Duplicate for Three Phase to Two Phase Transformation

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ABSTRACT: This paper the model that has been developed so far is for two phase machine Three phase induction machine are common: [1]-[3]two phase machine are rarely used in industrial application . a dynamic model for the three phase induction machine can be derived from the two phase machine if the equivalence between three and two phase is established .The equivalence is based on the equality of the MMF produced in the two phase and three phase winding and equal current magnitudes. Shows simulation results are compared.

I. INTRODUCTION

This transformation could also be thought of as a transformation from three (abc) axes to three new (dqo)axes for uniqueness of the transformation from one set of axes to another set of axes, including unbalances in the abc variables requires three variables such as the dq0.[4]The reason for this is that it is easy to converter from three abc variables to to qd variables if the abc variables have an inherent relationship among themselves, such as the equal phase displacement and magnitude. Therefore, in such a case there are only two independent variables in a,b,c: the third is a dependent variable obtained is unique under that circumstance This paper the variable s have no such inherent relationship, then there are three distinct and independent variables: Hence the third variable cannot be recovered from the knowledge of the other two variables only[5] .It is also mean that they are not recoverable from two variables qd but require another variable such as the zero sequence component, to recover the[7] abc variables from the dq0 variables.

## II. THREE PHASE(a,b,c) to TWO PHASE(d,q,0)TRANSFORMATION

In electrical engineering, direct–quadrature–zero (abc) transformation or zero–direct–quadrature (dqo) transformation is a mathematical transformation that rotates the reference frame of three-phase systems in an effort to simplify the analysis of three-phase circuits. In the case of balanced three-phase circuits, application of the dqo transform reduces the three AC quantities to two DC quantities. Simplified calculations can then be carried out on these DC quantities before performing the inverse transform to recover the actual three-phase AC results. It is often used in order to simplify the analysis of three-phase synchronous machines or to simplify calculations for the control of three-phase inverters. The power-invariant, right-handed dqo transform applied to any three-phase quantities (e.g. voltages, currents, flux linkages, etc.) is shown below in matrix form.

The inverse transform is:

$$x_{abc} = K^{-1}x_{dqo} = \sqrt{\frac{2}{3}} \begin{bmatrix} \cos(\theta) & -\sin(\theta) & \frac{\sqrt{2}}{2} \\ \cos(\theta - \frac{2\pi}{3}) & -\sin(\theta - \frac{2\pi}{3}) & \frac{\sqrt{2}}{2} \\ \cos(\theta + \frac{2\pi}{3}) & -\sin(\theta + \frac{2\pi}{3}) & \frac{\sqrt{2}}{2} \end{bmatrix} \begin{bmatrix} x_d \\ x_q \\ x_o \end{bmatrix}$$

A. Geometric Interpretation

The dqo transformation is two sets of axis rotations in sequence. We can begin with a 3D space where *a*, *b*, and *c* are orthogonal axes.
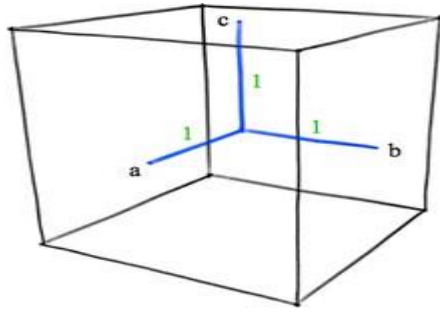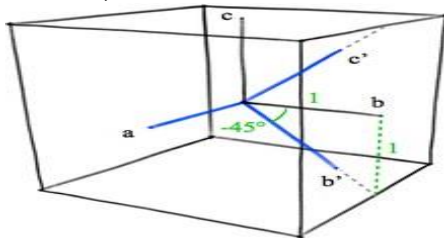
If we rotate about the axis by -45°, we get the following rotation matrix:

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos(-\pi/4) & \sin(-\pi/4) \\ 0 & -\sin(-\pi/4) & \cos(-\pi/4) \end{bmatrix}$$
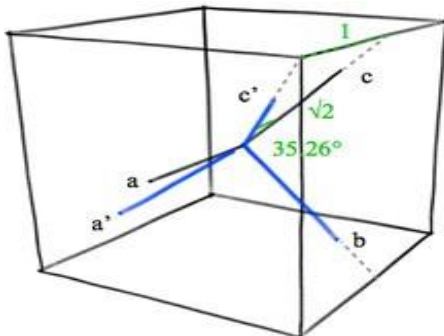
which resolves to

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & \frac{1}{\sqrt{2}} & \frac{-1}{\sqrt{2}} \\ 0 & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{bmatrix}$$

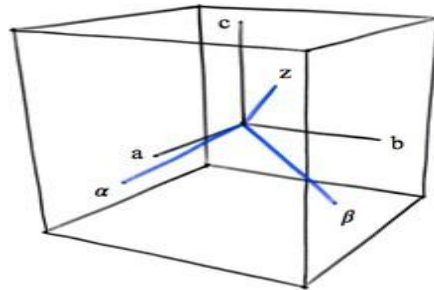With this rotation, the axes look like

Then we can rotate about the new *b* axis by Which resolves to

$$\begin{bmatrix} \frac{\sqrt{2}}{\sqrt{3}} & 0 & \frac{-1}{\sqrt{3}} \\ 0 & 1 & 0 \\ \frac{1}{\sqrt{3}} & 0 & \frac{\sqrt{2}}{\sqrt{3}} \end{bmatrix}.$$

When these two matrices are multiplied, we get the Clarke transformation matrix *C*:

$$\sqrt{\frac{2}{3}}\begin{bmatrix} 1 & \frac{-1}{2} & \frac{-1}{2} \\ 0 & \frac{\sqrt{3}}{2} & -\frac{\sqrt{3}}{2} \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{bmatrix} = \begin{bmatrix} \frac{\sqrt{2}}{\sqrt{3}} & 0 & \frac{-1}{\sqrt{3}} \\ 0 & 1 & 0 \\ \frac{1}{\sqrt{3}} & 0 & \frac{\sqrt{2}}{\sqrt{3}} \end{bmatrix} * \begin{bmatrix} 1 & 0 & 0 \\ 0 & \frac{1}{\sqrt{2}} & \frac{-1}{\sqrt{2}} \\ 0 & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{bmatrix}$$

This is the first of the two sets of axis rotations. At this point, we can relabel the rotated *a*, *b*, and *c* axes as *α*, *β*, and *z*. This first set of rotations places the *z* axis an equal distance away from all three of the original *a*, *b*, and *c* axes. In a balanced system, the values on these three axes would always balance each other in such a way that the *z* axis value would be zero. This is one of the core values of the dqo transformation; it can reduce the number relevant variables in the system.

The second set of axis rotations is very simple. In electric systems, very often the *a*, *b*, and *c* values are oscillating in such a way that the net vector is spinning. In a balanced system, the vector is spinning about the *z* axis. Very often, it is helpful to rotate the reference frame such that the majority of the changes in the *abc* values, due to this spinning, are canceled out and any finer variations in become more obvious. So, in addition to the Clarke transform, the following axis rotation is applied about the *z* axis:

$$\begin{bmatrix} \cos(\theta) & \sin(\theta) & 0 \\ -\sin(\theta) & \cos(\theta) & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Multiplying this matrix by the Clarke matrix results in the dqo transform:

$$\sqrt{\frac{2}{3}}\begin{bmatrix} \cos(\theta) & \cos\left(\theta - \frac{2\pi}{3}\right) & \cos\left(\theta + \frac{2\pi}{3}\right) \\ -\sin(\theta) & -\sin\left(\theta - \frac{2\pi}{3}\right) & -\sin\left(\theta + \frac{2\pi}{3}\right) \\ \frac{\sqrt{2}}{2} & \frac{\sqrt{2}}{2} & \frac{\sqrt{2}}{2} \end{bmatrix} = \begin{bmatrix} \cos(\theta) & \sin(\theta) & 0 \\ -\sin(\theta) & \cos(\theta) & 0 \\ 0 & 0 & 1 \end{bmatrix} * \sqrt{\frac{2}{3}}\begin{bmatrix} 1 & \frac{-1}{2} & \frac{-1}{2} \\ 0 & \frac{\sqrt{3}}{2} & -\frac{\sqrt{3}}{2} \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{bmatrix}$$

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The dqo transformation can be thought of in geometric terms as the projection of the three separate sinusoidal phase quantities onto two axes rotating with the same angular velocity as the sinusoidal phase quantities. The two axes are called the direct, or d, axis; and the quadrature or q, axis; that is, with the q-axis being at an angle of 90 degrees from the direct axis.
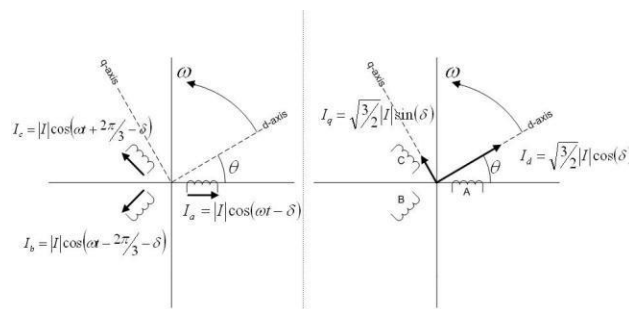
Shown above is the dqo transform as applied to the stator of a synchronous machine. There are three windings separated by 120 physical degrees. The three phase currents are equal in magnitude and are separated from one another by 120 electrical degrees. The three phase currents lag their corresponding phase voltages by δ. The d-q axis is shown rotating with angular velocity equal to , the same angular velocity as the phase voltages and currents. The d axis makes an angle $\theta = \omega t$ with the A winding which has been chosen as the reference. The currents I_d and I_q are constant DC quantities.

III.   SIMULATION RESULTS

Fig 1. Simulate three phase to two phase transformation
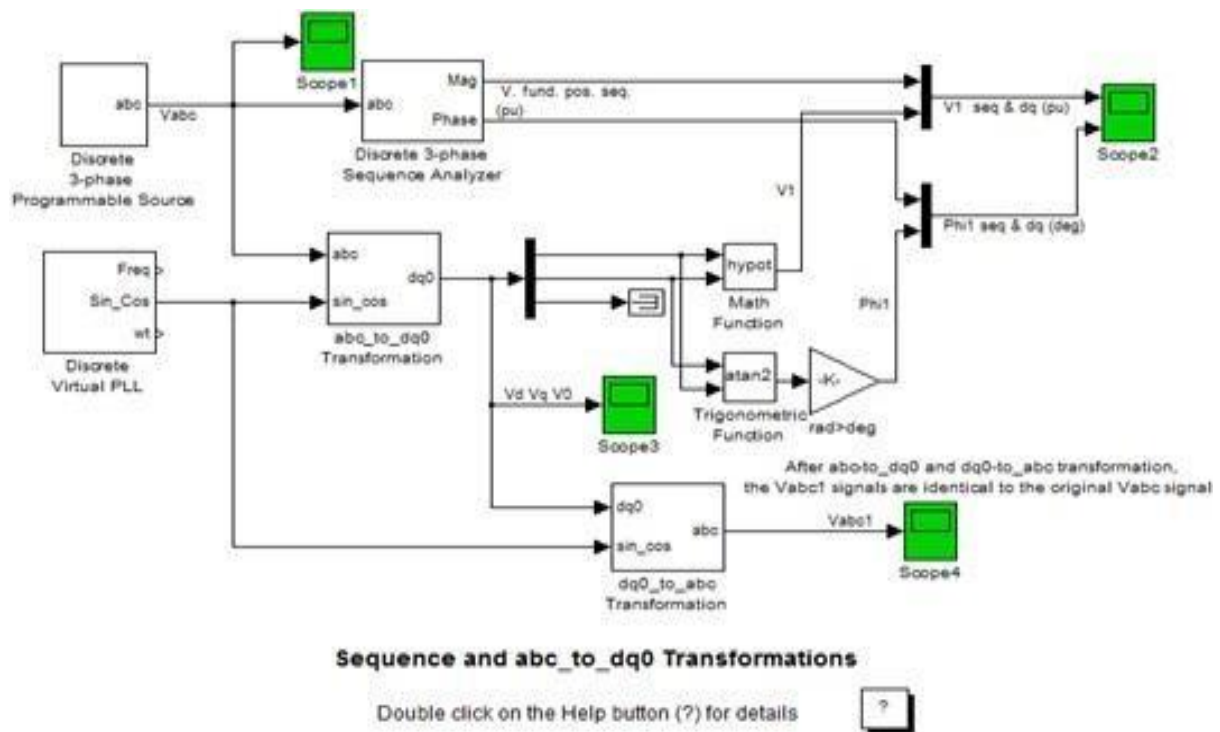

Sequence and abc_to_dq0 Transformations

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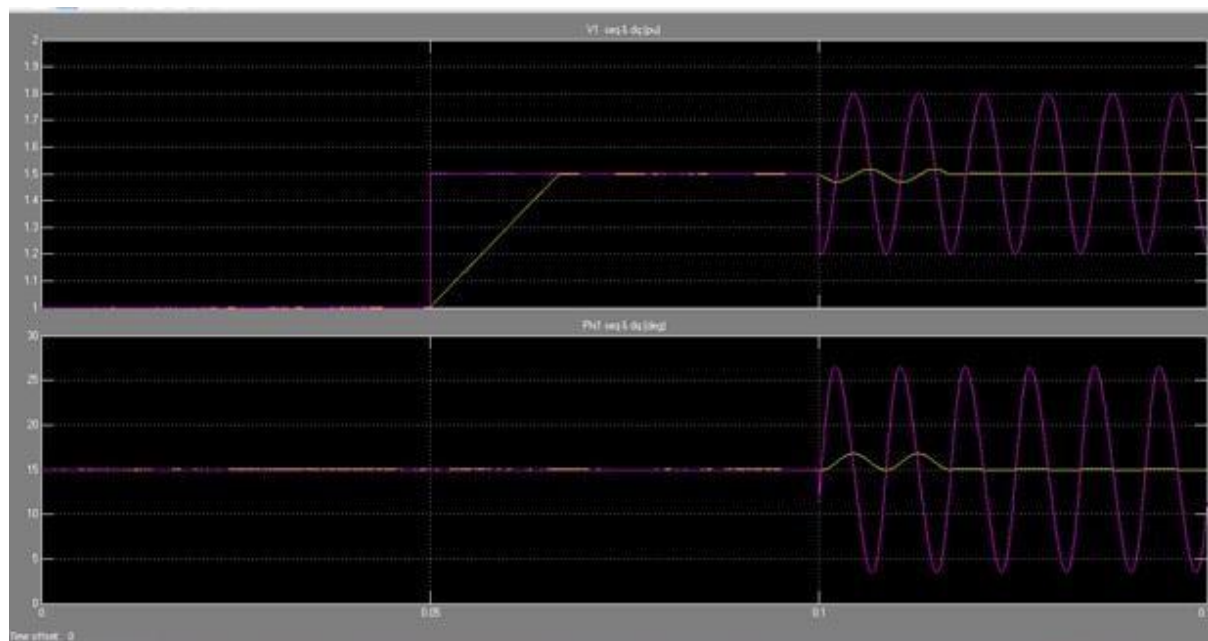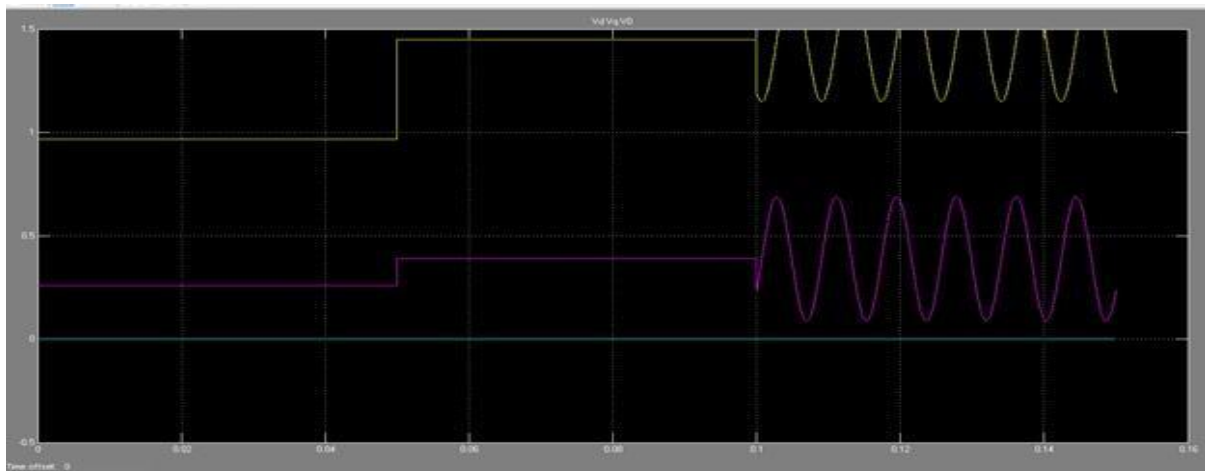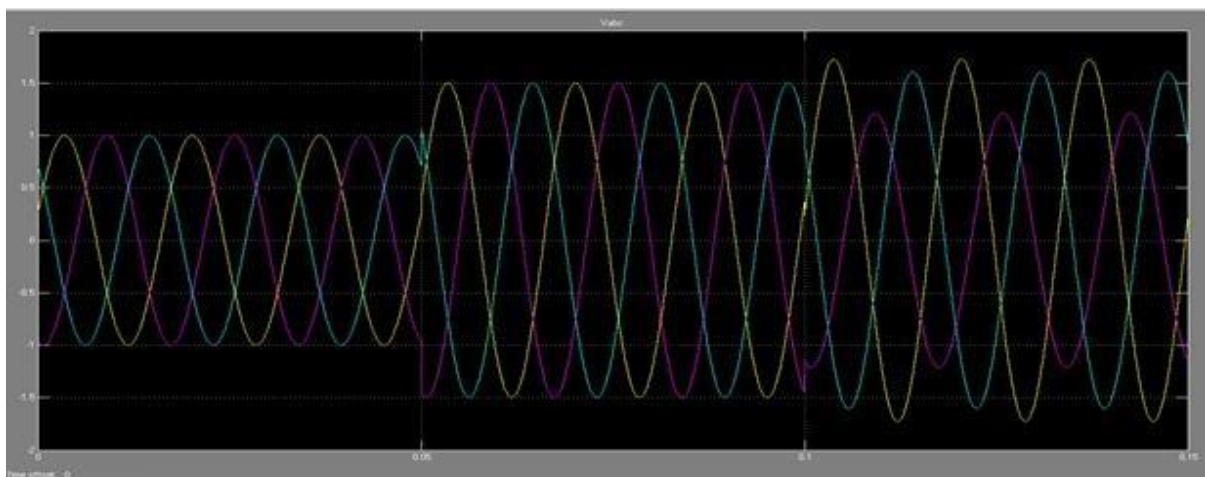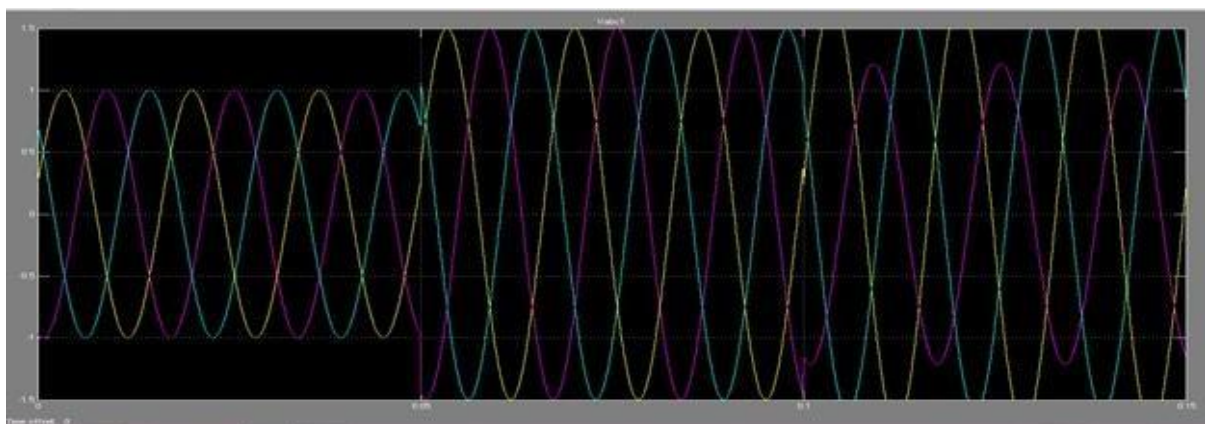
Fig 2. Simulate the voltage &current

Fig 3. Simulate the V$_d$ & V$_q$ voltage

Fig 4. Simulate the three phase voltage V$_{abc}$

Fig 5.Simulate the three phase voltage V$_{abc1}$

IV.   CONCLUSION

This paper presented two phase machine is rarely used in industrial application. a dynamic model for the three phase induction machine can be derived from the two phase machine if the equivalence between three and two phase is established .the equivalence is based on the equality of the MMF produced in the two phase and three phase winding and equal current magnitudes. Shows the simulation results are compared.

V.   REFERENCES

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