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FACTS Devices Formulas

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List of 21 FACTS Devices Formulas

FACTS Devices

AC Transmission Line Analysis

1) Effective Conductance of Load

Open Calculator

fx $$G_{eff} = \frac{P_{re}}{V_n^2}$$

ex $$1.078326\text{S} = \frac{440\text{W}}{(20.2\text{V})^2}$$

2) Electrical Length of Line

Open Calculator

fx $$\theta = \beta' \cdot L$$

ex $$20.62648^\circ = 1.2 \cdot 0.3\text{m}$$

3) Phase Constant of Compensated Line

Open Calculator

fx $$\beta' = \beta \cdot \sqrt{(1 - K_{se}) \cdot (1 - k_{sh})}$$

ex $$1.296919 = 2.9 \cdot \sqrt{(1 - 0.6) \cdot (1 - 0.5)}$$

4) Source Current in Ideal Compensator

Open Calculator

fx $I_s = I_L - I_{com}$

ex $32A = 42A - 10.0A$

5) Thevenin's Voltage of Line

Open Calculator

fx $V_{th} = \frac{V_s}{\cos(\theta)}$

ex $57.4656V = \frac{54V}{\cos(20^\circ)}$

6) Velocity Propagation in Lossless Line

Open Calculator

fx $V_p = \frac{1}{\sqrt{l \cdot c}}$

ex $0.566139m/s = \frac{1}{\sqrt{2.4H \cdot 1.3F}}$

7) Wavelength Propagation in Lossless Line

Open Calculator

fx $\lambda = \frac{V_p}{f}$

ex $0.0112m = \frac{0.56m/s}{50Hz}$

Static Synchronous Compensator(STATCOM)

8) Positive Sequence Voltage of STATCOM

Open Calculator

fx $$V_{po} = \Delta V_{ref} + X_{droop} \cdot I_{r(max)}$$

ex $$85.25\text{V} = 15.25\text{V} + 10\Omega \cdot 7\text{A}$$

9) RMS Error Vector in Load Distribution under STATCOM

Open Calculator

fx $$E_{rms} = \sqrt{\left(\frac{1}{T}\right) \cdot \int\left(\left(\varepsilon_1\right)^2 + \left(\varepsilon_2\right)^2 + \left(\varepsilon_3\right)^2 \cdot x, x, 0, T\right)}$$

ex $$4.182105 = \sqrt{\left(\frac{1}{2\text{s}}\right) \cdot \int\left(\left(2.6\right)^2 + \left(2.8\right)^2 + \left(1.7\right)^2 \cdot x, x, 0, 2\text{s}\right)}$$

Static Synchronous Series Compensator(SSSC)

10) Degree of Series Compensation

Open Calculator

fx $$K_{se} = \frac{X_c}{Z_n \cdot \theta}$$

ex $$0.630254 = \frac{1.32\Omega}{6\Omega \cdot 20^\circ}$$

11) Electrical Resonance Frequency for Series Capacitor Compensation

Open Calculator

fx $f_{r(se)} = f_{op} \cdot \sqrt{1 - K_{se}}$

ex $37.94733\text{Hz} = 60.0\text{Hz} \cdot \sqrt{1 - 0.6}$

12) Power Flow in SSSC

Open Calculator

fx $P_{sssc} = P_{max} + \frac{V_{se} \cdot I_{sh}}{4}$

ex $1565\text{W} = 300\text{W} + \frac{220\text{V} \cdot 23\text{A}}{4}$

13) Resonance Frequency for Shunt Capacitor Compensation

Open Calculator

fx $f_{r(sh)} = f_{op} \cdot \sqrt{\frac{1}{1 - k_{sh}}}$

ex $84.85281\text{Hz} = 60.0\text{Hz} \cdot \sqrt{\frac{1}{1 - 0.5}}$

14) Series Reactance of Capacitors

Open Calculator

fx $X_c = X \cdot (1 - K_{se})$

ex $1.32\Omega = 3.3\Omega \cdot (1 - 0.6)$

Static Var Compensator(SVC)

15) Steady State Change of SVC Voltage

Open Calculator

fx $$\Delta V_{svc} = \frac{K_N}{K_N + K_g} \cdot \Delta V_{ref}$$

ex $$7.537356V = \frac{8.6}{8.6 + 8.8} \cdot 15.25V$$

16) Total Harmonic Distortion Factor

Open Calculator

fx $$THD = \frac{1}{V_{in}} \cdot \sqrt{\sum\left(x, 2, N_h, V_n^2\right)}$$

ex $$8.533519 = \frac{1}{4.1V} \cdot \sqrt{\sum\left(x, 2, 4, (20.2V)^2\right)}$$

17) Voltage Distortion Factor in Single Tuned Filter

Open Calculator

fx $$D_n = \frac{V_n}{V_{in}}$$

ex $$4.926829 = \frac{20.2V}{4.1V}$$

Thyristor Controlled Series Capacitor(TCSC)

18) Capacitive Reactance of TCSC

Open Calculator

fx $$X_{tcsc} = \frac{X_C}{1 - \frac{X_C}{X_{tcr}}}$$

ex $$4.311258\text{F} = \frac{3.5\Omega}{1 - \frac{3.5\Omega}{18.6\Omega}}$$

19) Effective Reactance of GCSC

Open Calculator

fx $$X_{gcsc} = \frac{X_C}{\pi} \cdot (\delta_{ha} - \sin(\delta_{ha}))$$

ex $$419.9998\Omega = \frac{3.5\Omega}{\pi} \cdot (60\text{cyc} - \sin(60\text{cyc}))$$

20) TCR Current

Open Calculator

fx $$I_{tcr} = B_{tcr} \cdot \sigma_{tcr} \cdot V_{tcr}$$

ex $$0.929911\text{A} = 1.6\text{S} \cdot 9^\circ \cdot 3.7\text{V}$$

21) Voltage of Thyristor Controlled Series Capacitor

Open Calculator

fx $$V_{tcsc} = I_{line} \cdot X_{line} - V_{dl}$$

ex $$6.022\text{V} = 3.4\text{A} \cdot 2.33\Omega - 1.9\text{V}$$

Variables Used

- B_{tcr} TCR Susceptance in SVC *(Siemens)*
- **c** Series Capacitance in the Line *(Farad)*
- D_n Voltage Distortion Factor in Single Tuned Filter
- E_{rms} RMS Error Vector
- **f** Lossless Line Frequency *(Hertz)*
- f_{op} Operating System Frequency *(Hertz)*
- $f_{r(se)}$ Resonance Frequency of Series Capacitor *(Hertz)*
- $f_{r(sh)}$ Resonance Frequency of Shunt Capacitor *(Hertz)*
- G_{eff} Effective Conductance in Load *(Siemens)*
- I_{com} Compensator Current *(Ampere)*
- I_L Load Current in Ideal Compensator *(Ampere)*
- I_{line} Line Current in TCSC *(Ampere)*
- $I_{r(max)}$ Maximum Inductive Reactive Current *(Ampere)*
- I_s Source Current in Ideal Compensator *(Ampere)*
- I_{sh} Shunt Current of UPFC *(Ampere)*
- I_{tcr} TCR Current in SVC *(Ampere)*
- K_g SVC Gain
- K_N SVC Static Gain
- K_{se} Degree in Series Compensation
- k_{sh} Degree in Shunt Compensation
- **l** Series Inductance in Line *(Henry)*

- **L** Line Length *(Meter)*
- N_h Highest Order Harmonic
- P_{max} Maximum Power in UPFC *(Watt)*
- P_{re} Real Power of Load *(Watt)*
- P_{sssc} Power Flow in SSSC *(Watt)*
- **T** Time Elapsed in PWM Current Controller *(Second)*
- **THD** Total Harmonic Distortion Factor
- V_{dl} Voltage Drop Across Line in TCSC *(Volt)*
- V_{in} Input Voltage in SVC *(Volt)*
- V_n RMS Voltage in SVC *(Volt)*
- V_p Velocity Propagation in Lossless Line *(Meter per Second)*
- V_{po} Positive Sequence Voltage in STATCOM *(Volt)*
- V_s Sending End Voltage *(Volt)*
- V_{se} Series Voltage of UPFC *(Volt)*
- V_{tcr} TCR Voltage in SVC *(Volt)*
- V_{tcsc} TCSC Voltage *(Volt)*
- V_{th} Thevenin's Voltage of Line *(Volt)*
- **X** Line Reactance *(Ohm)*
- X_c Series Reactance in Capacitor *(Ohm)*
- X_C Capacitive Reactive *(Ohm)*
- X_{droop} Droop Reactance in STATCOM *(Ohm)*
- X_{gcsc} Effective Reactance in GCSC *(Ohm)*
- X_{line} Line Reactance in TCSC *(Ohm)*

- X_{tcr} TCR Reactance *(Ohm)*
- X_{tcsc} Capacitive Reactive in TCSC *(Farad)*
- Z_n Natural Impedance in Line *(Ohm)*
- β Phase Constant in Uncompensated Line
- β' Phase Constant in Compensated Line
- δ_{ha} Hold off Angle in GCSC *(Cycle)*
- ΔV_{ref} SVC Reference Voltage *(Volt)*
- ΔV_{svc} Steady State Change in SVC Voltage *(Volt)*
- ε_1 Error Vector in Line 1
- ε_2 Error Vector in Line 2
- ε_3 Error Vector in Line 3
- θ Electrical Length of Line *(Degree)*
- λ Wavelength Propagation in Lossless Line *(Meter)*
- σ_{tcr} Conducting Angle in TCR *(Degree)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- Function: **int**, int(expr, arg, from, to)
  The definite integral can be used to calculate net signed area, which is the area above the x -axis minus the area below the x -axis.
- Function: **sin**, sin(Angle)
  Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.
- Function: **sqrt**, sqrt(Number)
  A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- Function: **sum**, sum(i, from, to, expr)
  Summation or sigma (∑) notation is a method used to write out a long sum in a concise way.
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Electric Current** in Ampere (A)
  Electric Current Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Power** in Watt (W)
  Power Unit Conversion

- Measurement: **Angle** in Degree (°), Cycle (cyc)
  Angle Unit Conversion
- Measurement: **Frequency** in Hertz (Hz)
  Frequency Unit Conversion
- Measurement: **Capacitance** in Farad (F)
  Capacitance Unit Conversion
- Measurement: **Electric Resistance** in Ohm (Ω)
  Electric Resistance Unit Conversion
- Measurement: **Inductance** in Henry (H)
  Inductance Unit Conversion
- Measurement: **Wavelength** in Meter (m)
  Wavelength Unit Conversion
- Measurement: **Electric Potential** in Volt (V)
  Electric Potential Unit Conversion
- Measurement: **Transconductance** in Siemens (S)
  Transconductance Unit Conversion

Check other formula lists

- **FACTS Devices Formulas**
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