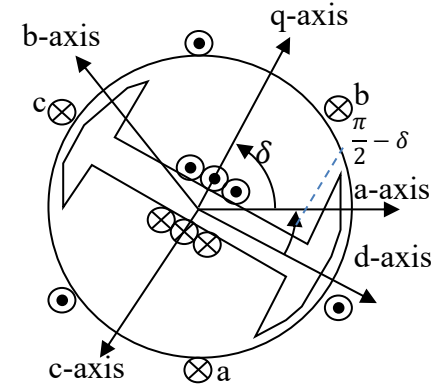
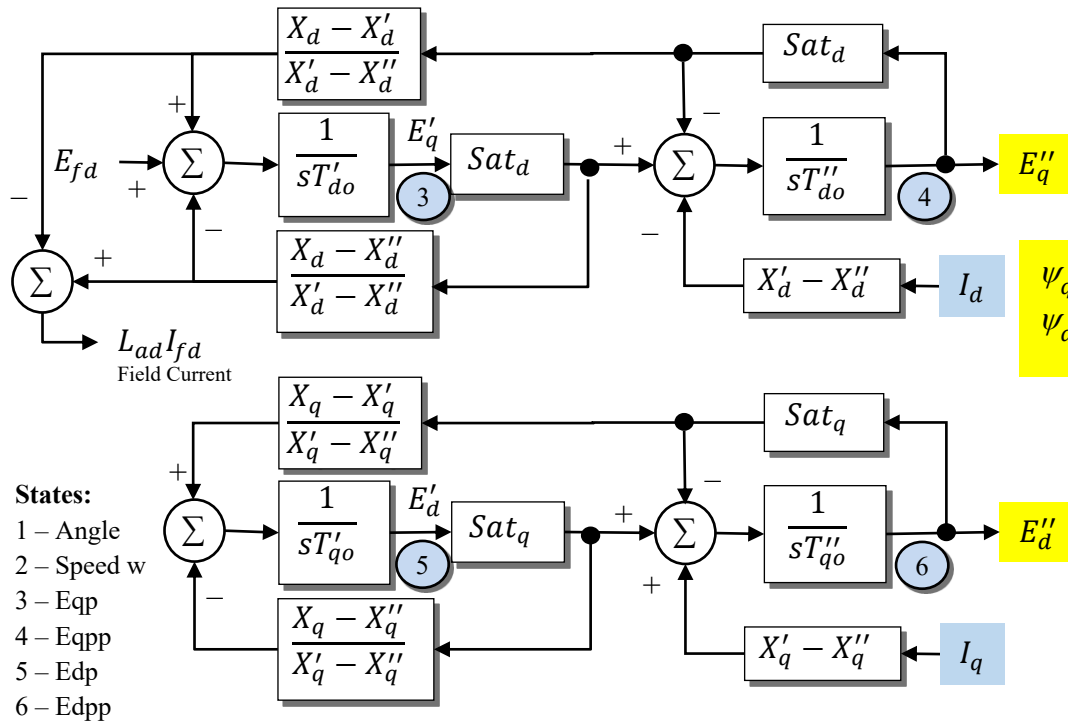


Machine Model GENTPF

Generator Represented by Uniform Inductance Ratios Rotor Modeling to Match WSCC Type F Model GENTPF



$$\psi_q'' = -E_d''$$

$$\psi_d'' = +E_q''$$

$$\psi_{ag} = \sqrt{(V_{qterm} + I_q R_a + I_d X_l)^2 + (V_{dterm} + I_d R_a - I_q X_l)^2}$$

$$\text{D-Axis: } Sat_d = 1 + \text{SaturationFunction}(\psi_{ag})$$

$$\text{Q-Axis: } Sat_q = 1 + \frac{x_q}{x_d} \text{SaturationFunction}(\psi_{ag})$$

Model supported by PSLF

Mechanical Swing Equations

$$\textcircled{1} \quad \dot{\delta} = \omega * \omega_0$$

$$\textcircled{2} \quad \dot{\omega} = \frac{1}{2H} \left(\frac{P_{mech} - D\omega}{1 + \omega} - T_{elec} \right)$$

ω = per unit speed deviation, so $\omega = 0$ means we are at synchronous speed and $\omega = 1$ would mean it's spinning at double synchronous speed
 ω_0 = synchronous speed $2\pi f_0$ where f_0 is the nominal system frequency in Hz

Note: If option *Ignore Speed Effects in Generator Swing Equation* is true, then instead use

$$\dot{\omega} = \frac{1}{2H} (P_{mech} - D\omega - T_{elec})$$

The GENTPF model includes saturation not simply as an additive term to the derivative of the E'_d and E'_q terms, but instead as the saturation of the inductance terms (X) directly. This means that the network interface equations and Electrical Torque equations are impacted by the saturation as well. The relationships are as described in the following.

Saturated Impedance Terms

$$\psi_{ag} = \sqrt{(V_{qterm} + I_q R_a + I_d X_l)^2 + (V_{dterm} + I_d R_a - I_q X_l)^2}$$

$$X''_{dsat} = \frac{X''_d - X_l}{Sat_d} + X_l$$

$$X''_{qsat} = \frac{X''_q - X_l}{Sat_q} + X_l$$

Electrical Torque

$$\psi_q = \psi_q'' - I_q X''_{qsat}$$

$$\psi_d = \psi_d'' - I_d X''_{dsat}$$

$$T_{elec} = \psi_d I_q - \psi_q I_d$$

Network Interface Equations

$$\mathbf{V} = \frac{d\boldsymbol{\Psi}}{dt} = j(1 + \omega) (\psi_d'' + j\psi_q'')$$

$$V_d + jV_q = (-\psi_q'' + j\psi_d'')(1 + \omega)$$

$$V_d + jV_q = (E_d'' + jE_q'')(1 + \omega)$$

Because of transient saliency ($X''_d <> X''_q$) and saturation effects, X''_{dsat} may not be equal to X''_{qsat} . Because of this the network interface equations cannot be written as a complex number equation. Instead the network interface equations are written as follows

$$V_{dterm} = V_d - R_a I_d + X''_{qsat} I_q$$

$$V_{qterm} = V_q - X''_{dsat} I_d - R_a I_q$$

These equations must be used directly when modeling the network boundary equations

Treatment of R_{comp} and X_{comp}

When specified, the compensated voltage fed as an input to the exciter is calculated as:

Solid Rotor Machine

Time Constants must be greater than zero

Reactances must be greater than zero

Salient Pole Machine with single amortisseur windings on d and q axis

$T_{qop} = 0$

$X_{qp} = X_q$

Other time constants greater than zero

Salient Pole Machine without amortisseur windings

T_{dop} greater than zero

All other times constant equal zero

$X_{dpp} = X_{dp}$

$X_{qpp} = X_{qp} = X_q$

$$V_{comp} = |\bar{V}_t - (R_{comp} + jX_{comp})\bar{I}_t|$$