UPFC-ASSISTED POWER FLOW IMPROVEMENT IN THE TRANSMISSION LINE

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ABSTRACT: In this paper, we describe a new real- and reactive-power coordination controller for a UPFC. The series converter of the UPFC regulates the actual and reactive power flows along the transmission line. In comparison to the DC link capacitor, the shunt converter controls not only its own voltage but also the UPFC bus voltage and the shunt reactive power. The UPFC's shunt converter provides the steady-state real power required by the series converter. To prevent DC link capacitor voltage instability and shortage during rapid changes, a novel real power coordination controller has been developed. UPFC requires reactive power coordination since the shunt converter is connected to the transit voltage. A new reactive power coordination controller has been developed to reduce voltage variations during power exchanges. The Matlab simulations below demonstrate how the recommended controller for coordinating real and reactive power improves the performance of the UPFC controller.

Keywords: FACTS, Unified Power Flow Controller (UPFC), CoordinationController

1. INTRODUCTION

The Unified Power Flow Controller (UPFC) is one of the most often utilized FACTs controls. Its primary function is to control the voltage, phase angle, and resistance of the power system. It also regulates the line reactance and power transfer of the transmission line. The UPFC contains two Voltage Source Inverters (VSIs). They are linked to the power supply via coupling transformers and share a dc storage capacitor.

Two cables are used to connect the transmission tools. A series transformer connects it to the first transformer, and a shunt transformer connects it to the second transformer. By connecting a three-phase system voltage in series with the transmission line, two types of power flows can be managed. You can control the phase angle (Vc) as well as the size of this voltage.

This inverter will then switch between active and reactive energy. The shunt inverter is configured to maintain a constant voltage (Vdc) across the storage capacitor and to request either positive or negative terminal dc power from the line. As a result, the losses of the inverter and transformer are equivalent to the UPFC's net real power draw from the line.

Using the excess capacity of the shunt inverter, reactive power can be switched with the line to maintain the voltage stable at the connection point.By isolating the two VSIs' DC wires, they can operate independently. The shunt converter, also known as a STATCOM, regulates the voltage at the link point by adding or subtracting reactive power. The series converter (SSSC) generates or consumes reactive power to control the flow of energy and current in the transmission line. The UPFC can function in a variety of ways.

VAR Control Mode

The control system always preserves the regular input, which is a variable request, regardless of the bus voltage.

Automatic Voltage Control Mode

It is simple to adjust the reactive current of the shunt inverter so that the transmission line voltage at the connecting point maintains a constant reference number and slope. The slope factor indicates how precise the voltage is per unit of reactive current in the current range of the inverter.

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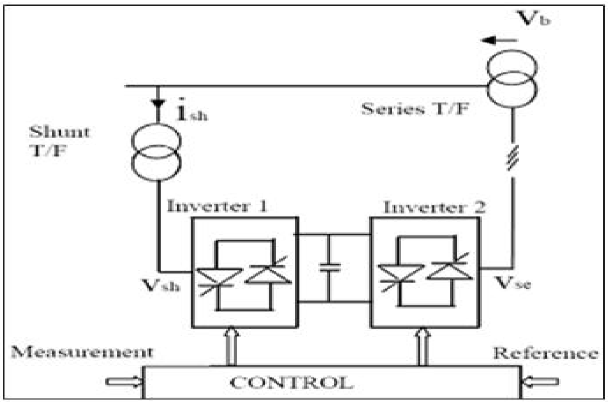

Fig.1: A UPFC is installed in a power line.

A critical component of the system is the shunt converter, which increases the controlled current of the transmission line. Figure 1 depicts the connection between the phone line and the (UPFC).

2. CONTROLSTRATEGYFORUPFC

Shunt Converter Control Strategy

We are discussing shunt reactive power. The UPFC shunt converter regulates the dc link capacitor voltage as well as the UPFC bus voltage. The shunt converter's power is now divided in half. Some areas of the UPFC bus have voltages that are out of phase with one another, while others have voltages that are in phase with one another. A decoupled control method was utilized to control both the dc link capacitor and the UPFC bus voltage at the same time.

Series Converter Control Strategy

When connected in series, the UPFC controls both the active and reactive power flows in the transmission line. This is accomplished by dividing the energy sent by the series converter into two pieces. The voltage introduced in series has two components: one that is in phase with the UPFC bus voltage and one that is out of phase. The transmission line is notified how much power to provide via the quadrature-inserted component. In many ways, this method is similar to a phase changer. This component regulates the movement of responding power along the transmission line. It's the same as changing the faucets.

Shunt Converter Control System

Figure 2 depicts the disconnected control approach for the shunt converter. This system regulates the dc link capacitor voltage, as well as the shunt reactive power and UPFC bus voltage.

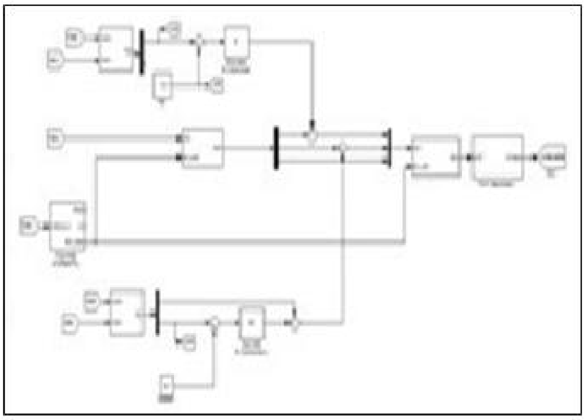

Fig.2: A Series Coordination Manager

The disconnected control system was created utilizing linear control system concepts. The outside loop control system assists the inner loop control system in determining what to do. The computer system keeps track of the reference in its loop.

Series Converter Control System

Figure 3 depicts the overall control of the series converter. The true flow of power along the transmission line (Pline) is managed by adding a quadrature of the series voltage (VseQ) to the UPFC bus voltage. When the bus voltage reference on the transmission line side is changed, the Qline reactive power on the line changes. By adding a portion of the series voltage that is in phase with the UPFC bus voltage (VseD), the transmission line side bus voltage (VseD) is modified. The inner loop controller Kp is 0.15 and Ki is 25, whereas the outer loop controller Kp is -0.1 and Ki is -1.

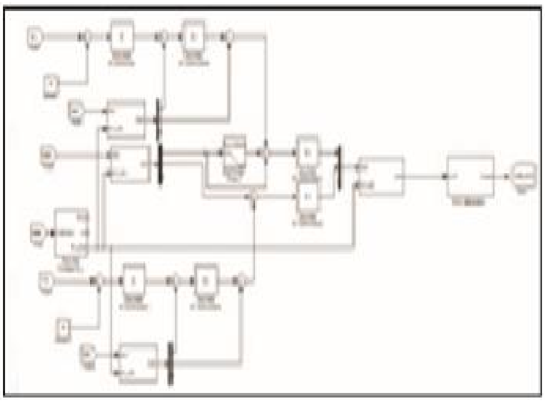

Fig.3: Shunt Configuration Modification

3. PROPOSE DFRAME WORK

Figure 4 illustrates a communication connection that connects a Unified Power Flow Controller (UPFC). The provided visual representation

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portrays the process of constructing an authentic power coordinating unit for a Unified Power Flow Controller (UPFC). The real power between the series converter and the transmission line is altered by the interplay of the injected voltage in the series and the current flowing through the transmission line.

The magnitude of the direct current (DC) link capacitor voltage (Vdc) exhibits variability contingent upon the polarity of the electric current flowing through the series converter. The reason for this phenomenon might be attributed to the real power requirements (Pse) of the series converter. The shunt converter controller adjusts the shunt converter's real power deviation in accordance with variations in the voltage of the dc link capacitor. This brings it back to the intended level.

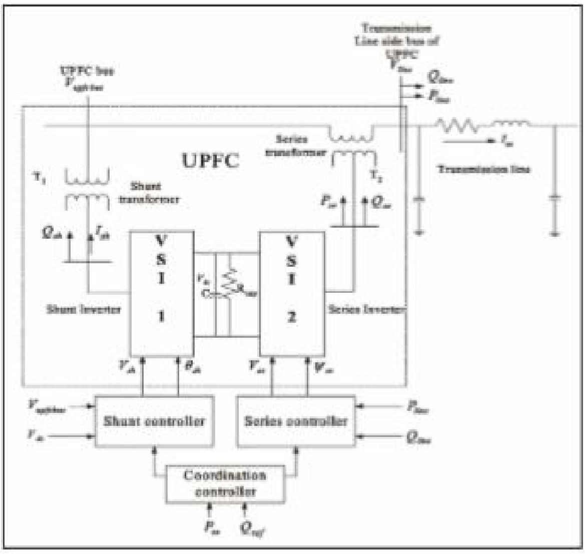

Fig. 4: A UPFC can be connected to a power line.

However, changing the voltage of the dc link capacitor is the best way for the shunt converter driver to determine how much power the sequence converter requires. As a result, the shunt and series conversion processes are performed in separate ways. So that the shunt and the sequence converter's control methods can perform well together, the sequence converter instructs the shunt converter's control method what to do. Based on how much power the series converter actually requires, a suggestion signal is generated.

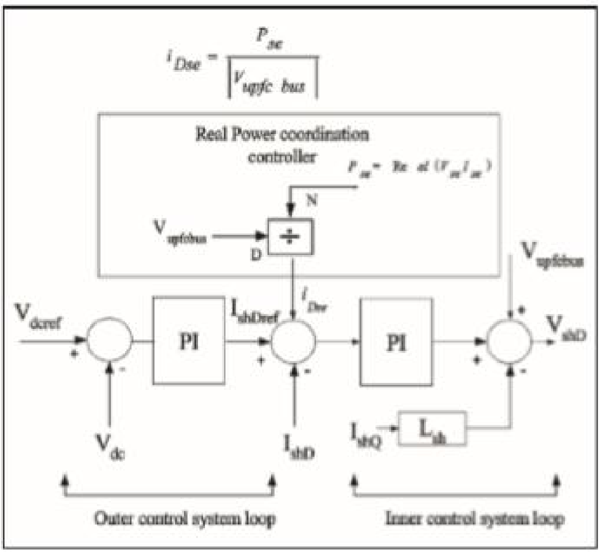

Fig.5: A real power coordination controller is used to handle a D-axis shunt converter.

Based on the amount of power used, the shunt converter has the same D-axis current as the sequence converter. As a result, the shunt converter quickly responds to changes in the D-axis current and provides the necessary power to the critical series converter. Figure 5 depicts the D-axis as an additional control input for the D-axis shunt converter.

4. RESULTS AND DISCUSSIONS

Figure 6 depicts the power flow as a single line across a 500 kV/230 kV transmission system. Three transmission lines (L1, L2, and L3) and two 500 kV/230 kV transformer banks (Tr1 and Tr2) are present. These lines connect five buses (numbered B1 through B5). The system has been disconnected. Two 230 kV power stations generate a total of 1500 MW (Figure 6). This energy is routed to a demand with a voltage of 500 kV and a capacity of 15,000 MVA-equivalent, which is connected to bus B3. Every type of plant has a power system stabilizer (PSS), an excitation system, and a speed control. MATLAB Simulink was used to create a line sketch.

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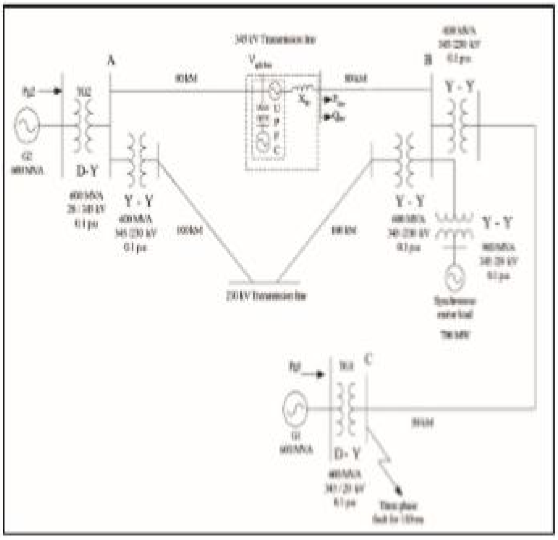

Fig.6: The UPFC method of supplying electricity

Figure 7 depicts the MATLAB Simulink model of the single-line transmission system with UPFC.

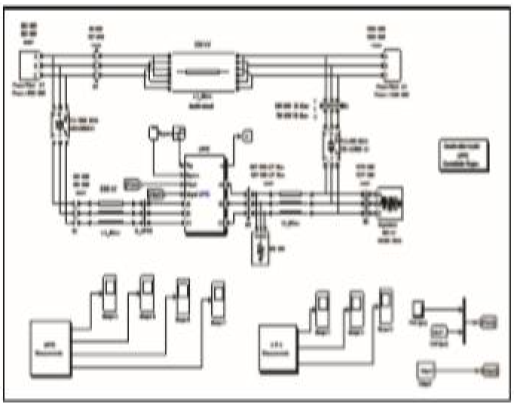

Fig.7: The Transmission Line Diagram Using a Single Line Model in MATLAB Simulink

When a (VSIs) is connected in series with the transmission line, it increases voltage to the PU. A series generator is utilized instead of UPFC. Remember that the Y-axis represents the voltage delivered in series to the PU, while the X-axis represents the time in seconds. Whether it has UPFC or not.

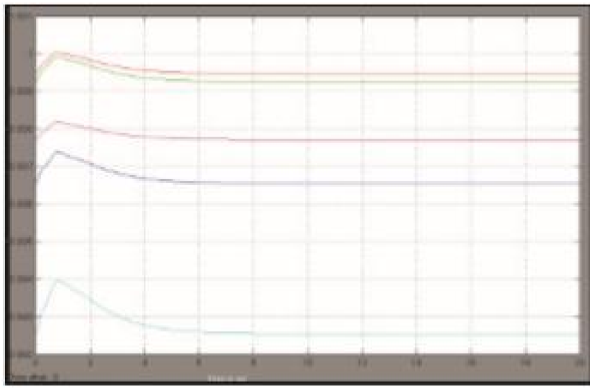

Fig.8: A simulation of what would have happened if UPFC had not been there.

A voltage was added to the PU series by connecting the VSIs in series with the transmission line via a series transformer.

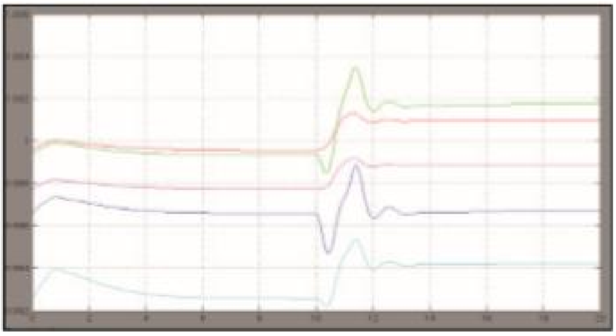

Fig.9 The following UPFC model

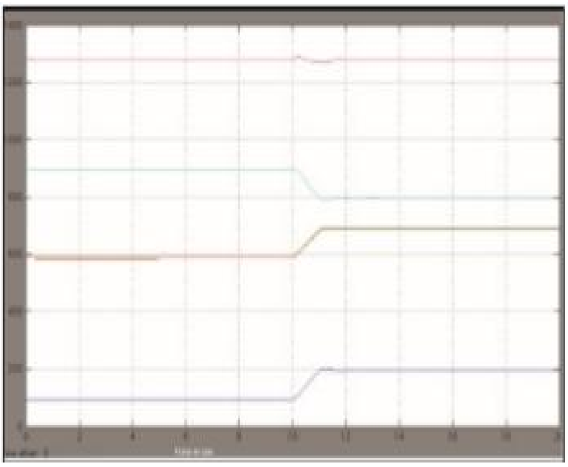

Fig.10 The following UPFC model

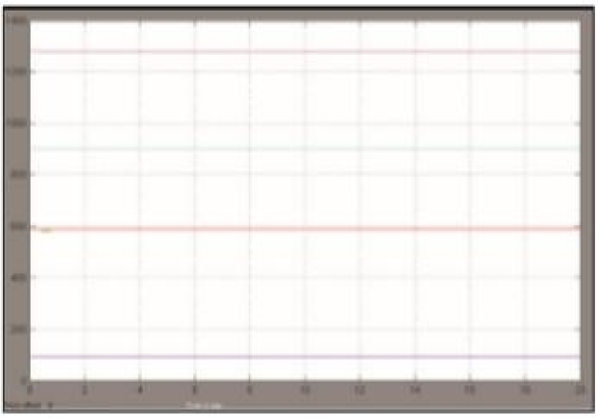

Fig.11: What the graph would look like if UPSC was not present.

The reactive power rates of transmission lines with and without UPFC are studied in this study. On the Y-axis, the response power is displayed in MVAR.

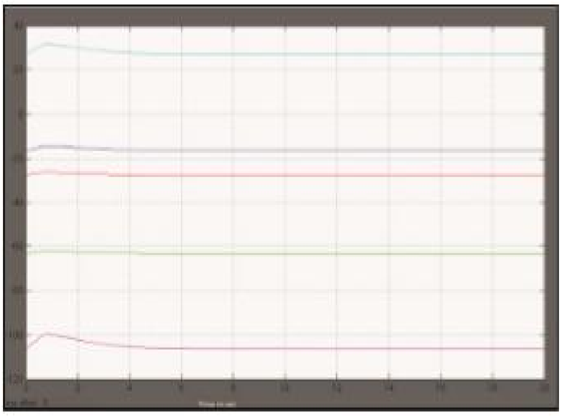

Fig. 12: A simulation of what would have happened if UPFC had not been there.

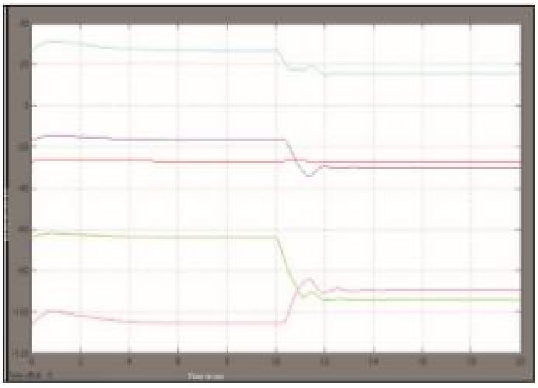

Fig.13 The following UPFC model

5. CONCLUSION

The transmission system's voltage level, phase angle, and line impedance must all remain constant. Matlab Simulink is utilized to model a UPFC coupled to a three-phase transmission system for this investigation. This research focuses at how to maintain and operate a UPFC, which is a device that generates more efficient energy. As the injection angle increases, so do the actual and reactive forces. The simulation data showed that the UPFC has excellent control over real and reactive powers. Because of UPFC, the transmission line's actual and response forces become stronger. The UPFC system has fewer maintenance costs and can manage both reactive and real power.

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