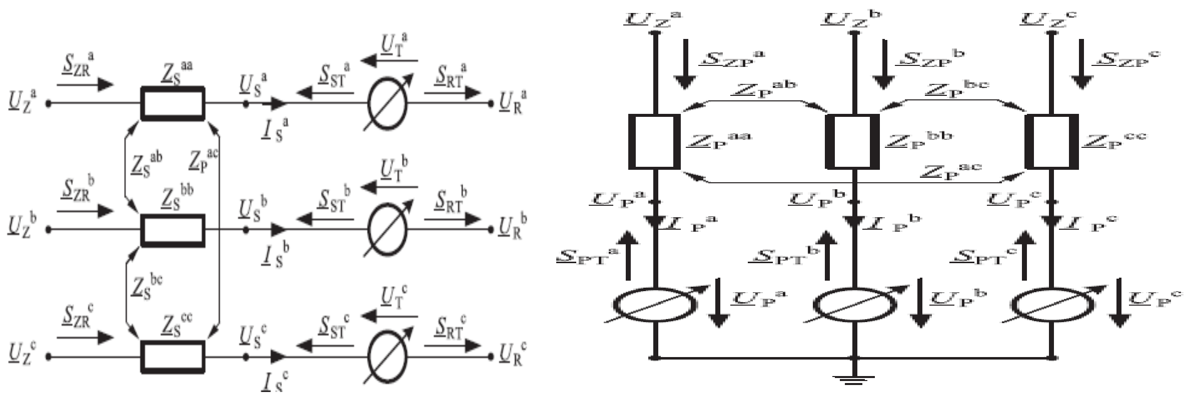
The overall computational procedure of Newton-Raphson power flow method with FACTScontrollers is as follows.
Step-1: Read bus data, line data and device data
Step-2: Assume flat voltage profile, iteration count iter=1
Step-3: Compute active & reactive power values without device.
Step-4: Modify the active & reactive power values at device connected buses and determine active and reactive power mismatch values
Step-5: Determine Jacobian matrix with power flow equation
Step-6: Modify the Jacobian elements and calculate the values of the newly formed elements because of device
Step-7: Solve NR method to find voltage magnitude and angle correction vector.
Step-8: Update the solution with correction vector.
Step-9: Increase the iteration count, iter=iter+1.
Step-10: Stop the process, if the maximum mismatch is less than given tolerance and print theoutput. Otherwise go to step 3.

V. Computational procedure of Three-Phase load Flow

The overall computational procedure of Newton-Raphson load flow method is as follows.
Step-1: Read bus data, line data
Step-2: Assume flat voltage profile, iteration count iter=1
Step-3: Compute active & reactive power values
Step-4: Determine active and reactive power mismatch values
Step-5: Determine Jacobian matrix with power flow equation
Step-6: Solve NR method to find voltage magnitude and angle correction vector.
Step-7: Update the solution with correction vector.
Step-8: Increase the iteration count, iter=iter+1.
Step-9: Stop the process, if the maximum mismatch is less than given tolerance and print the output. Otherwise go to step 3.

VI. Current based modeling of three-phase FACTS controllers

The current-based model is based on currents flowing via the branches of FACTS devices. These currents are multiplied by the terminal-bus voltages and thus result in active P and reactive Q powers.



Three phase modeling of SSSC and STATCOM

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.542
|| Volume 9, Issue 12, December 2021 ||
| DOI: 10.15680/IJIRCCE.2021.0912015 |

Injected powers by SSSC, STATCOM and UPFC

$$Pst^a = -V_s{}^a \times (\mathrm{Re}(I_s^a) \times \cos\delta_s^a + \mathrm{Im}(I_s^a) \times \sin\delta_s^a), \Pr t^a = V_r{}^a \times (\mathrm{Re}(I_s^a) \times \cos\delta_r^a + \mathrm{Im}(I_s^a) \times \sin\delta_r^a)$$

$$Pst^b = -V_s{}^b \times (\mathrm{Re}(I_s^b) \times \cos\delta_s^b + \mathrm{Im}(I_s^b) \times \sin\delta_s^b), \Pr t^b = V_r{}^b \times (\mathrm{Re}(I_s^b) \times \cos\delta_r^b + \mathrm{Im}(I_s^b) \times \sin\delta_r^b)$$

$$Pst^c = -V_s{}^c \times (\mathrm{Re}(I_s^c) \times \cos\delta_s^c + \mathrm{Im}(I_s^c) \times \sin\delta_s^c), \Pr t^c = V_r{}^c \times (\mathrm{Re}(I_s^c) \times \cos\delta_r^c + \mathrm{Im}(I_s^c) \times \sin\delta_r^c)$$

$$Qst^a = -V_s{}^a \times (\mathrm{Re}(I_s^a) \times \sin\delta_s^a - \mathrm{Im}(I_s^a) \times \cos\delta_s^a), Qrt^a = V_r{}^a \times (\mathrm{Re}(I_s^a) \times \sin\delta_r^a - \mathrm{Im}(I_s^a) \times \cos\delta_r^a)$$

$$Qst^b = -V_s{}^b \times (\mathrm{Re}(I_s^b) \times \sin\delta_s^b - \mathrm{Im}(I_s^b) \times \cos\delta_s^b), Qrt^b = V_r{}^b \times (\mathrm{Re}(I_s^b) \times \sin\delta_r^b - \mathrm{Im}(I_s^b) \times \cos\delta_r^b)$$

$$Qst^c = -V_s{}^c \times (\mathrm{Re}(I_s^c) \times \sin\delta_s^c - \mathrm{Im}(I_s^c) \times \cos\delta_s^c), Qrt^c = V_r{}^c \times (\mathrm{Re}(I_s^c) \times \sin\delta_r^c - \mathrm{Im}(I_s^c) \times \cos\delta_r^c)$$

VII. SIMULATION RESULTS

In this section the proposed methodology is tested on a standard IEEE-5 bus system. Theresults are analyzed for comparison of voltage source basedmodel (VSB) and current based model (CBM) of FACTS controllers.

A. *Load Flow Solution*

IEEE-5 bus system is taken and the system data is given in the appendix1. In IEEE-5 bussystem bus-1 is slack bus, bus 2 is generator bus and remaining are load buses. Load flowsolution for IEEE-5 bus system is performed using NR load flow method. Voltages at buses andpower flows in lines are tabulated in Tables 5.1 and 5.2 respectively.

Table 5.1 Voltage profile of IEEE -5 bus system

B.no	Voltage magnitude(PU)		
	A	B	C
1	1.06	1.06	1.06
2	1	1	1
3	0.987246895	0.987246895	0.987246895
4	0.9841319	0.9841319	0.9841319
5	0.971695985	0.971695985	0.971695985

Table 5.2 Power Flows of IEEE -5 bus system

line.No		P flow(MW)			Q flow(MVAR)	
	A	B	C	A	B	C
1-2.	89.33137935	89.33137935	89.33137935	73.99518217	73.99518217	73.99518217
1-3.	41.79084846	41.79084846	41.79084846	16.82033651	16.82033651	16.82033651
2-3.	24.47266215	24.47266215	24.47266215	-2.518493724	-2.518493724	-2.518493724
2-4.	27.71299814	27.71299814	27.71299814	-1.723911769	-1.723911769	-1.723911769
2-5.	54.65985389	54.65985389	54.65985389	5.557938409	5.557938409	5.557938409
3-4.	19.38617713	19.38617713	19.38617713	2.864796279	2.864796279	2.864796279
4-5.	6.598251275	6.598251275	6.598251275	0.518315757	0.518315757	0.518315757

The location of the FACTS controllers is based on the severity index. In IEEE 5bus systemthe severity index is less for 4-5 line, so the SSSC,UPFC is placed in 4-5 line. To compare theSSSC,STATCOM,UPFC it is necessary to place STATCOM at 4th bus because the shunt branchof UPFC is placed at 4th bus.

B. *With SSSC*

SSSC is connected in line-7 that is connecting between buses 4-5. Now load flow solution isperformed in the presence of SSSC as discussed in section 2.2 and in section 2.5.

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.542

|| Volume 9, Issue 12, December 2021 ||

| DOI: 10.15680/IJIRCCE.2021.0912015 |

Table 5.3 Voltage profiles and Power Flows of IEEE -5 bus system with SSSC

B.no	VoltageA(pu)	VoltageB(pu)	VoltageC(pu)
1	1.06	1.06	1.06
2	1	1	1
3	0.987292072	0.987292048	0.987292216
4	0.984231124	0.984231088	0.984231301
5	0.971610113	0.971610144	0.971609794
6	0.98517031	0.985170124	0.98517059
7	0.983490278	0.983490473	0.983489493

line.No	PflowA(MW)	PflowB(MW)	PflowC(MW)	QflowA(Mvar)	QflowB(Mvar)	QflowC(Mvar)
1-2.	88.60533717	88.605384	88.60539393	74.20868453	74.20865394	74.2086836
1-3.	42.52838111	42.52833348	42.52833054	16.62043419	16.62045938	16.62039648
2-3.	25.61687845	25.61680539	25.61679543	-2.866888504	-2.866845749	-2.866934039
2-4.	29.16628559	29.16619257	29.16618147	-2.179982167	-2.179927374	-2.180039592
2-5.	51.35341453	51.35362696	51.35365844	6.505476029	6.505357778	6.505621305
3-4.	21.19452922	21.19441365	21.19440376	2.096712384	2.096792246	2.096650953
7-5.	9.809075152	9.808869668	9.808841918	-0.712239281	-0.71210835	-0.712355309
4-6.	9.803339402	9.803134603	9.803114485	-0.874817231	-0.874672054	-0.874921442

From Tables 5.2 and Table 5.3 by comparing the results obtained without and with SSSC, it isobserved that the major change in power flow occurred in SSSC connected line. The power flowin the device connected line increases from 6.6MW to 9.8034MW. From Table 5.3 it is observedthat the voltages and power flows are same for both methods, but number of iterations requiredfor convergence in VSB model is more.

C. *With STATCOM*

STATCOM is placed at bus 4 and load flow solution is performed as discussed in Section 2.3and in section 2.6. The voltage values and power flow in the lines in the presence of STATCOMare tabulated in Tables 5.4.

Table 5.4 Voltage profile and Power Flows of IEEE -5 bus system with STATCOM

B.no	VoltageA(pu)	VoltageB(pu)	VoltageC(pu)
1	1.06	1.06	1.06
2	1	1	1
3	0.9924	0.9924	0.9924
4	0.9907	0.9907	0.9907
5	0.9739	0.9739	0.9739
6	1.0007	1.0007	1.0007

line.No	PflowA(MW)	PflowB(MW)	PflowC(MW)	QflowA(Mvar)	QflowB(Mvar)	QflowC(Mvar)
1-2.	88.62817259	88.62810236	88.62814168	74.20197843	74.20199101	74.20195146
1-3.	41.52868087	41.52864578	41.52866512	14.66028353	14.66028141	14.66027716
2-3.	24.26547015	24.26544797	24.26546011	-5.284252616	-5.284256881	-5.28425119
2-4.	27.45746684	27.45743562	27.4574524	-5.273979561	-5.273983411	-5.273978469
2-5.	54.43594374	54.43592708	54.43593686	3.76742575	3.767421786	3.767425421
3-4.	18.98917477	18.9891218	18.98914789	-1.798015804	-1.798009419	-1.798015195
4-5.	6.816295264	6.816309353	6.816301459	2.240933878	2.240934658	2.240933588
4-6.	-0.865113308	-0.865208235	-0.865160624	-9.869674025	-9.869666189	-9.869669523

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.542

|| Volume 9, Issue 12, December 2021 ||

| DOI: 10.15680/IJIRCCE.2021.0912015 |

From Tables 5.1 and Table 5.4 by comparing the results obtained without and withSTATCOM, it is observed that the major change in bus voltage occurred at STATCOMconnected bus .STATCOM connected bus voltage increases from 0.9841p.u to 0.9907p.u. FromTable 5.4, it is observed that the voltages and power flows are same for both methods, butnumber of iterations required to get convergence in VSB model is more.

D. *With UPFC*

UPFC is placed in the line-7 connecting between buses 4-5 and the shunt branch is connectedto bus-4 and load flow solution is performed as discussed in section 2.5. Voltages at buses andpower flow in the lines are tabulated in Tables 5.5.

Table 5.5 Voltage profile and Power Flows for IEEE -5 bus system with UPFC

B.no	VoltageA(pu)	VoltageB(pu)	VoltageC(pu)
1	1.06	1.06	1.06
2	1	1	1
3	0.9935	0.9935	0.9935
4	0.9922	0.9922	0.9922
5	0.9716	0.9716	0.9716
6	0.9932	0.9932	0.9932
7	0.9835	0.9835	0.9835
8	1.0022	1.0022	1.0022

line.No	PflowA(MW)	PflowB(MW)	PflowC(MW)	QflowA(Mvar)	QflowB(Mvar)	QflowC(Mvar)
1-2.	87.97521564	87.97535913	87.97520112	74.39421638	74.39423831	74.3943121
1-3.	42.2429603	42.24296752	42.24286766	13.99176813	13.99186538	13.99180265
2-3.	25.33825822	25.33822599	25.33814687	-6.213963216	-6.213849791	-6.213945362
2-4.	28.82991743	28.82987981	28.82977292	-6.478913543	-6.478766791	-6.478884795
2-5.	51.35295425	51.35316804	51.35319712	6.501434176	6.501316691	6.501578107
3-4.	20.71383838	20.71381201	20.7136454	-3.573204116	-3.573001284	-3.57312621
7-5.	9.809506117	9.809300421	9.809273096	-0.70839745	-0.708267416	-0.708512867
4-6.	9.882355903	9.882147168	9.882127747	-0.893477298	-0.893331904	-0.893580353
4-8.	-0.893477298	-0.893331904	-0.893580353	-9.882355903	-9.882147168	-9.882127747

From Tables 5.1, Table 5.2 and Table 5.5 comparing the results obtained without and withUPFC it is observed that, the major change in power flow occurred in UPFC connected line andthe major change in bus voltage occurred at UPFC sending end bus. The power flow in thedevice connected line increases from 6.6MW to 9.81MW and the voltage at UPFC connected busincreases from 0.9841p.u to 1.001p.u.From Table 5.5, it is observed that the voltages and powerflows are same for both methods, but number of iterations required for convergence in VSBmodel is more.

From Table 5.3 and Table 5.5 it is observed that the power flows in the device connected lineincreases further when compared with SSSC. This is because of the increase in the bus voltage inaddition to the series compensation provided because of series device.From the above section we can conclude by placing the devices namely SSSC, STATCOM

and UPFC in the system, the power flow increases when SSSC is placed in the line, the busvoltages increases at device connected bus when STATCOM is placed and when UPFC is placedin the system because of the presence of both series branch and shunt branch both power flow inthe device connected line and voltage at device connected buses increases.

Also it is observed that by modelling the FACTS controllers with CBM modelling the numberof iterations required for convergence is less when compared with VSB model. From Chapter 2 itis observed that modelling of FACTS controllers is less complex with CBM when comparedwith VSB. Thus finally we can conclude that modelling of FACTS controllers using CBM is bestwhen compared with VSB modelling.

VIII. CONCLUSION AND FUTURE WORK

In this paper, SSSC, STATCOM, UPFC are modeled using two methods i.e. VSB methodand CBM method. Comparing these two methods it is observed that CBM is better than VSB.N-R load flow with SSSC, STATCOM, UPFC have been performed.In this paper, N-R load flow for three-phase power system is performed and three-

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.542

|| Volume 9, Issue 12, December 2021 ||

| DOI: 10.15680/IJIRCCE.2021.0912015 |

phasemodeling of SSSC, STATCOM, UPFC by using CBM is done. N-R load flow for three-phasepower system with SSSC, STATCOM, UPFC have been performed.In this paper, a controlled operation for SSSC, STATCOM,UPFC is also performed. WithSSSC, by using this controlled operation, the active power flow in the three-phase line wascontrolled. With STATCOM by using this controlled operation, the bus voltage is controlled.With UPFC, by using this controlled operation, the active and reactive power flows in the threephaseline, voltage at bus have been controlled.

The effect of SSSC,STATCOM,UPFC on IEEE 5bus system can be done. Finally UPFC is proved as a better FACTS controller to improve the activepower flow in the line and voltage at bus compared to SSSC,STATCOM.

REFERENCES

1. Acha E, Fuerte-Esquivel CR, Amirez-Perez H, Angeles-Camacho C. FACTS –modelling and simulation in power networks. John Wiley & Sons; 2004.
2. Zhang X-P, Rehtanz C, Pal B. Flexible AC transmission systems: modelling and538 control. Springer; 2006.
3. Vinkovic A, Mihalic R. A current-based model of the static synchronous series compensator (SSSC) for Newton–Raphon power flow. Elect Power Syst Res 2008;78(10):1806–13.
4. Vinkovic A, Mihalic R. A current-based model of an IPFC for Newton–Raphon power flow. Elect Power Syst Res 2009;79(8):1247–54.
5. Vinkovic A, Mihalic R. A universal method for the modeling of the 2nd generation FACTS devices in Newton–Raphson power flow. Int J Elect Power Energy Syst 2011;33(10):1631–7.
6. Wasley RG, Shlash MA. Newton–Raphson algorithm for 3-phase load flow. Proc IEE 1974;121(7):630–8.
7. Arrillaga J, Harker BJ. Fast decoupled three-phase load flow. Proc IEE 1978;125(8):734–40.
8. Harker BJ, Arrillaga J. 3-Phase a.c./d.c. load flow. Proc IEE 1979;126(12): 1275–81.
9. Quintela FR, Arevalo JMG, Redondo RC, Melchor NR. Four-wire three-phase load balancing with static VAr compensators. Int J Elect Power Energy Syst 2011;33(3):562–8.
10. TavakoliBina M, Kashefi A. Three-phase unbalance of distribution systems: complementary analysis and experimental case study. Int J Elect Power Energy Syst 2011;33(4):817–826..

INNO SPACE
SJIF Scientific Journal Impact Factor
Impact Factor: 7.542

doi crossref

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

निस्केयर NISCAIR

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING