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Modelling of Transformerless Upfc Toimprovepower System Stability using Optimization Technique

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Abstract: ***Generally, power system faces the problem to transfer power from one system to another system without any fluctuations, with minimal of system losses. To overcome this problems, a flexible ac transmission system is implemented in this paper. In present scenario, facts devices are used to reduce the transmission losses for improving transmission capacity and also to improve the system capability. Unified Power Flow Controller plays a most prominent role in FACTS controller to improve the system stability. The structure of UPFC is combination of back-back converters with boosting and zigzag transformer. This type of UPFC system consists of high losses due to presence of magnetic properties in this transformer. With this, a transformer-less multilevel inverter based UPFC topology is proposed in this paper. This paper focuses on the modulation of transformerless UPFC with PSO, which controlsfundamental frequency for better controlling of active and reactive power, harmonic minimization, and improvement in efficiency of system by controlling DC link voltage.***

Keywords: UPFC, Power System Stability, PSO technique, Harmonic Distortion factor.

I. INTRODUCTION:

As the demand of electrical power is increases rapidly and effects the transmission system expansion and generation of plants is restricted, this mainly causes the stability limits in power system. And also, the interconnection between the power systems in remote areas causes the oscillations in low frequency. If these oscillations are not damped well, it will effects the system conditional parameters. In last decades, PSS have been used to damp the frequency transients in system. These stabilizers effectively reduce the oscillations, but it effects the system parameters and unable to suppress the oscillations obtained by severe disturbances. To overcome these situation FACTS controllers have been proposed. As FACTS controller shows a better result for improving the system performance in steady-state conditions [1].

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Out of all controllers, unified power flow controller is the most promising device and has an ability to control three parameters of transmission system i.e line voltage, line impedance and phase angle between the two phases. This can be obtained by control of in-phase voltage, quadrature voltage and shunt compensation. A number of control strategies have been proposed to damp the oscillations.In these a single controller uniquely controls all the transmission parameters namely bus voltage, impedance and phase angle. This controller is also called as series-shunt controller or unified power flow controller.Huang et al. [2] proposed a controller based on lag-lead compensator for UPFC installed in the tie line of a multi-area system for damping the inter-area mode of oscillation. In this paper, a new control strategy i.e Partical swarm optimization technique proposed. This technique is used to select the control signal which is most suitable for damping the oscillations.

II. PROPOSED SYSTEM CONFIGURATION:

UPFC is one of the controller in facts family, which is used to improve the power systemtransfer capability. The block diagram of UPFC system is shown in figure 1. It is combination of two converters separated by a common DC link voltage [3]. The shunt controller is used to mitigate the problems in current by controlling the DC-link voltage. The purpose of series converter is used to control the bus voltage with controlling grid and bus reference voltages.

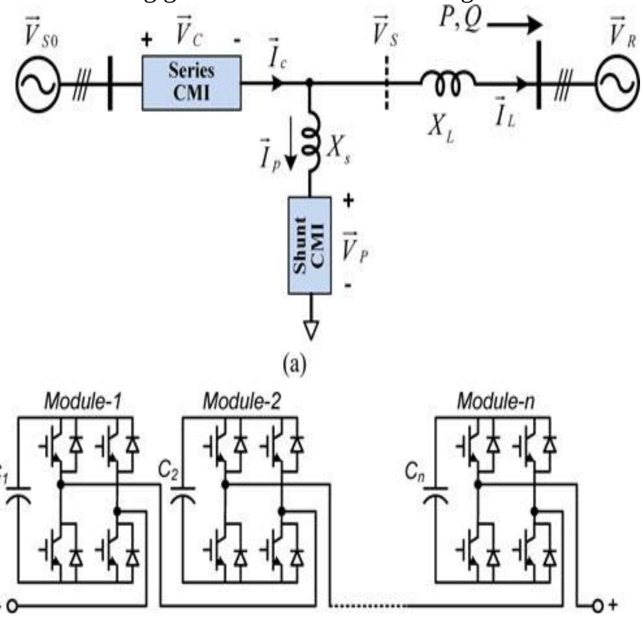

Figure 1: Structure of transformer lessUPFC

CONTROL DIAGRAMS FOR CONVERTERS OF UPFC:

In the present scenario, the transmission systems mainly effects due to increasing of day by day demands in electrical utilization and usage of different loads such as non-linear and commercial appliances. These mainly causes the changes in system voltages (such as sag, swell, harmonics), harmonics in current. For compensating these problems a custom power device is proposed in this paper. The main components in this system is compensating element and a three phase converter for controlling the compensator [4].A shunt converter is a one of the repaid hardware which is associated at the transmission framework. This shunt repaid framework has the capacity of either assimilate or produce dynamic power at the purpose of association subsequently controlling the voltage extent. Since the transport voltage extent must be fluctuated inside specific breaking points, controlling the power stream along these lines is constrained and shunt converter primarily fill different needs. A gadget that is associated in arrangement with the transmission line is alluded to as an 'arrangement gadget'. Arrangement gadgets impact the impedance of transmission lines. The guideline is to change (decrease or increment) the line impedance by embeddings a reactor or capacitor.

The dc link capacitor also acts as compensation device which helps to control the transmission line parameters i.e impedance, voltage, power factor and load angle.

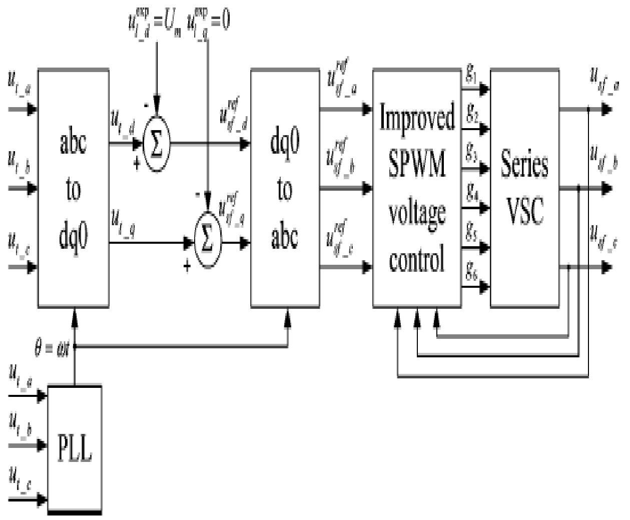

Figure 2: Control diagram for Series converter for UPFC

The series controller shown in above figure is used to compensate voltage interruptions like sag/swell or harmonics. In series converter the gate signals required for three phase VSC is obtained by using PWM technique. The PWM technique is operated by comparison of carrier and reference signal. In series controller [5], the reference signal is generated by using PCC and Dc link voltages. This controller consists of two loop namely, inner loop which acts as a DC link controller and the outer loop which control the pcc voltages which helps to compensates voltage distortions.

UPFC SHUNT CONVERTER CONTROL STRUCTURE:

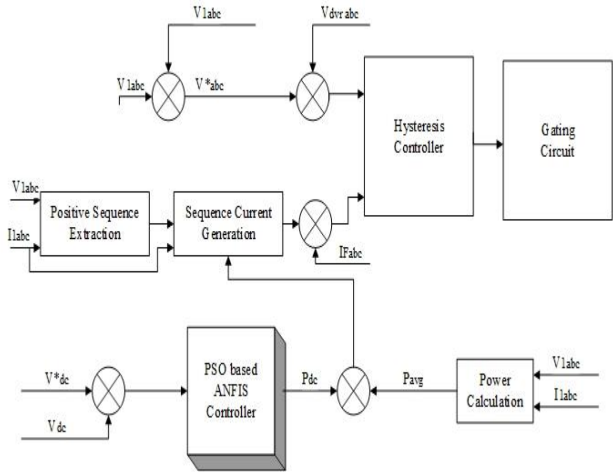

Figure 3: Closed loop control Diagram for shunt converter.

Shunt converter in UPQC is used to compensate the harmonics in current and for controlling the load current. The three phase shunt converter is operated/controlled by a three phase hysteresis controller. The reference signals required for the shunt converter is generated by using PCC signals and dc link voltage. In the inner loop of shunt converter the reference current is generated by controlling DC link voltage and actual current is obtained from the PCC current signals in the outer loop [6]. The closed loop control diagram of shunt converter is shown in figure 3.

PARTICAL SWARM OPTIMIZATION TECHNIQUE:

PSO is a nature-motivated and worldwide improvement calculation, created by Kennedy and Eberhard [7]. It is roused by the social conduct of winged creature and fish swarms. The looking through begins from a gathering of starting in the issue space so as to expand the likelihood of finding the ideal answer for the issue. The population is designed by N_P individual's particles, being every molecule a conceivable answer for the issue. The following position of every molecule is administered by this following condition which relies upon the last position in addition to a refreshed speed.

$$x(i) = x(i) + \Delta x(i)_k ; i = 1 : n_p$$

The speed term has two attributes: investigate different districts of the hunt space and permits getting away from nearby optima. The outflow of the refreshed speed is

$$\Delta x(i)_{k+1} = \omega \Delta x(i)_k + \rho_i (x_{pbest}(i) - x(i)) + \rho_2 (x_{gbest} - x(i)$$

Where $\Delta x(i)_{k+1}$ is acts as Partical velocity which is a function of weight matrix w and previous velocity of Partical [8]-[9].

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ANALYSIS OF PSO TECHNIQUE:

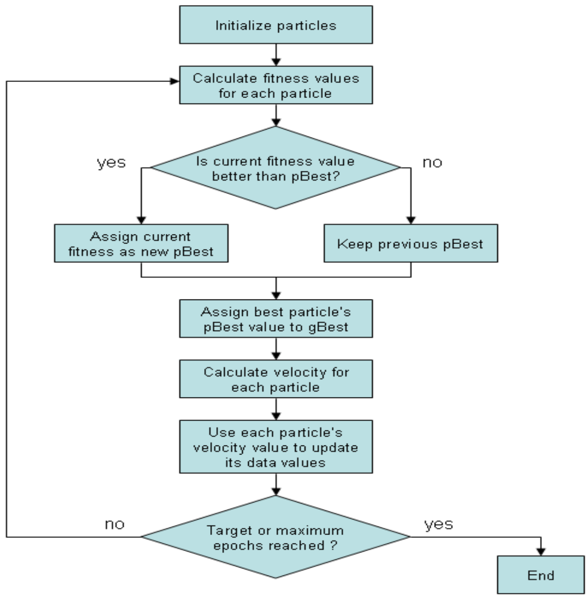

Figure4: Algoritham for PSO Optimization

SIMULATION RESULTS:

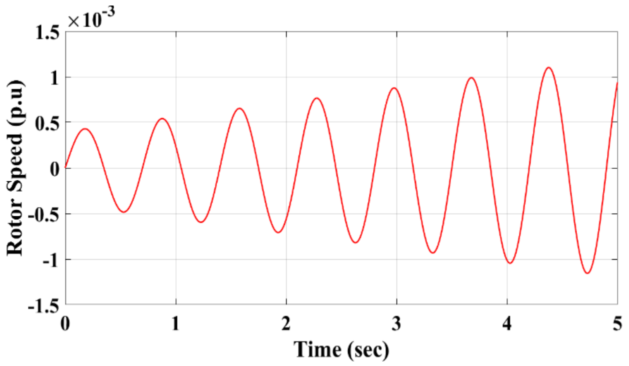

Figure 5:Experimental Waveform for Speed of Rotor in SMIB without controller

The experimental results for proposed SMIB system without any controller is shown in above. From these results the rotor speed and rotor angle has consists of more oscillations. The waveforms for rotor speed and angle are shown in figure 5 and figure 6.

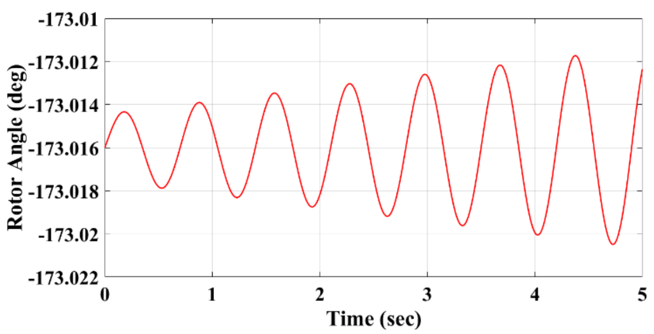

Figure 6:Experimental Waveform for Angle of Rotor in SMIB without controller

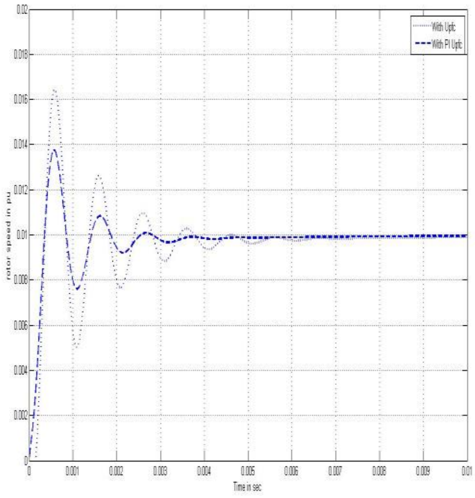

Figure 7:Experimental Waveform for Speed of Rotor in SMIB UPFC-PI controller

The experimental results for proposed SMIB system PI based UPFC controller is shown. The oscillations in the SMIB system is reduced by controlling system parameters. The damped waveform for rotor speed and angle are shown in figure 7 and figure 8.

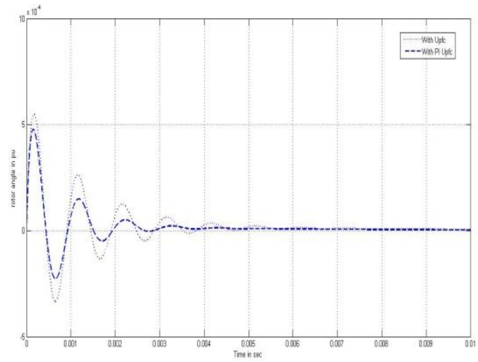

Figure 8:Experimental Waveform for Angle of Rotor in SMIB UPFC-PI controller

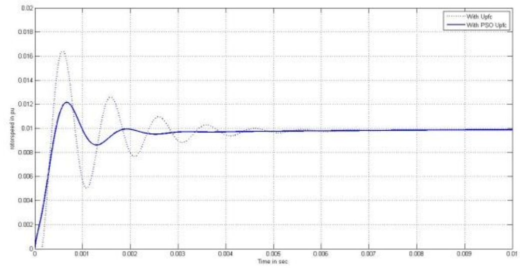

Figure 9:Experimental Waveform for Speed of Rotor in SMIB UPFC-PSO controller

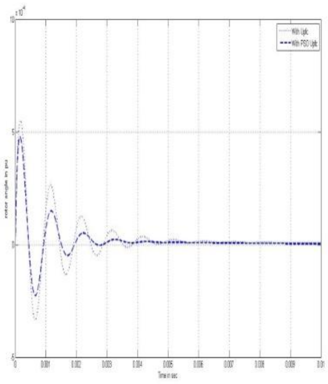

Figure 10: Experimental Waveform for Angel of Rotor in SMIB UPFC-PSO controller

CONCLUSION:

This paper proposes stability improvement i.e damping of oscillations, voltage level and controlling of reactive power in a proposed system using UPFC controller with different control strategies. In this, the UPFC controller is implemeted with partical swarm optimization technique to imrpove stability. PSO optimization technique is used to search the parameter controller settings that minimizes the non-linear time domain function.The proposed system has sucessfully implemented and verified using MATLAB/SIMULINK environment. From that results, the proposed PSO based UPFC controller provides the better damping action as compared with other controllers.

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