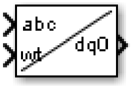
Perform transformation from three-phase (abc) signal to dq0 rotating reference frame or the inverse

Library

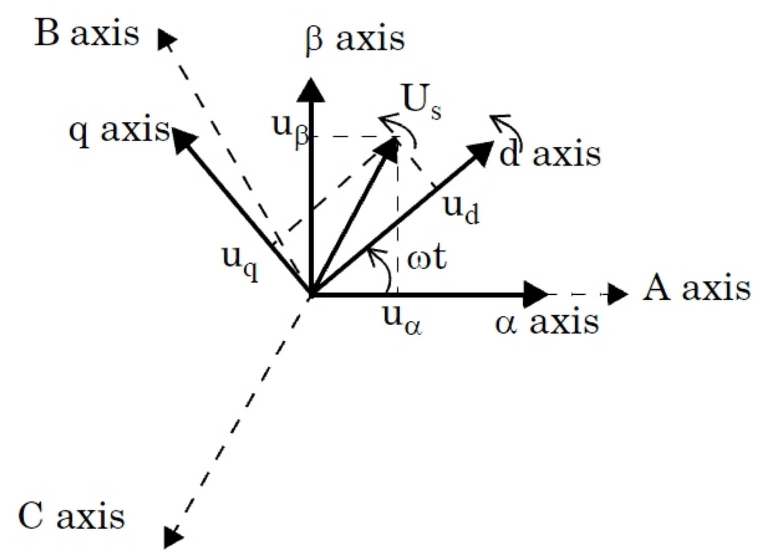
Control and Measurements/Transformations

Description



The abc to dq0 block performs a Park transformation in a rotating reference frame.

The dq0 to abc block performs an inverse Park transformation.



The block supports the two conventions used in the literature for Park transformation:

- Rotating frame aligned with A axis at t = 0. This type of Park transformation is also known as the cosinus-based Park transformation.
- Rotating frame aligned 90 degrees behind A axis. This type of Park transformation is also known as the sinus-based Park transformation. Use it in SimPowerSystems models of three-phase synchronous and asynchronous machines.

Deduce the dq0 components from abc signals by performing an abc to αβ0 Clarke transformation in a fixed reference frame. Then perform an αβ0 to dq0 transformation in a rotating reference frame, that is, −(ω.t) rotation on the space vector Us = uα + j· uβ.

The abc-to-dq0 transformation depends on the dq frame alignment at t = 0. The position of the rotating frame is given by ω.t (where ω represents the dq frame rotation speed).

When the rotating frame is aligned with A axis, the following relations are obtained:

$$U_s = u_d + j \cdot u_q = (u_a + j \cdot u_\beta) \cdot e^{-j\omega t} = \frac{2}{3} \cdot \left(u_a + u_b \cdot e^{\frac{j2\pi}{3}} + u_c \cdot e^{\frac{j2\pi}{3}} \right) \cdot e^{-j\omega t}$$

$$u_0 = \frac{1}{3}(u_a + u_b + u_c)$$

$$\begin{bmatrix} u_d \\ u_q \\ u_0 \end{bmatrix} = \frac{2}{3} \begin{bmatrix} \cos(\omega t) & \cos\left(\omega t - \frac{2\pi}{3}\right) & \cos\left(\omega t + \frac{2\pi}{3}\right) \\ -\sin(\omega t) & -\sin\left(\omega t - \frac{2\pi}{3}\right) & -\sin\left(\omega t - \frac{2\pi}{3}\right) \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \end{bmatrix} \begin{bmatrix} u_a \\ u_b \\ u_c \end{bmatrix}$$

$$\begin{bmatrix} u_a \\ u_b \\ u_c \end{bmatrix} = \begin{bmatrix} \cos(\omega t) & -\sin(\omega t) & 1 \\ \cos\left(\omega t - \frac{2\pi}{3}\right) & -\sin\left(\omega t - \frac{2\pi}{3}\right) & 1 \\ \cos\left(\omega t + \frac{2\pi}{3}\right) & -\sin\left(\omega t - \frac{2\pi}{3}\right) & 1 \end{bmatrix} \begin{bmatrix} u_d \\ u_q \\ u_0 \end{bmatrix}$$

When the rotating frame is aligned 90 degrees behind A axis, the following relations are obtained:

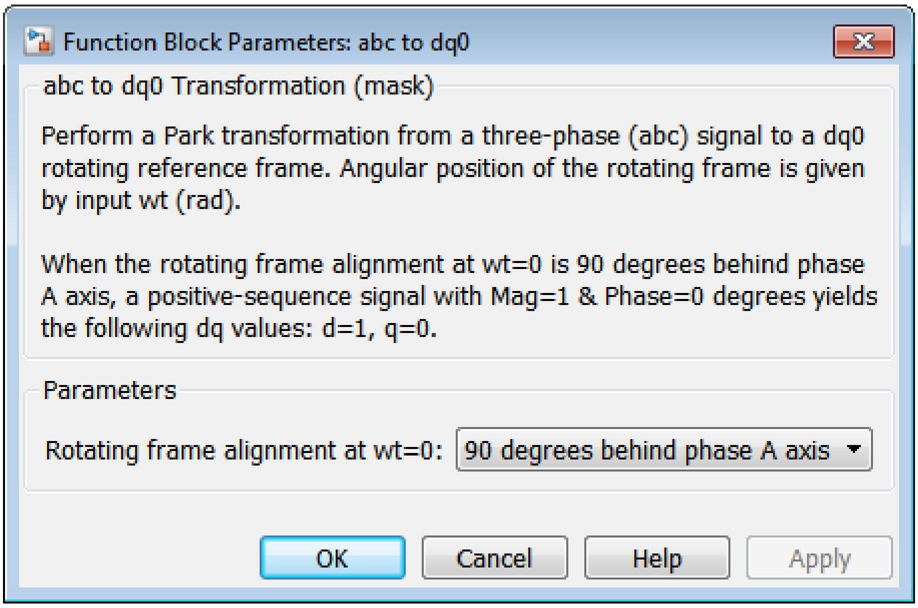
$$U_s = u_d + j \cdot u_q = (u_\alpha + j \cdot u_\beta) \cdot e^{-j\left(\omega t - \frac{\pi}{2}\right)}$$

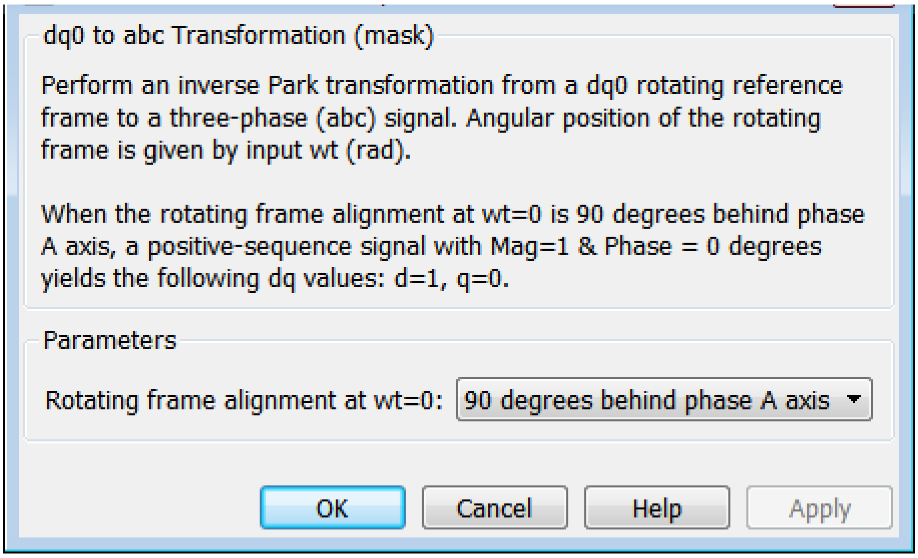
$$\begin{bmatrix} u_d \\ u_q \\ u_0 \end{bmatrix} = \begin{bmatrix} \sin(\omega t) & -\cos(\omega t) & 0 \\ \cos(\omega t) & \sin(\omega t) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} u_a \\ u_b \\ u_c \end{bmatrix}$$

Inverse transformation is given by

$$\begin{bmatrix} u_a \\ u_b \\ u_c \end{bmatrix} = \begin{bmatrix} \sin(\omega t) & \cos(\omega t) & 1 \\ \sin\left(\omega t - \frac{2\pi}{3}\right) & \cos\left(\omega t - \frac{2\pi}{3}\right) & 1 \\ \sin\left(\omega t + \frac{2\pi}{3}\right) & \cos\left(\omega t + \frac{2\pi}{3}\right) & 1 \end{bmatrix} \begin{bmatrix} u_d \\ u_q \\ u_0 \end{bmatrix}$$

Dialog Box and Parameters





Rotating frame alignment (at wt=0)

Select the alignment of rotating frame a t = 0 of the d-q-0 components of a three-phase balanced signal:

$$u_a = \sin(\omega t); \quad u_b = \sin\left(\omega t - \frac{2\pi}{3}\right); \quad u_c = \sin\left(\omega t + \frac{2\pi}{3}\right)$$

(positive-sequence magnitude = 1.0 pu; phase angle = 0 degree)

When you select `Aligned with phase A axis`, the d-q-0 components are d = 0, q = −1, and zero = 0.

When you select `90 degrees behind phase A axis`, the d-q-0 components are d = 1, q = 0, and zero = 0.

Inputs and Outputs

`abc`

The vectorized abc signal.

`dq0`

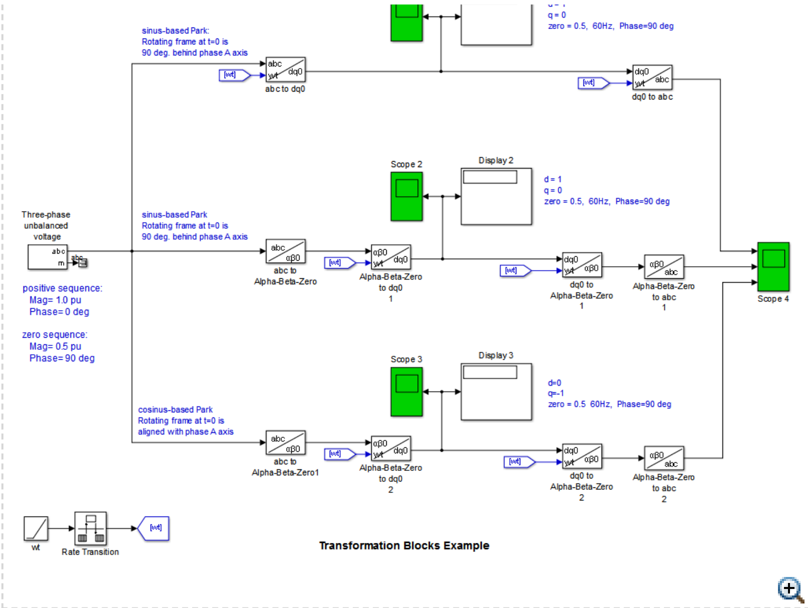
The vectorized dq0 signal.

`wt`

The angular position of the dq rotating frame, in radians.

Example

The `power_Transformations` example shows various uses of blocks performing Clarke and Park transformations.



Introduced in R2013a