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“Power Flow Control in Power System Using UPFC"

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ABSRACT:- Unified Power Flow Controller (UPFC) is used to control the power flow in the transmission systems by controlling the impedance, voltage magnitude and phase angle. This controller offers advantages in terms of static and dynamic operation of the power system. It also bringsin new challenges in power electronics and power system design. FACTS controllers can be introduced to the power system toregulate terminal voltage and to improve system’s stability and power quality.

Keywords: FACTS, power transmission, three phasesystems, transmission of electrical energy

I. INTRODUCTION:-

The power transmitted over an ac transmission line is a function of the line impedance, themagnitude of sending-end and receiving-end voltages, and the phase angle between thesevoltages. Traditional techniques of reactive line compensation and step-like voltageadjustment are generally used to alter these parameters to achieve power transmissioncontrol. Fixed and mechanically shunt and series reactive compensation are employed tomodify the natural impedance characteristics of transmission lines in order to establish the desired effective impedance between the sending and receiving-ends to meet power transmission requirements. Voltage regulating and phase shifting transformers with mechanical tap-changing gears are used to minimize voltage variation and control power flow. These conventional method provide adequate control under steady-state and slowlychanging system conditions, but are largely ineffective in handling dynamic disturbances.

The traditional approach to contain dynamic problems is to establish generous stability margins enabling the system to recover from faults, line and generator outages, and equipment failures. This approach, although reliable, generally results in a significant under utilization of the transmission system. As a result of recent environmental legislation, rights-of-way issues, construction cost increases, and deregulation policies, there is an increasingrecognition of the necessity to utilize existing transmission system assets to the maximumextent possible. To this end, electronically controlled, extremely fast reactive compensatorsand power flow controllers have been developed within the overall framework of the FACTSinitiative. These compensators and controllers either use conventional reactive components and tap-changing transformer arrangements with thyristor valves and control electronics or employ switching power converters, as synchronous voltage sources, which can internallygenerate reactive power for, and also exchange real power with, the ac system. The UnifiedPower Flow Controller (UPFC) is a member of this latter family of compensators and powerflow controllers which utilize the synchronous voltage source(SVS) concept for providing auniquely comprehensive capability for transmission system control. Within the framework oftraditional power transmission system concepts, the UPFC is able to control, simultaneouslyor selectively, all the parameters affecting power flow in the transmission line. Alternatively,it can provide the unique functional capability ofindependently controlling both the real and reactive power flow in the line. These basic capabilities make the Unified Power Flow Controller the most powerful device presently available for transmission system control. Centralized power generation system faces a shortage of main energy sources (fossil fuels).

Lenght of the transmission line is one of themain causes of electrical power losses.

Therefore, the emphasis on the integration of renewable energy systems to the grid, able to lead to energy efficiency and emission reduction. With the increase of the renewable energypenetration to the grid, power quality of the medium to low voltage power transmissionsystem is becoming a major area of interest. Most of the integration of renewable energysystems to the grid performedwith the aid of power electronic converters. The main purpose of the power electronicconverter is to integrate distributed generation to the grid power factor standards. However,high switching frequency inverter can inject additional harmonics to the system, creatingmajor power quality problems if not carried out correctly.

II. OBJECTIVES:-

This project will be implemented based on the main objectives as expressed below:

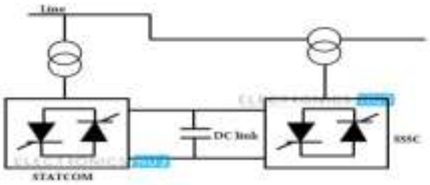
- factor correction through continuous voltage injection and in

combination with a properly structured controller.

- Load balancing in interconnected distribution networks.
- To cover the capacitive and reactive power demand.
- Power flow control.
- Reducing harmonic distortion by active filtering.
- Supply of desired electric power without surpassing the transmission anddistribution thermal limit.
- In substantial Power System, security issues inflicting power disturbances andpower outages resulting to huge losses.
- New establishments of power stations and different services are exceptionallydetermined based on different factors basically on environmental andeconomic factors.
- Installing new transmission lines are very high priced and require lot of time.
- Design and simulation of an UPFC for the power system model by usingMATLAB/Simulink.
- Hardware implementation is done and adapt it to power system model in theuniversity Practical outputs is compared with simulation result and doing necessarychanges to get better outcome from it.
- End up with controllable UPFC for power system model to improve powerquality.

The Unified Power Flow Controller (UPFC):-

UPFC is the combination of STATCOM and SSSC which are coupled by via a common DClink. It can exhibit the characteristics of both SSSC with series voltage injection and STATCOM with shunt current injection, with added features.It has a unique ability to perform independent control of real and reactive power flow. Also, these can be controlled to provide concurrent reactive and real power series linecompensation without use of an external energy source.



the above UPFC, SSSC (or converter-2) injects a voltage with controllable magnitude andphase angle in series with the line though a series transformer. The function of STATCOM(or converter-1) is to absorb or supply the reactive power demanded by SSSC at the common DC link.

III. UPFC WORKING:-

In the presently used practical implementation, the UPFC consists of two voltage-.sourcedconverters, as illustrated in Figure. These back-to-back converters, label"Converte1" and" Converter 2" in the figure, are operated from a common de linkprovided by a destorage capacitor. As indicated before, this arrangement functions as an ideal acto-ac power converter in which the real power can freely flow in either directionbetween the ac terminalsof the two converters, and each converter can independently generate reactive power at itsown ac output terminal. Converter 2 provides the main function of the UPFC by injecting a voltage Vpq with controllable magnitude Vpq and phase angle p in series with the line via aninsertion transformer. This injected voltage acts essentially as a synchronous ac voltagesource. The transmission line current flows through this voltage source resulting in reactiveand real power exchange between it and the ac system. The reactive power exchanged at theac terminal is generated internally by the converter. The real power exchanged at the ac terminal is converted into de power which appears at the de link as a positive or negative realpower demand. The basic function of Converter 1 is to supply or absorb the real powerdemanded by Converter 2 at the common de link to support the real power exchange resulting from the series voltage injection. This de

link power demand of Converter 2 is convertedback to ac by Converter 1 and coupled to the transmission line bus via a shunt connectedtransformer. In addition to the real power need of Converter 2, Converter 1 can also generateor absorb controllable reactive power, if it is desired, and thereby provide independent shuntreactive compensation for the line. It is important to note that whereas there is a closed directpath for the real power negotiated by the action of series voltage injection through Converters1 and 2 back to the line, the corresponding reactive power exchanged and therefore does notmagnitude of the injected series voltage is ramped, from 0.0094 to 0.1 pu. At 10 s, the angle of the injected voltage starts varying at a rate of 45 degree/s.Fig. 11 show the reactive power measured at bus B3 follow the reference values. At t=5 s, when the bypass breaker is opened the natural power is div-erted from the bypass breaker to the UPFC series branch with-out noticeable transient. The variations of active powers at bu-ses B1, B2, B4 and B5 is show in Fig. 12 and the variations of reactive powers at buses B1, B2, B4 and B5 is show in Fig. have to be transmitted by the line. Thus, Converter 1 can beoperated at a unity power factoror be controlled to have a reactive power exchange with the line independent of the reactivepower exchanged by Converter 2. Obviously, there can be no reactive power flow through the
UPFC de link.

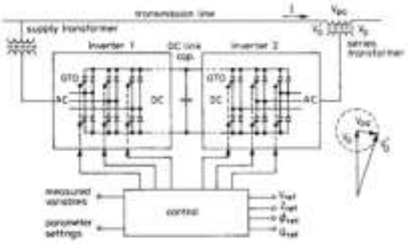


Fig.Unified Power Flow Controller

IV. SIMULATION:-

The test system and UPFC data are given in table I. The voltage generated by the series inverter is controlled by two external signals. The power regulator gains are KP=0.025 and KI=1.5. Maximum rate of change for reference active power and reactive power are 1 pu/s. Initially the bypass breaker is closed and the resulting natural power flow at bus B3 is 487 MW and -27 MVar. The blue numbers on the block diagram of the power system with UPFC in service, show the power flow with controlling the B3 active and reactive powers respectively at 587.1MW and -27 MVar. The trajectory of the UPFC reactive power as function of its active power, measured at bus B3 is show in Fig. The area located inside the ellipse represents the UPFC controllable region. For the first five seconds the PQ trajectory stays at the -27Mvar, 487 MW point (bypass breaker stays closed). The magnitude and phase of the injected series voltage are shown in Figs. When the breaker opens, the magnitude of the injected series voltage is ramped, from 0.0094 to 0.1 pu. At 10 s, the angle of the injected voltage starts varying at a rate of 45 degree/s.Fig. 11 show the reactive power measured at bus B3 follow the reference values. At t=5 s, when the bypass breaker is opened the natural power is div-erted from the bypass breaker to the UPFC series branch with-out noticeable transient. The variations of active powers at bu-ses B1, B2, B4 and B5 is show in Fig. and the variations of reactive powers at buses B1, B2, B4 and B5 is show in fig.

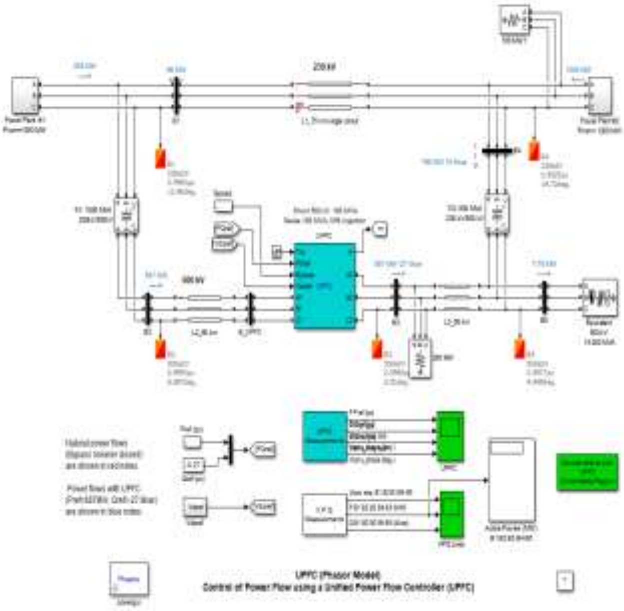


Fig.Simulation block diagram of the power system with a UPFC in MATLAB/Simulink.

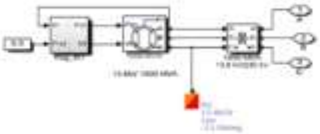


Fig.power plant 1in Matlab/Simulink.

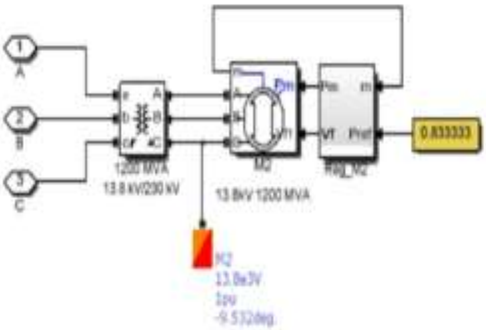


Fig.power plant 2 in Matlab/Simulink.

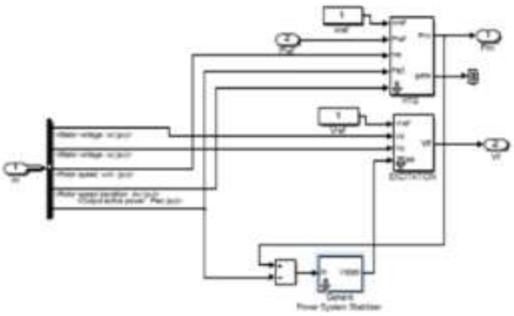
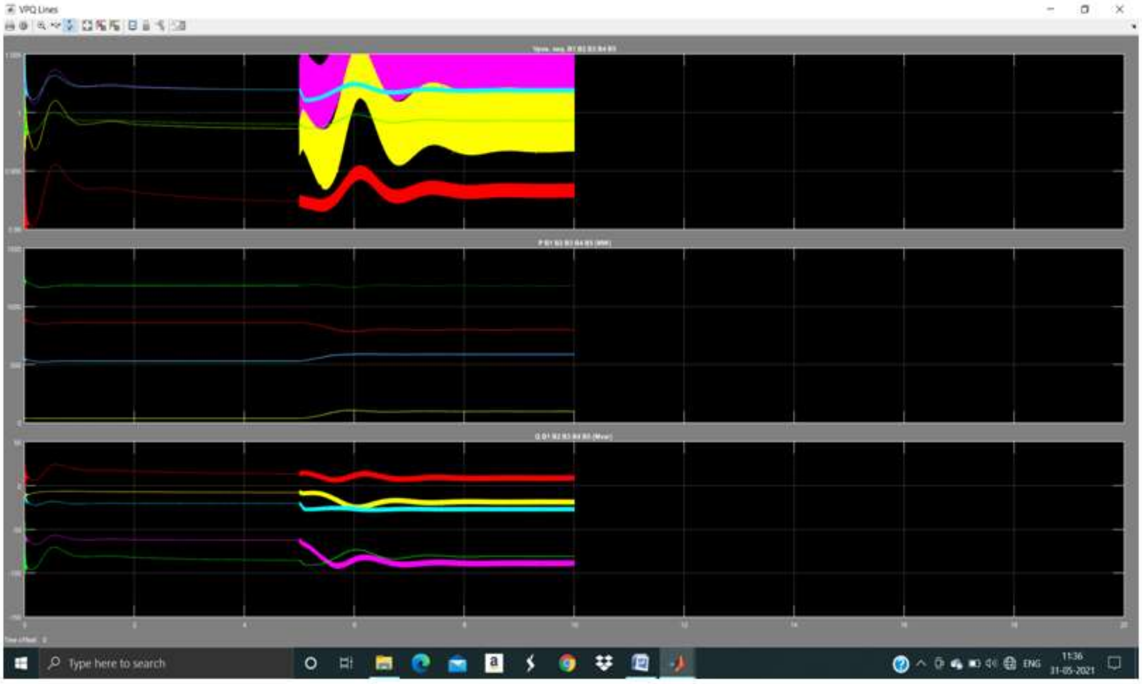


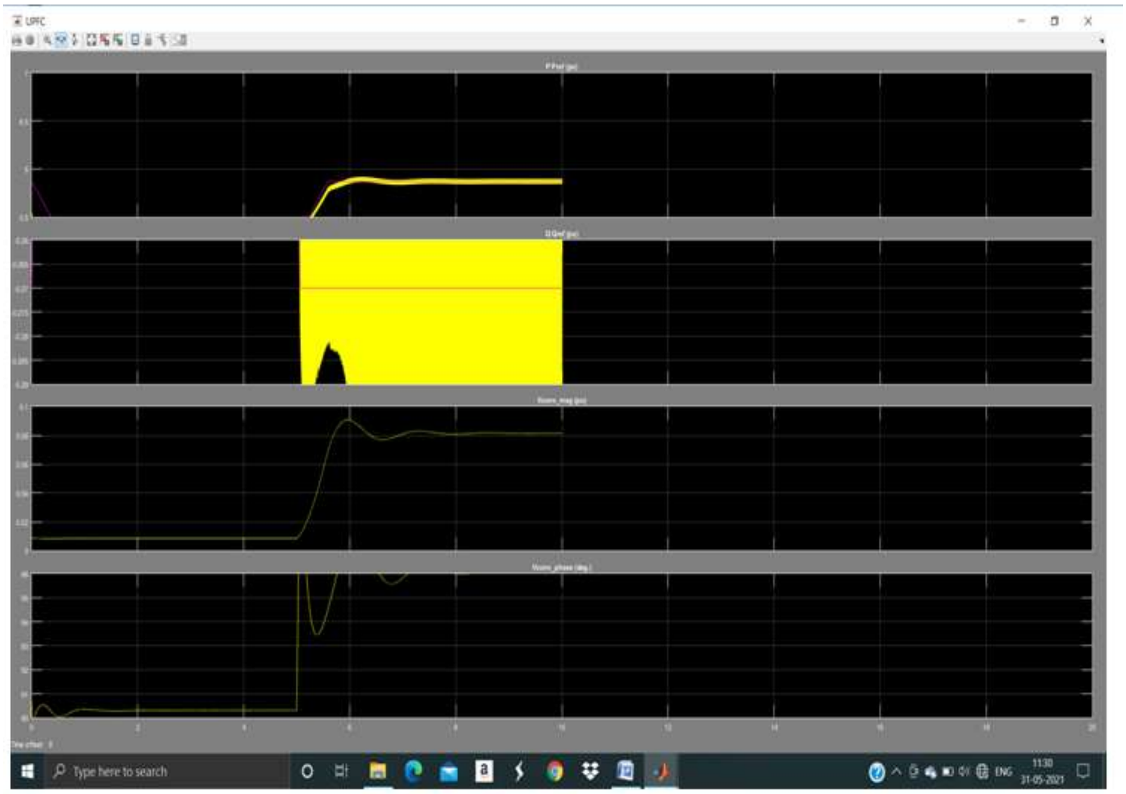
Fig. View inside the block

SYSTEM PARAMETERS

Comments	Value
UPFC	100 MVA
line L1	Single circuit, 230KV, 75Km
line L2	60Km, 500KV
line L3	60Km, 500KV
Transformer banks T1	1000MVA, 500KV/230KV
Transformer banks T2	800MVA, 500KV/230KV
Voltage buses B1 and B4	500KV
Voltage buses B2, B3 and B5	230KV
Load at bus B5	500KV, 15000MVA
Load at bus B3	500KV, 200MW
Load at power plant 2	230KV, 100MW
Power plant 1	13.8KV,1000MVA
Powerplant2	13.8KV,1200MVA

V. RESULTS:-





VI. CONCLUSION:-

A MATLAB-SIMULINK model was developed in this work for design and validation of UPFC control strategy for a UPFC located at a load substation using local measurements only. With this control approach, UPFC can perform independent control of transmittable real and reactive power at series output while regulating the shunt input voltage and maintaining the D.C. link capacitor voltage constant. The developed SIMULINK model was used to arrive at satisfactory control gain settings in various parts of the UPFC controller. Detailed simulation of UPFC system with bus voltage, UPFC second port voltage and line power flow control was carried out using the developed SIMULINK model for various cases involving load switching, step change in voltage reference and power flow references. Real, reactive power, and voltage balance of the UPFC system are analyzed. The basic control strategy is such that the shunt converter of the UPFC controls the transmission-line reactive power and the dc-link voltage. The series converter controls the transmission- line real power flow and the UPFC bus voltage. The shunt converter provides all of the required reactive power during the power flow changes if the UPFC bus voltage is constant. The UPFC bus voltage can be controlled both from the sending side and from the receiving-end side.

REFERENCES:-

[1]. L. Gyugyi,"Direct power control of series converter of unified power-flow controller with three-level neutral point clamped converter",IEEE Trans. Power system., vol. 27, no. 12, December 2012.

[2]. L. Gyugyi, C. Schauder, S.Williams, T. Rietman, D. Torgerson, and A. Edris,"The unified power flow controller: A new approach to power transmission control",IEEE Trans. Power system,vol. 11, no. 2, pp. 221227, Mar. 1996.

[3]. A. R.Munoz and T. A. Lipo, "Control and analysis of a unified power flow controller" ,IEEE Trans. Power Electron., vol. 14, no. 4,