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Research Article

A Review on FACTS Technology, Devices and Applications (Flexible AC Transmission System)

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A B S T R A C T

FACTS in recent years is gaining controllability of power with the use of power electronics devices. This paper brings out conceptual knowledge about FACTs system. Its advantages and applications. It also explains about convertersthat are now a days used as FACTS devices.

Keywords: Voltage, Compensator, Thyristor, Power Flow, Reactor

Introduction

FACTS is the abbreviation for "Flexible AC Transmission Systems" and alludes to a gathering of assets used to beat certain confinements in the static and dynamic transmission limit of electrical systems. A Flexible Alternating Current Transmission System (FACTS) is a framework made out of static hardware utilized for the AC transmission of electrical vitality. It is intended to improve controllability and increment control move capacity of the system. It is commonly a power gadgets-basedframework.

The fundamental reason for these frameworks is to supply the system as fast as conceivable with inductive or capacitive receptive power that is adjusted to its specific necessities, while additionally improving transmission quality and the productivity of the power transmission framework.

Concept

Vr= Voltage at receiving end.
Vs= Voltage at sending end.
Let, Phase angle be= a

No-Loss line:

Vs=Vr=V and Phase angle may differ
Vs= V cos(a/2) + jV[sin(a/2)]
Vr= Vcos(a/20) – JV[sin(a/2)]
I= Vs-Vr/jX, where X is the given Reactance of the circuit.

Series Devices:

P= active power. Q= reactive power.

X is reactance of device. X' is decrease in reactance due to series addition(may be Xl or Xc).

P= V^2/X-X' [sin(a)]
Q = 2{V^2/X-X' [sin[1-cos(a)]]}

Shunt/ Parallel Devices;

In this case also, let, P be active power and Q be the reactive power.

P= 2{V^2/X [sin(a/2)]}
Q= 2{V^2/X [1- cos(a/2)]}

Advantages/ Application

Power Flow Control

Flow control requires techniques that are applied at transmission and distribution levels to influence the path that power (real & reactive) travels. This functionality is enabled by tools such as Fexible AC Transmission Systems (FACTS), phase angle regulating transformers (PARs), series capacitors, and very low impedance superconductors.

Increase of Transmission Capability

Transmission Capacity means the amount of power (in multiples of Watts [W]) which can be sent over a transmission line within acceptable line losses limit.

Voltage Control

By Voltage control we can keep the voltage of output in a controlled limit. The FACTS devices can be used instead of voltage regulators to keep voltage within the prescribed range that can be tolerated by electrical equipment using that voltage.

Reactive Power Compensation

Reactive power compensation is well-defined as the administration of reactive power to recover the presentation of alternating-current (ac) power systems. In over-all, the problematic of reactive power compensation is connected to load and voltage support. In load provision, the purposes are to growth the worth of the system power factor, to stabilize the real power drawn from the ac source, to improve voltage regulation, and to eradicate current harmonic machineriesformed by large and fluctuating nonlinear industrial loads. Voltage support is normallyobligatory to decrease voltage fluctuation at a given incurable of a transmission line. Reactive power compensation in transmission systems also recovers the stability of the ac system by growing the maximum active power that can be communicated.

Stability Improvement

It is cast-off to describe the aptitude of the scheme to take back its operation to fixed state complaintinside a smallestlikely time after having experienced any transience or trouble. Ever since the 20th century, till the new times, all main power producing stations over the globe has mostlytrusted on AC system as the greatestactual and inexpensive option for generation and transmission of electrical power. It is mostlyworried with the manufacture of electrical power and its transmission from the sending end to getting end as per supplies, experiencing a minimum amount of losses. The power frequentlyfluctuations due to the difference of load or due to turbulences.

Power Quality Improvement

Electric power quality, or just power quality, includes voltage, frequency, and waveform. Good power quality can be distinct as a steady supply voltage that breaks within the agreed range, steady ac. frequency nearby to the rated value, and smooth voltage curve waveform (resembles a sine wave). In over-all, it is valuable to reflect power quality as the compatibility between input and output and the load that is plugged into it.

Power Conditioning

Power conditioning is the period used to describe the quality of power complete to a constituent by supplying voltage at near that lets that component to function properly. It improves the quality using transient impulse protection, power factor correction and noise suppression. Power conditioning is recognized by the IEEE, NEMA and other standards. Power conditioners are used by both individual users and large corporations.

Converters for FACTS

LTT- Light Triggered Thyristors

Thyristors are a key component in controlling (turning on and off) the aloof segments in receptive power pay frameworks. The arrangement of direct light activating created by Siemens initiates the thyristors with a heartbeat of light that goes on for 10 microseconds and has a pinnacle intensity of 40 factory watts. The gadget likewise consolidates overvoltage assurance, with the goal that it is self-ensuring if the forward voltage surpasses the most extreme allowed limit. The light heartbeat is conveyed by fiber optics at ground potential legitimately from the valve control to the thyristor entryway. Regular high-voltage thyristor valve innovation utilizes electrically activated thyristors, which need a heartbeat with a pinnacle intensity of a few watts. Electronic hardware put nearby each thyristor produces this heartbeat. Thus, this electronic hardware, which needs an assistant power supply, is actuated at ground potential by optical sign from the valve control. Substituting direct light activating for this electronic gear decreases the quantity of electrical and electronic parts in the thyristor valve – and, thus, the probability of disappointment – by around 80 percent which improves dependability and wipes out issues related with electromagnetic similarity. The other significant reality about the new thyristor innovation is that long haul accessibility of electronic parts for substitution purposes over a time of at any rate 30 years is never again an issue.

Devices

Static Var Compensator

It is a shunt type controller which controls the power stream in transmission framework and improves the transient soundness of intensity networks. This controller manages the voltage at its terminals by controlling the measure of responsive power infused into or assimilated from the power framework. At the point when the framework voltage is low, SVC creates the responsive power and when the voltage is high it assimilates the receptive power. The responsive power is fluctuated by exchanging the three-stage inductor and capacitor banks.

Thyristor Controlled Reactor

It is a shunt associated static var safeguard or generator. It comprises of a fixed reactor in arrangement with bidirectional thyristor switches. The impedance of this gadget differed in a constant way by shifting the conduction edges of thyristors. The yield of this gadget is changed in accordance with trade either inductive or capacitive current. It keeps up and controls the parameters (normally a transport voltage) of the power framework. It is an option to STATCOM as far as cost.

Thyristor Switched Capacitor

It comprises of a shunt associated capacitor which is associated in arrangement with bidirectional thyristor switches. The impedance or reactance of this gadget is shifted in a stepwise way by controlling the thyristors either in a zero or full conduction activity. This controller offers no harmonics, no transients and low losses.

Thyristor Switched Reactor

It is a unique instance of a TCR where stage control of the current isn't worked out, rather the reactor is exchanged with the end goal that thyristors are either completely ON or OFF as in the event of TSC. The benefit of TSR over TCR is that no music current age. Additionally, this controller use thyristors without terminating control and subsequently lower cost and misfortunes.

STATCOM

STATCOM implies static synchronous compensator and it has the comparative qualities to that of synchronous condenser however it has no latency as it is an electronic gadget. It comprises of a strong state voltage source inverter combined with a transformer and this plan is attached to a transmission line. This course of action supplies or draws receptive power at a quicker rate contrasted and synchronous engine condenser. This controller infuses the current nearly in quadrature with the line voltage, so it coordinates a capacitive or an inductive reactance at the point where it is associated. STATCOM can be either voltage source or current source-based controller however generally voltage source is liked.

Static Series Synchronous Compensator

It is an arrangement variant of STATCOM and it is a propelled sort of control arrangement remuneration. It delivers the yield voltage in quadrature with the line current to such an extent that the general receptive voltage drops over the line is expanded or diminished. In spite of the fact that it resembles a STATCOM, the yield voltage is in arrangement with the line and consequently it controls the voltage over the line, so its impendence. It has an ability to prompt both inductive and capacitive voltage in arrangement with the line and thus the power control.

Unified Power Flow Controller

UPFC is the blend of STATCOM and SSSC which are coupled by means of a typical DC connect. It can display the attributes of both SSSC with arrangement voltage infusion and STATCOM with shunt current infusion, with included highlights. It has a novel capacity to perform free control of genuine and receptive power stream. Likewise, these can be controlled to give simultaneous receptive and genuine power arrangement line remuneration without utilization of an outer vitality source.

Thyristor Controlled Series Capacitor

It is a capacitive reactance compensator. It comprises of an arrangement capacitor bank which associated in parallel with a thyristor-controlled reactor that gives a smooth variable arrangement capacitive reactance. The all-out impedance of the framework can be fluctuated by changing the conduction point of the thyristors and consequently the circuit turns out to be either inductive or capacitive. On the off chance that the all-out circuit impedance is inductive, the issue current is restricted by this controller.

Thyristor Controlled Series Reactor

Like TCSC, it is likewise a capacitive reactance compensator comprising of thyristor exchanged reactor in parallel with an arrangement capacitor. It gives the stepwise control of arrangement capacitive reactance. Rather than controlling in persistent way, it switches the reactor with the end goal that the thyristors are terminated at 900 and 1800. This controller can be actualized without terminating edge control to decrease the expense and misfortunes.

Thyristor Switched Series Reactor

It is an inductive reactance compensator which includes of an procedure reactor in parallel with thyristor exchanged reactor. This organizer gives a smooth variable inductive reactance.

Thyristor Power Flow Controller

It is the new procedure for successful power stream and

remuneration the executives of multiline transmission frameworks. It comprises of various converters which are associated with a typical DC interface and every converter is accommodated arrangement remuneration for a chose transmission line. Notwithstanding the receptive power pay, this controller can ready to move genuine power among the transmission lines because of a typical DC interface. So, it is conceivable to adjust both genuine and receptive power between the lines.

Thyristor Controlled Phase Shifting Transformer

It is a variable stage point controller, which comprises of thyristors and stage moving transformer. The variable stage edge control is accomplished by exchanging the thyristor for various conduction angles.

Conclusion

This paper thus improves the knowledge of FACTS and about its system. With the development of FACTS devices, controllability of power is enhanced. This happened due to incorporation of power electronics in it. Therefore, FACTS found its way in various applications.

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