Power flow control using facts devices engineering essay

Profession

\n[toc title="Table of Contents"]\n

\n \t

\n[/toc]\n \n

With the increased capableness of power system web, increased complex tonss and with the interstate power transportation, the control of power in both transmittal and distribution lines has gained premier importance. The conventional method of power control utilizing power sloughing is no more cost effectual and causes power perturbations in the system. Alternatively a smooth control of power is the alternate solution to get the better of the above job.

Fast response existent power control will be necessary to take transients, maintain rotor angle stableness and supply equal post-contingency control of the web. Reactive power flow capableness on the other manus will function to minimise line VARs flow under normal runing conditions while maximising flows necessary to keep voltage stableness during the undermentioned eventualities. Power flow control may besides be strategically used to minimise or cut down the demand for transmittal enlargement.

In general, the control action in power systems can be categorized as on/off of uninterrupted (including measure wise uninterrupted) . The uninterrupted controls for illustration can besides be categorized as either coevals based or web electric resistance based. The web electric resistances used for uninterrupted control can be either physical or practical (non-physical) reactive or resistive constituents. Virtual constituents are presented to the web via interpolation of controlled synchronal electromotive force beginnings shunt connected to the coach and/or connected in series with transmittal lines.

Development of high power and high exchanging power electronic devices has made it possible to command big power flows utilizing FACTS devices.

Structure of the power system (Kundur)

Electric power systems vary in size and structural constituents. However, they all have the same basic features.

Are comprised of three-phase ac systems runing basically at changeless electromotive force. Generation and transmittal installations use three-phase equipment. Industrial tonss are constantly three-phase. Single stage residential and commercial tonss are distributed every bit among the stages so as to efficaciously organize a balanced three-phase system.

Use synchronal machines for coevals of electricity. Prime movers convert the primary beginnings of energy (fossil, atomic, and hydraulic) to mechanical energy that is, in bend converted to electrical energy by synchronal generators.

Transmit power over important distances to consumers spread over a broad country. This requires a transmittal system consisting subsystems runing at different electromotive force degrees.

Power flow in an a. c. system

In ac power system, given the in important electrical storage, the electrical coevals and burden must equilibrate at all times. To some extent the electrical system is self modulating. If coevals is less than burden, the electromotive force and frequence bead and at that place by burden goes down to be the coevals minus the transmittal losingss. However, there is merely a few per centum border for such self-regulation. If electromotive force is propped up with reactive power support so the burden will travel up, and accordingly frequence will maintain dropping and the system will fall in. Alternatively, if there is in equal reactive power, the system can hold electromotive force prostration.

Demand for electrical energy uninterrupted to travel steadily (F19)

Reactive power demand (text book diabetes mellitus tagare)

The reactive power demand of big public-service corporations like the province electricity boards in India can be divided into two groups.

Fixed KVAR required by the public-service corporations to:

maintain their transformers energized and

to cover their KVAR for the distribution system to transport a minimal base burden.

Variable KVAR to cover

load reactive power demands non covered by the consumer

reactive power demands by the public-service corporations transformers and distribution system to transport variable consumer burden.

Ripples and power system transeunt analysis [T 11]

Ripples are utile for transeunt analysis. Much of power system analysis is steady province analysis. However in the country of electric power quality analysis, transients may presume an of import function. For illustration, it is sometimes necessary to cipher the extension of a lightning shot urge in a radial distribution system or a networked transmittal system. The transient created by a communicatingfailureof an electronic convertor might hold to be analyzed in some instances. The computation of the extension of transformer inpouring and shunt capacitance exchanging currents is besides transeunt jobs. A choice of power system transients appear in tabular array.

Type

Location

Duration

Lightning

Overhead circuits

µs - MS

Line exchanging

Transmission and stand in transmittal system

µs - MS

Capacitor exchanging

Transmission and Distribution systems

µs - MS

Communicationfailure

Converters

MS

Transformer inpouring currents

Transformers in transmittal and distribution systems.

ms - s

Analysis of these transients might be done in the clip sphere, in the frequence sphere or parallel simulation. These methods have their advantages and disadvantages. But all are stressed in the analysis of short clip transients assorted with low frequence signals. Ripples offer certain clip frequence advantages over strictly frequence sphere methods. The window of a ripple (and besides a transform based on the ripples) is automatically adjusted in breadth in the presence of long or short term signals. The female

parent ripple in a ripple transform employs clip compaction or dilation instead than frequence transition as might be used in Fourier analysis. Besides it may be possible to choose the female parent ripple to fit the expected response- there by contracting ripple spectrum as compared to the frequence spectrum.

Rebeiro is by and large credited with proposing ripple analysis for power system/power quality analysis. Rebeiro chief part apart from the cardinal suggestion of ripples on powertechnologyis in the country of signalReconstruction. Robertson, Camps, Mayer and Gish have late proposed the usage of ripples in power technology to:

Capture power system transients for event recording equipment applications.

Report power system perturbations

Detect inchoate failure of equipment.

Resolve power quality struggles.

(Hingorani)

Series Compensation

When a generator accelerates and angle ? additions ??/? t & A ; gt ; 0, the electric power transmitted must be increased to counterbalance for the extra mechanical input power. When the generator decelerates and angle ? decreases ??/? t & A ; lt ; 0, the electric power must be decreased to equilibrate the deficient mechanical input power.

K = grade of series compensation = Xc/X 0 ? K ? 1

Ninety is the reactance of the series capacitance.

Ten is the entire reactance of the line at the cardinal power system frequence degree Fahrenheit.

K = upper limit when ??/? t & A ; gt ; 0

K = 0 ??/? t & A ; lt ; 0

with maximal k the effectual line electric resistance lower limit.

i. e the electromotive force across the existent line electric resistance is maximal.

i. e the electric power transmitted over the line is maximal.

With minimal K i. e K = 0.

The effectual line electric resistance is minimal.

i. e the electromotive force across the existent line electric resistance is minimal.

i. e power transmitted is minimal.

This means K is controlled in bang-bang operation. (the end product of the series compensator is varied between the lower limit and upper limit)

This type of control is the most effectual for muffling big oscillations.

Sustained oscillation below the cardinal system frequence can be caused by series capacitive compensation. It is called sub synchronal resonance (SSR) .

Degree of series compensation is in the scope of 25 to 75 % .

A capacitance in series with the entire circuit induction of the transmittal line (including the appropriate generator and transformer escape induction) forms a series resonant circuit with natural frequence fc = 1/2? vLC = fv Xc/X.

If the electric circuit is brought into oscillation (by some web perturbation) so the bomber harmonic constituent of the line current consequences in a corresponding bomber harmonic field in the machine which as it rotates backwards comparative to the magnetic field produces an jumping torsion on the rotor at the difference frequence of f - iron. if this difference frequence coincides with one of the torsional resonance of the turbine generator set, mechanical torsional oscillation is excited, which in bend farther excites the electrical resonance. This status is defined as bomber synchronal resonance.

Large generators with multi phase steam turbines which have multiple torsional manners with frequences below the power frequence are most susceptible to stand in synchronal resonance with series capacitance compensated transmittal lines.

The series compensator is chiefly applied to work out power flow jobs.

Fixed or controlled series capacitive compensation can besides be used to minimise to stop electromotive force fluctuation of radial lines and prevent electromotive force prostration.

Series compensation is used to command

to antagonize prevalent machine swings

important transeunt stableness betterment for station mistake systems

Highly effectual in power oscillation damping.

However the operating and public presentation features of the two types of series compensator are well different.

Approachs to governable series compensation

Two basic attacks:

Thyristor switched capacitances and thyristor controlled reactors to recognize a variable reactive entree.

Switch overing power convertor to recognize a governable synchronal electromotive force beginning.

The series compensator is a reciprocal of the shunt compensator.

The shunt compensator is functionally a controlled reactive current beginning which is connected in analogue with the transmittal line to command its electromotive force. The series compensator is functionally a

controlled electromotive force beginning which is connected in series with the transmittal line to command its current.

The map of the series capacitance is merely to bring forth an appropriate electromotive force at the cardinal Ac system frequence in quadrature with the transmittal line current in order to increase the electromotive force across the inductive line electric resistance and thereby increase the line current and the familial power.

By doing the end product electromotive force of the synchronal electromotive force beginning a map of line current the same compensation as provided by the series capacitance is accomplished. However in contrast to the existent series capacitance the SVS is able to keep a changeless compensating electromotive force in the presence of variable line current or controlled the amplitude of the injected compensating electromotive force independent of the amplitude of the line current.

The series reactive compensation strategy utilizing a exchanging power convertor (voltage beginning convertor) as a synchronal electromotive force beginning to bring forth a governable electromotive force in quadrature with the line current as per IEEE and CIGRE definition termed the Static Synchronous Series Compensator (SSSC) .

The SSSC can diminish every bit good as addition power flow to the same grade merely by change by reversaling the mutual opposition of the injected Ac electromotive force. The rearward electromotive force adds straight to

the reactive electromotive force bead of the line as if the reactive line electric resistance was increased.

If the injected electromotive force is made larger than the electromotive force impressed across the unsalaried line by the sending and having terminal systems that is if Vq & A ; gt ; | Vs -Vr| so the power flow will change by reversal with the line current

I = (Vq & A ; gt ; | Vs -Vr|) /Xc

The SSSC can supply capacitive or inductive compensating electromotive force independent of the line current up to its specified current evaluation.

The VA evaluation of the SSSC (solid province convertor and matching transformer) is merely the merchandise of the maximal line current (at which compensation is still desired) and the maximal series counterbalancing electromotive force.

VA = Imax * Vmax.

The control scope is uninterrupted from -1. 0 p. u (capacitive) to +1. 0 p. u (inductive) volt-amperes. In many practical applications merely capacitive series line compensation is required. One of import application is the coincident compensation of both the reactive and resistive constituents of the series line electric resistance in order to maintain the X/R ratio is high.

At transmittal electromotive force degrees of 115, 230 and even 340KV where the X/R ratio is normally low (in the scope of normally 3 to 10) , a high grade of series capacitive compensation could farther cut down the

effectual reactive to resistive line electric resistance ratio to such low values at which the increasingly increasing power demand of the line and associated line losingss and possible electromotive forcedepressionwould get down to restrict the catching active power.

The SSSC with an appropriate District of Columbia power supply (which could be powered from an accessible coach or from the Tertiary of handily located transformer) would be able to shoot in add-on to the reactive compensating electromotive force, a constituent of electromotive force in anti-phase with that developed across the line opposition to antagonize the consequence of the opposition electromotive force bead on the power transmittal.

In this manner by supplying coincident and independently governable compensation of both the reactive and existent electric resistance of the line in consequence an ideal reactive line can be created for maximal power transmittal.

The line losingss I2R is still be dissipated by the physical line. However this debauched power would be replenished by the SSSC from the subsidiary power supply. The existent power compensation capableness could besides be used efficaciously in minimising loop power flows by equilibrating both the existent and reactive power flows of parallel lines.

From the point of dynamic system stableness reactive line compensation combined with coincident active power exchange can besides heighten power oscillation damping.

During the period of angular acceleration, the SSSC with suited energy storage can use maximal capacitive line compensation to increase the familial active power and at the same time absorb active power to supply the consequence of a muffling resistance in series with the line.

During the period of angular slowing, the SSSC can put to death opposite compensating actions, that is, apply maximal inductive compensation to diminish the familial active power and at the same time supply the consequence of negative opposition (i. e. a generator) to provide extra active power for the line (negative damping) .

In practical SSSC the electromotive force sourced convertor on the dc side is terminated by a finite (and comparatively little) energy storage capacitance to keep the coveted District of Columbia runing electromotive force.

(Remember that this District of Columbia capacitance is kept changed by the energy absorbed from the system by the convertor itself) therefore the District of Columbia capacitance in consequence interacts with the Ac system via operating switch (valve) array of the convertor. This interaction may conceivably act upon the bomber synchronal behavior of a practical SSSC.

The SSSC is based on the synchronal electromotive force beginning construct which is implemented by a electromotive force beginning convertor.

WAVELETS (A18)

Ripples theory is the mathematical associated with constructing a theoretical account for a non-stationary signal, with a set of constituents that are little moving ridges, called ripples.

(A16) in the procedure of ripple transform the signal is non in footings of a trigonometric multinomial, but by ripple generated utilizing the interlingual rendition (switch in clip) and dilation (compressed in clip) of a fixed ripple map called the female parent ripple.