Using Flexible AC Transmission System to Enhanced Power Transfer

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Abstract: The electrical power industry has encountered various challenges in recent years as a result of technological advancements. It causes manufacturing and product-based firms to expand, resulting in a power demand that surpasses supply. Because every unit of load that grows linearly with demand reduces efficiency, efficiency is largely impacted by two factors: damping and frequency oscillation. FACTS technology (Flexible AC Transmission System) is a concept that deals with active and reactive power control monitoring to improve the operation of electrical power system networks.

Flexible AC Transmission Systems (FACTS) are used to approximate the functioning of stable power system networks in this study. The Flexible AC Transmission System (FACTS) was developed by the Electric Electricity Research Institute (EPRI) to effectively regulate the flow of power using various power electronic devices. The key components of FACTS technology include high-power electronics, a variety of thyristor devices, microelectronics, communications, and complicated control actions.

To verify the proposed system, soft computing techniques such as Fuzzy, Genetic Algorithm, BAT algorithm, and Artificial Neural Network concept are employed. It's also utilized to fine-tune the settings of a grid-connected multiline system that creates renewable energy. A Simulink model is built and analyzed using soft computing approaches to assess the possibilities of a grid-connected power flow controller in a multi-line power system. The results were compared to established methods for improving performance characteristics.

IndexTerms: **FACTS (Flexible AC Transmission System), Damping and Frequency Oscillation, Electric Power Research Institute (EPRI)**

1. INTRODUCTION

Because it translates electrical properties, the converter is said to be a vital component in an electrical power system. The converter circuit accepts any type of electrical system, such as AC or DC, as an input and outputs the same acceptable value independent of voltage or current variation. It is widely used in conjunction with inductors and capacitors for effective conversion and control.[1] 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.. Most electrical equipment, including computers, personnel gadgets, solar chargers, and so on, includes a converter. The researchers investigate and assess the converter in a variety of methods. In this research, the power flow converter is given a lot of attention.

1.1Converters of Electronic Power

[2] The lines that contain the static switches are the converter circuit's legs. The voltage or current value delivered into the circuit as input might vary. An electrical device that converts Direct Current (DC) from a battery to Alternating Current (AC) and vice versa is known as a three-level converter.

2. Devices Facts

The FACTS concept was presented by Hingorani (1991), and is comprised of two generations: traditional thyristor switched capacitors/quadrature tap changing transformers and GTO-based controllers. In such cases, the generation's schemes are employed as Voltage Source Converters (VSC). Figure 2 shows the categorization of conventional and FACTS devices, as well as their generating types. The distinct classifications are determined by the operation type.

The thyristor-controlled set-up regulates the process with both capacitor and reactor using powerful static switches in shunt or series RLC transformers. Thyristor Valve Compensation with a Voltage Source Converter for Switched Shunts FACTS Compensator for Static Synchronous Events (Conventional) Static VAR Compensator (STATCOM)[3] Static Synchronous Series Capacitor with Thyristor Control (TCSC) Compensator (SSSC) Interline Power Flow Controller is a device that regulates the flow of electricity between two (IPFC) Interline Power Flow Controller is a device that regulates the flow of electricity between two (IPFC) Interline Power Flow Controller is a device that regulates the flow of electricity between two (IPFC) Compensation of interline power flow in a switched series A phase-shifting transformer's circuit By altering the ON and OFF durations of the thyristor switches, variable reactance approximations of the settling capacitor and reactor banks may be detected. The FACTS controller, which is based on the VSC, has self-commutated DC to AC converters and GTO thyristors that can create internal capacitive and inductive reactive power for the transmission line.

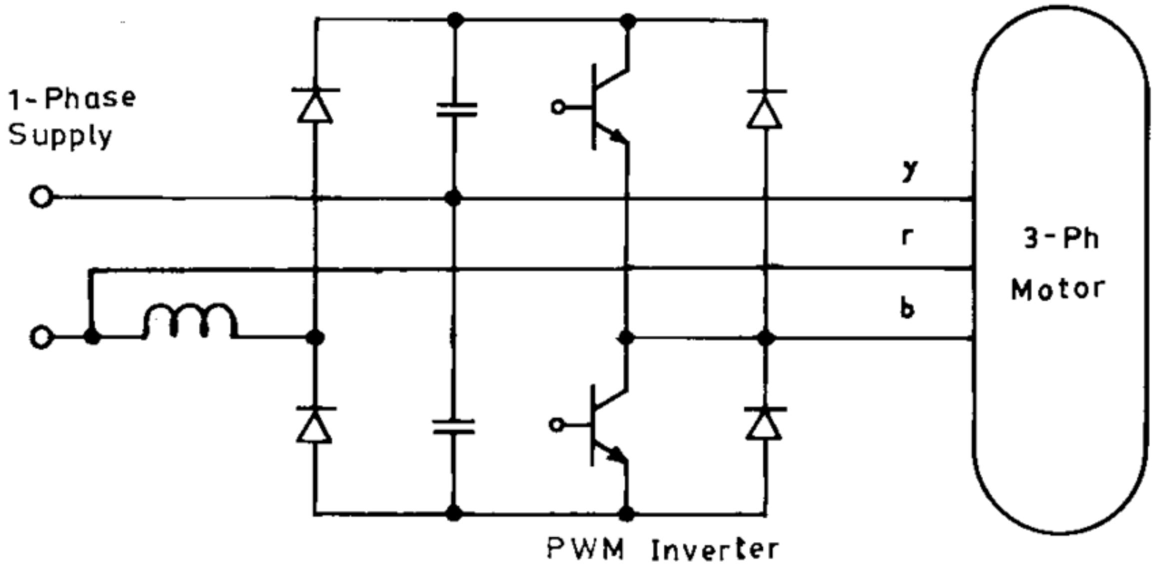

Fig 1. (a) Asymmetrical single-to-three-phase converter. (b) Modified asymmetrical phase converter.

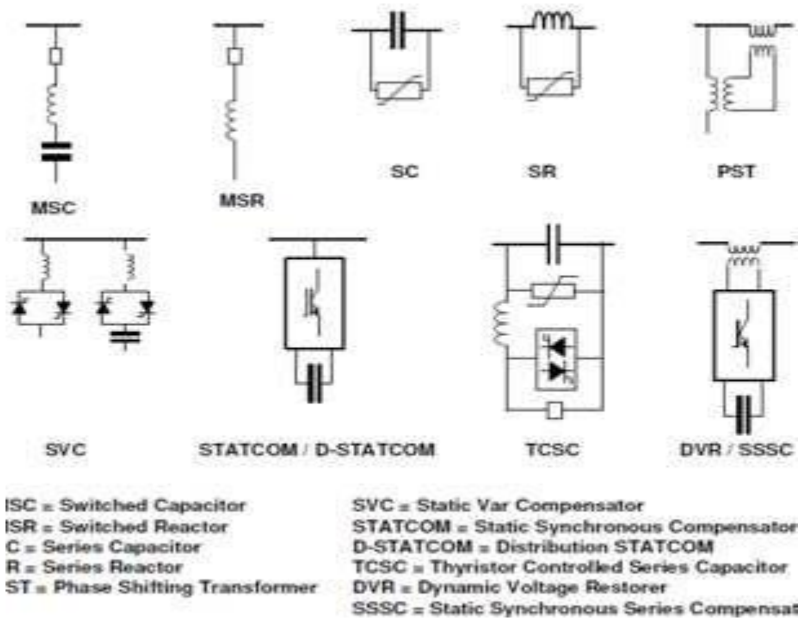

Fig. 2. Traditional Classification of FACTS

3. Controlling Power Flow Devices

The ongoing development of power flow regulating equipment is responsible for the expansion of global power systems. When unexplained power streams are included, putting a lot of demand on the transmission network becomes a concern.

Simultaneously, a few grid congestion worries emerge from nowhere. Controlling electricity streams is one approach for enhancing the usage of the current transmission network without having to build new lines, but it is dangerous owing to political, environmental, and social concerns. Control stream regulating devices are rapidly gaining favor among power utilities and transmission network modifications, according to this paper. [4]

In comparison to the typical stability compensation scheme, when additional devices for congestion management in the transmission system are added, the total number of external devices develops at a considerably quicker pace than in the normal system. The parallel functioning of this module is based on a phenomenon known as regulated electrical power flows. Adjusting system characteristics such as system voltage magnitude, line impedance, and transmission angle regulate the flow of electrical power.

4. Electronic Device with High Power

The power electronic component used in the bridge circuit in the recommended simulation circuit is chosen suitably. In the Simulink converter model, thyristors are the default device. A Voltage Source Converter type analogous model is created by selecting a switching function based on VSC, with two voltage sources on the AC side and a current source on the DC side substituting the switches. By employing the same firing pulses as the other power electronic components, the proposed model induces the harmonics that are normally formed by the bridge.

If the nominal VSC (Voltage Source Converter) is used, the average-model kind of Voltage Source Converter is utilized to signify the power-electronic switches. The suggested model, unlike earlier power electronic devices, uses reference signals (ref), which reflect the average voltages generated at the ABC terminals of the bridge circuit. [5] The harmonics aren't reflected in the model that's been proposed. The system may be employed with longer sample durations while maintaining the average voltage dynamics. One example is a high-capacity AC-DC-AC converter. In an AC/DC/AC converter, this method employs a DC link system to simulate a diode-based rectifier and an IGBT inverter using the Universal Bridge block.

5. Harmonics of the Proposed System

The faults found in the intended IPFC (Interline Power Flow Controller) components, as well as the type of harmonics, are as follows:

• Resonance in series and parallel
• Increase in RMS / Peak Value

The Harmonics Sources are shown as follows:

• Static vs. Dynamic • Voltage source vs. Current source • Utility companies, customers, and manufacturers • IEC / IEEE standards on harmonics with harmonic limits

5.1 THE IDEAL LOCATION FOR THE IPFC

To achieve the greatest benefit from the proposed IPFC (Interline Power Flow Controller), it must be installed in a suitable location in the intended grid-connected power system. The proposed IPFC is a multi-line FACTS controller that entails the connection of two separate transmission lines to a single bus. The standard method for choosing the ideal location is unsuccessful when it comes to determining where the controller should go. The proposed simulated device is used to regulate the actual and reactive power flow in transmission lines by altering the compensation mechanism using the Voltage Source Converter (VSC).[6]

6. Waveforms of Output

For all buses linked to the transmission line, the proposed system's output voltage varies from 0.9 to 1. An abrupt change in load on any of the transmission lines causes a load imbalance in the transmission system. The load's real power consumption rises, but the flow of useless reactive power across the lines accelerates.

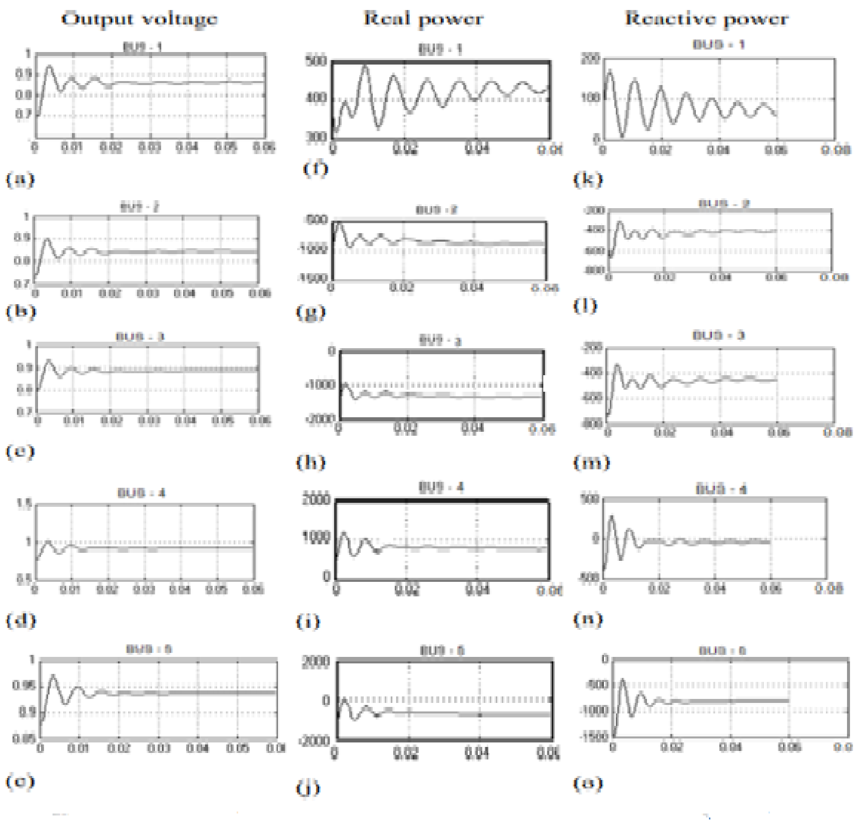

Fig. 3. Output Power real and reactive

By absorbing reactive power and injecting real power, our suggested controller keeps the grid-linked system steady. [7] While the system is initially unstable and produces oscillations, the obtained waveform from the suggested Simulink model indicates that it becomes stable with time.

6.1. Waveforms of Sub-System Output

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

7. Conclusion

Real-time power electronics equipment requires control and dynamic adjustment for various transmission modules. The UPFC is utilized in these situations to alleviate power transmission concerns while delivering electricity. It's usually used to select and regulate all of the factors that affect power flow in transmission lines. The UPFC system's fundamental flaw is that it struggles to handle multiline power systems. The IPFC (Interline Power Flow Controller) device is proposed in this paper for the execution of operational dependability and financial profitability. The full literature investigation suggested the exact control unit for optimal utilization and regulation of the current transmission system architecture, in addition to compensated FACTS controllers.

In response to the technique, the Interline Power Flow Controller module, as well as the windmill and solar-PV systems, were created. As one of the power sources, these devices are linked to the electric grid. Throughout this investigation, the MATLAB Simulink model is utilized for testing and verification. The Simulink model is designed for a grid-connected system to ensure stability. IPFC is evaluated utilizing real-time, reactive-time, and output voltage waveforms for diverse loads in the grid to transmit real and reactive power between transmission lines.

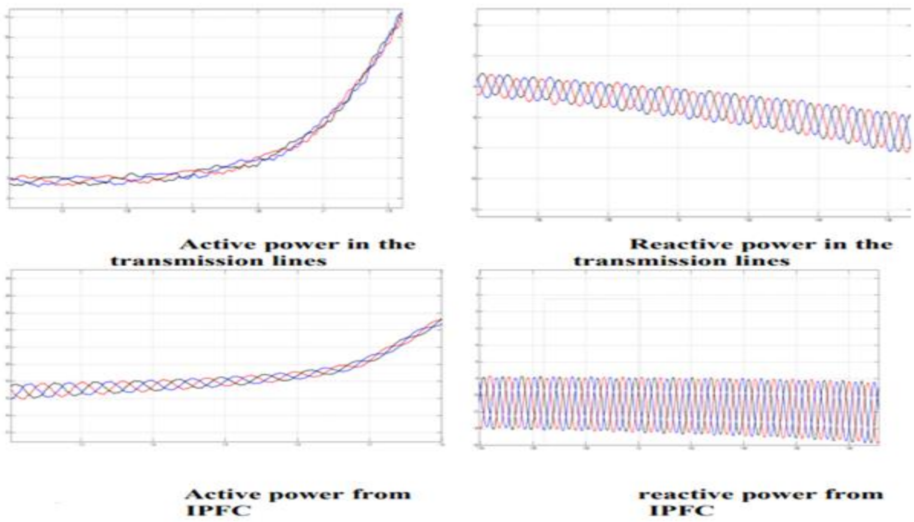

Fig. 4. Output Power

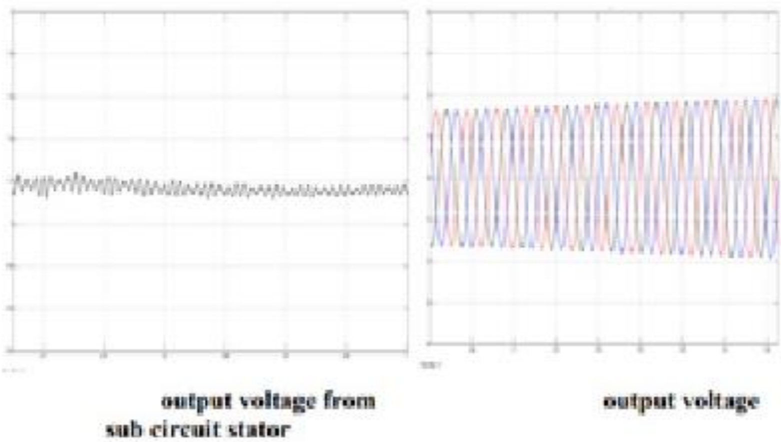

Fig. 5. Output Power

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