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# ENHANCED POWER TRANSFERIN A POWER GRID WITH FACTS DEVICES

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**Abstract**
Due to the revolution in technical developments, the electrical power business has faced numerous hurdles in recent years. It leads to an expansion in manufacturing and product-based businesses, resulting in a power demand that exceeds supply. There is a drop in efficiency for every unit of load that increases linearly with demand, hence efficiency is primarily influenced by two factors: damping and frequency oscillation.FACTS (Flexible AC Transmission System) technology is a concept that deals with active and reactive power control monitoring in order to improve the performance of electrical power system networks.
The operation of stable power system networks is approximated using Flexible AC Transmission Systems (FACTS) in this work. The Electric Power Research Institute (EPRI) created the Flexible AC Transmission System (FACTS) to effectively manage the flow of power utilising various power electronic devices. High-power electronicsa variety of thyristor devices, microelectronics,communications and complex control actions are the main components of FACTS technology.
Soft computing techniques such as Fuzzy, Genetic Algorithm, BAT algorithm, and Artificial Neural Network idea are used to verify the suggested system. It is also used to adjust the parameters of a multiline system that's connected to a grid and generates renewable energy. For the potential of a grid-connected power flow controller in a multi-line power system, a Simulink model is constructed and evaluated using soft computing techniques. The generated findings is compared to traditional approaches in order to improve performance parameters.
Keywords:FACTS (Flexible AC Transmission System), Damping and Frequency Oscillation,Electric Power Research Institute (EPRI)

**I. INTRODUCTION**The converter is stated to be an important component in an electrical power system because it converts electrical characteristics. The converter circuit accepts any type of electrical system as input, such as AC or DC, and outputs the same acceptable value regardless of voltage or current change. For efficient conversion and control, it is frequently used alongside devices such as inductors and capacitors. In general, the converter may have a variety of functions to deliver the output by modifying the input form. The converter is also used in some systems to explain the fluctuation in magnitude of a given voltage, as discussed by Cortés, P et al.all.A converter is an important component in most electronic equipment, including as computers, personnel devices, solar chargers, and so on. The converter is examined and analysed by the researchers in various ways. The power flow converter is given considerable attention in this study.

### 1.2Electronic Power Converters

Power Electronics are a more advanced type of electronic control system that can be used to switch over the procedure and control of electrical power. It isdeliver voltages and currents that are optimal for consumer loads, and it is utilised to switch over electrical power from one form (Source) to the next (Load). According to Kouro et al., it possesses the following characteristics: high effectiveness, most accessibility, highest quality, lowest cost, smallest size, and lightest weight.Three Phase Converter,the converter circuit is made up of semiconductor devices, and the number of semiconductor devices connected to the circuit determines the output level. Legs of the converter circuit are the lines that contain the static switches. The voltage or current value fed to the circuit as input may fluctuate. A three-level converter is an electronic device that converts Direct Current (DC) from a battery to Alternating Current (AC) and vice versa.

## 2. Facts Devices

Hingorani (1991) proposed the FACTS idea, which consisted of two generations: classic thyristor switched capacitors/quadrature tapchanging transformers and GTO-based controllers. The generation's schemes are used as Voltage Source Converters in such circumstances (VSC). The classification of conventional and FACTS devices is depicted in Figure 2, along with their generation kinds. The different classes are dependent on the type of operation. With strong static switches in shunt or series RLC transformers, the thyristor-controlled set-up manages the process with both capacitor and reactor.

Voltage Source Converter for Thyristor Valve Compensation for Switched Shunts FACTS Static VAR Compensator (Conventional) Compensator for Static Synchronous Events (STATCOM)
Series Capacitor with Thyristor Control (TCSC) Compensator for Static Synchronous Series (SSSC) Interline Power Flow Controller (IPFC) Interline Power Flow Controller (IPFC) Interline Power Flow Controller (IPFC) Interline Power Flow Compensation in a switched series Circuit for a phase shifting transformer Variable reactance approximations of the settling capacitor and reactor banks are observed by adjusting the ON and OFF periods of the thyristor switches. The self-commutated DC to AC converters and GTO thyristors in the FACTS controller, which is based on the VSC, can generate internal capacitive and inductive reactive power for the transmission line.

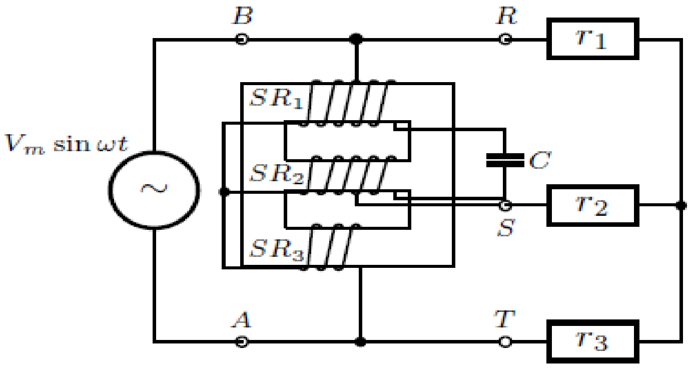


Fig 1. Three Phase Convertor

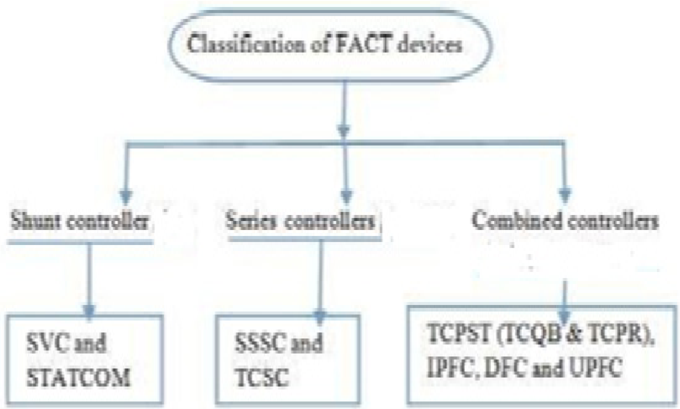


Fig. 2. Traditional Classification of FACTS

**3. Devices For Controlling Power Flow**

The expansion of worldwide power systems is caused by the constant improvement of power flow controlling equipment. When unexplained power streams are incorporated, driving the transmission network with a lot of strain becomes a problem. At the same time, a few grid congestion concerns pop up out of nowhere. Controlling power streams is one method for increasing the utilisation of the existing transmission network without constructing additional lines, but it is risky due to political, ecological, and social considerations. In this Paper, control stream regulating devices are swiftly gaining traction among power utilities and transmission network upgraders.
When new devices for congestion management in the transmission system are installed, the total number of external devices grow at a much faster rate than in the regular system, when compared to the traditional stability compensation scheme. This module's simultaneous functionality is based on a phenomenon known as controlled electrical power flows. The flow of electrical power is controlled by adjusting system parameters including system voltage magnitude, line impedance, and transmission angle.

**4. Power Electronic Device**

For the suggested simulation circuit, the power electronic device employed in the bridge circuit is chosen appropriately. Thyristors are the default device in the Simulink converter model. The selection of a switching function based on VSC results in a Voltage Source Converter type equivalent model, with two voltage sources on the AC side and a current source on the DC side replacing the switches. The suggested model induces the harmonics that are ordinarily created by the bridge by using the same firing pulses as the other power electronic components.
The average-model kind of Voltage Source Converter is used to denote the power-electronic switches if the nominal VSC (Voltage Source Converter) is selected. Unlike previous power electronic devices, the proposed model employs reference signals (uref), which represent the average voltages generated at the bridge circuit's ABC terminals. The harmonics are not represented in the suggested model. Larger sampling times can be used with the system while the average voltage dynamics are preserved. The power AC-DC-AC Converter, for example, is one example. This system uses a DC link system to represent a diode-based rectifier and an IGBT inverter using the Universal Bridge block in an AC/DC/AC converter.

**5. The Proposed System's Harmonics**

The following are the issues identified in the planned IPFC (Interline Power Flow Controller) components, as well as the type of the harmonics:

- Parallel / Series Resonance
- RMS / Peak Value Increase
- Source of Harmonics are displayed as follows
- Voltage source vs. Current source
- Static vs. Dynamic Standards on Harmonics with Harmonic Limits are
- Utility companies / Customers / Manufacturers
- IEC / IEEE

**5.1 IPFC'S Ideal Location**

It is required to find an appropriate place to install the suggested IPFC (Interline Power Flow Controller) in the planned grid connected power system in order to get the most value from it. The proposed IPFC is a multi-line FACTS controller that involves the installation of two distinct transmission lines with a common bus. The typical approach for determining the best placement is ineffective for determining where the controller should be placed. By adjusting the compensation mechanism utilising the Voltage Source Converter, the suggested simulated device is utilised to manage the real and reactive power flow in transmission lines (VSC).

**6. Forms of Output Waves**

The proposed system's output voltage ranges from 0.9 to 1 for all buses connected to the transmission line. The load imbalance in the transmission system is caused by a sudden change in load on any of the transmission lines. The load's usage of actual power grows, while the flow of unneeded reactive power between the lines increases rapidly.

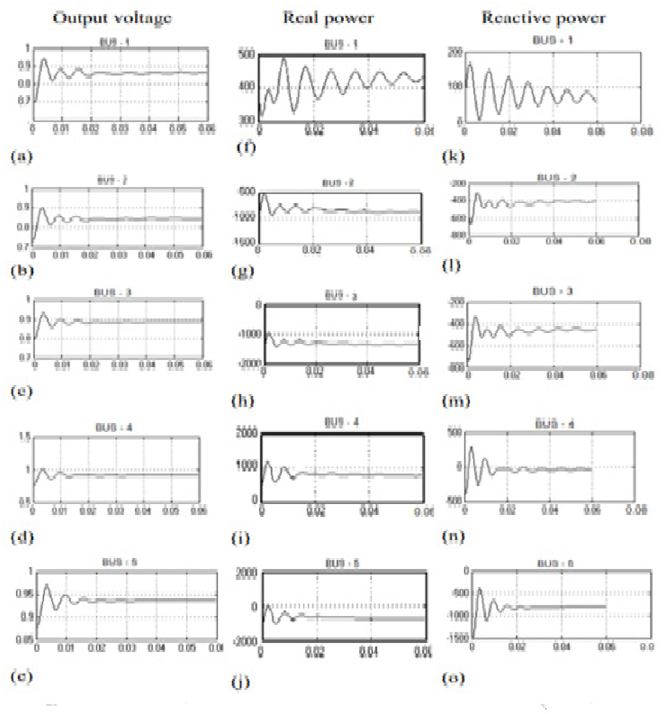


Fig. 3. Output Power real and reactive

Our proposed controller is employed to keep the grid linked system stable by absorbing reactive power and injecting actual power. The derived waveform from the proposed Simulink model shows that while the system is initially unstable and produces oscillations, it becomes stable over a period of time.

**6.1. Sub-System Output Wave Forms**

Figures 3,4 and 5demonstrate the output graphical representations of real and reactive power of systems with and without IPFC from the proposed Simulink module.

7. Conclusion

Control and dynamic adjustment for multiple transmission modules are required in real-time power electronics equipment. In such instances, the UPFC is used to address power transmission issues while supplying power. It's typically utilised to control and choose all of the parameters that influence power flow in transmission lines. The main drawback of the UPFC system is that it performs poorly in multiline power system control. This Paper proposes the IPFC (Interline Power Flow Controller) device for the execution of both operational dependability and financial profitability. In addition to compensated FACTS controllers, the entire literature research indicated the exact control unit for optimal usage and control of the current transmission system infrastructure.

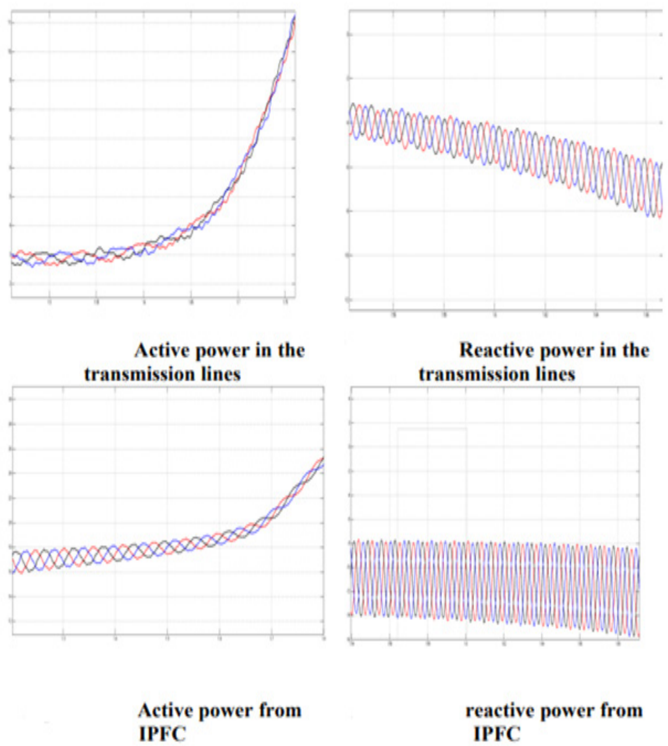


Fig. 4. Output Power

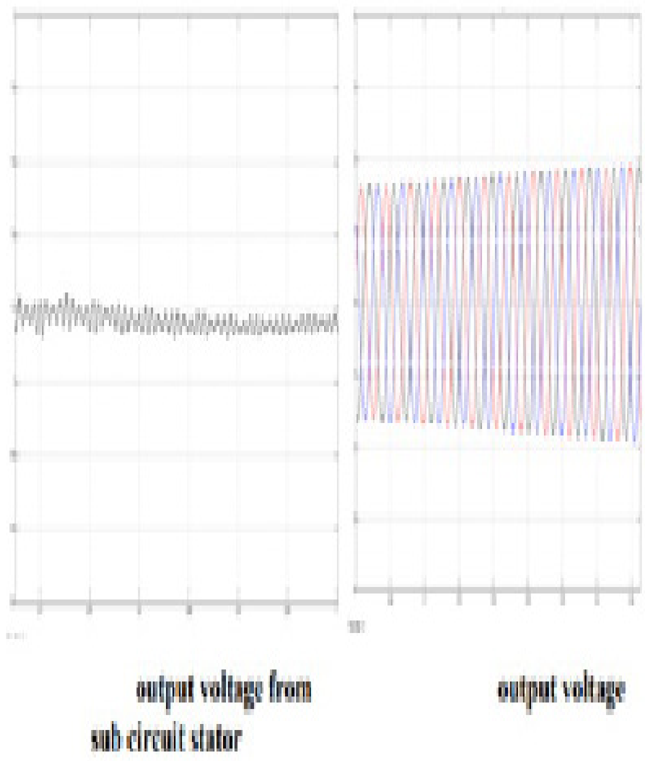


**Fig. 5. Output Power**

The Interline Power Flow Controller module, as well as the wind mill and solar-PV systems, were developed in response to the above-mentioned procedure. These units are connected to the utility grid as one of the power sources. The MATLAB Simulink model is used for testing and verification throughout this study. In order to preserve stability, the Simulink model is developed for a grid-connected system. IPFC is used in the grid to transfer real and reactive power between transmission lines, and it is tested using real-time, reactive-time, and output voltage waveforms for various loads.

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