Review of d-q-o Transformation

d-q-o Transformation

$$\begin{bmatrix} f_a \\ f_b \\ f_c \end{bmatrix} = [C_P] \begin{bmatrix} f_d \\ f_q \\ f_o \end{bmatrix}$$

$$[C_P] = \begin{bmatrix} k_d \cos\theta & k_q \sin\theta & k_o \\ k_d \cos(\theta - 2\pi/3) & k_q \sin(\theta - 2\pi/3) & k_o \\ k_d \cos(\theta + 2\pi/3) & k_q \sin(\theta + 2\pi/3) & k_o \end{bmatrix}$$

Inverse Transformation

$$\begin{bmatrix} f_d \\ f_q \\ f_o \end{bmatrix} = [C_P]^{-1} \begin{bmatrix} f_a \\ f_b \\ f_c \end{bmatrix}$$

$$[C_P]^{-1} =$$

$$\begin{bmatrix} k_1 \cos\theta & k_1 \cos(\theta - 2\pi/3) & k_1 \cos(\theta + 2\pi/3) \\ k_2 \sin\theta & k_2 \sin(\theta - 2\pi/3) & k_2 \sin(\theta + 2\pi/3) \\ k_3 & k_3 & k_3 \end{bmatrix}$$

$$k_1 = \frac{2}{3k_d}, k_2 = \frac{2}{3k_q}, k_3 = \frac{1}{3k_o}$$

Flux equations in the dqo Variables

$$\begin{bmatrix} \psi_{dqo} \\ \psi_r \end{bmatrix} = \begin{bmatrix} L'_{ss} & L'_{sr} \\ L'_{rs} & L_{rr} \end{bmatrix} \begin{bmatrix} i_{dqo} \\ i_r \end{bmatrix}$$

where

$$[L'_{ss}] = \begin{bmatrix} L_d & 0 & 0 \\ 0 & L_q & 0 \\ 0 & 0 & L_o \end{bmatrix}$$

$$L_d = L_{aao} - L_{abo} + \frac{3}{2} L_{aa2}$$

$$L_q = L_{aao} - L_{abo} - \frac{3}{2} L_{aa2}$$

$$L_o = L_{aao} + 2L_{abo}$$

$$[L'_{rs}] = \begin{bmatrix} (\frac{3}{2}M_{af}k_d) & 0 & 0 \\ (\frac{3}{2}M_{ah}k_d) & 0 & 0 \\ 0 & (\frac{3}{2}M_{ag}k_q) & 0 \\ \\ 0 & (\frac{3}{2}M_{ak}k_q) & 0 \end{bmatrix}$$

$$[L'_{sr}] = \begin{bmatrix} (\frac{M_{af}}{k_d}) & (\frac{M_{ah}}{k_d}) & 0 & 0 \\ 0 & 0 & (\frac{M_{ag}}{k_q}) & (\frac{M_{ak}}{k_q}) \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

Only if

$$k_d^2 = \frac{2}{3} \quad \text{and} \quad k_q^2 = \frac{2}{3}$$

then

$$[L'_{rs}]^T = [L'_{sr}]$$

Transformed Voltage Equation

$$-\frac{d}{dt}[C_P \psi_{dqo}] - [R_s][C_P]i_{dqo} = [C_P]v_{dqo}$$

$$-\frac{d}{dt}[C_P \psi_{dqo}] = -\frac{d[C_P]}{d\theta}\frac{d\theta}{dt}\psi_{dqo} - [C_P]\frac{d\psi_{dqo}}{dt}$$