For the non-power-invariant transformation the constant *k* equals *k*=2/3. In this case, the quantities *isa* and *is*a are equal. If we assume , the quadrature-phase components can be expressed utilizing only two phases of the 3-phase system:

$$i_{s\alpha} = i_{sa}$$
$$i_{s\beta} = \frac{1}{\sqrt{3}} i_{sa} + \frac{2}{\sqrt{3}} i_{sb}$$

Ta

The inverse Clarke transformation goes back from a 2-phase (a,b) to a 3-phase *isa, isb*, *isc* system. For

constant *k*=2/3, it is given by the following equations

$$i_{sa} = i_{s\alpha}$$
$$i_{sb} = -\frac{1}{2} i_{s\alpha} + \frac{\sqrt{3}}{2} i_{s\beta}$$
$$i_{sc} = -\frac{1}{2} i_{s\alpha} - \frac{\sqrt{3}}{2} i_{s\beta}$$

3.3 Forward and Inverse Park Transformation (a,b to d-q and backwards)

The components *is*a and *is*b, calculated with a Clarke transformation, are attached to the stator reference frame a, b. In vector control, it is necessary to have all quantities expressed in the same reference frame. The stator reference frame is not suitable for the control process. The space

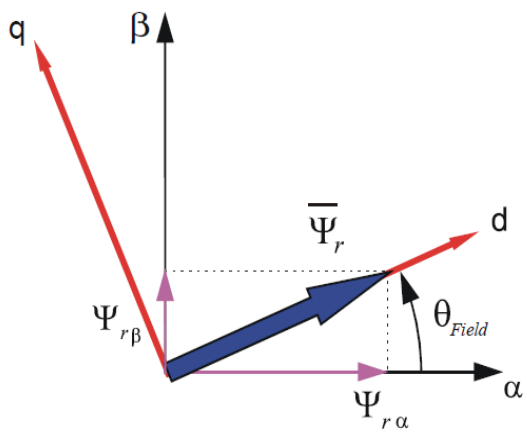

Figure-4 Park Transformation

vector *is* is rotating at a rate equal to the angular frequency of the phase currents. The components *is*a and *is*b depend on time and speed. We can transform these components from the stator reference frame to the d-q reference frame rotating at the same speed as the angular frequency of the phase currents. Then the *isd* and *isq* components do not depend on time and speed. If we consider the *d*-axis aligned with the rotor flux, the transformation is illustrated in **Figure-4[6][7]**, where is the rotor flux position.

The components *isd* and *isq* of the current space vector in d-q reference frame are determined by the following equations

$$i_{sd} = i_{s\alpha}\cos\theta_{Field} + i_{s\beta}\sin\theta_{Field}$$
$$i_{sq} = -i_{s\alpha}\sin\theta_{Field} + i_{s\beta}\cos\theta_{Field}$$

The components *isd* and *isq* of the current space vector in d-q reference frame are determined by the following equations:

The component *isd* is called the direct axis component (flux producing component) and *isq* is called the quadrature axis component (torque producing component). They are time invariant and the flux and torque control with them is easy. To avoid using trigonometric functions on the DSP we

can directly calculate sinq*Field* and cosq*Field* using division. They are defined by the following

equations:

$$\Psi_{rd} = \sqrt{\Psi_{r\alpha} + \Psi_{r\beta}}$$
$$\sin\theta_{Field} = \frac{\Psi_{r\beta}}{\Psi_{rd}}$$
$$\cos\theta_{Field} = \frac{\Psi_{r\alpha}}{\Psi_{rd}}$$

The inverse Park transformation from the d-q to a,b coordinate system is given by the following equations:

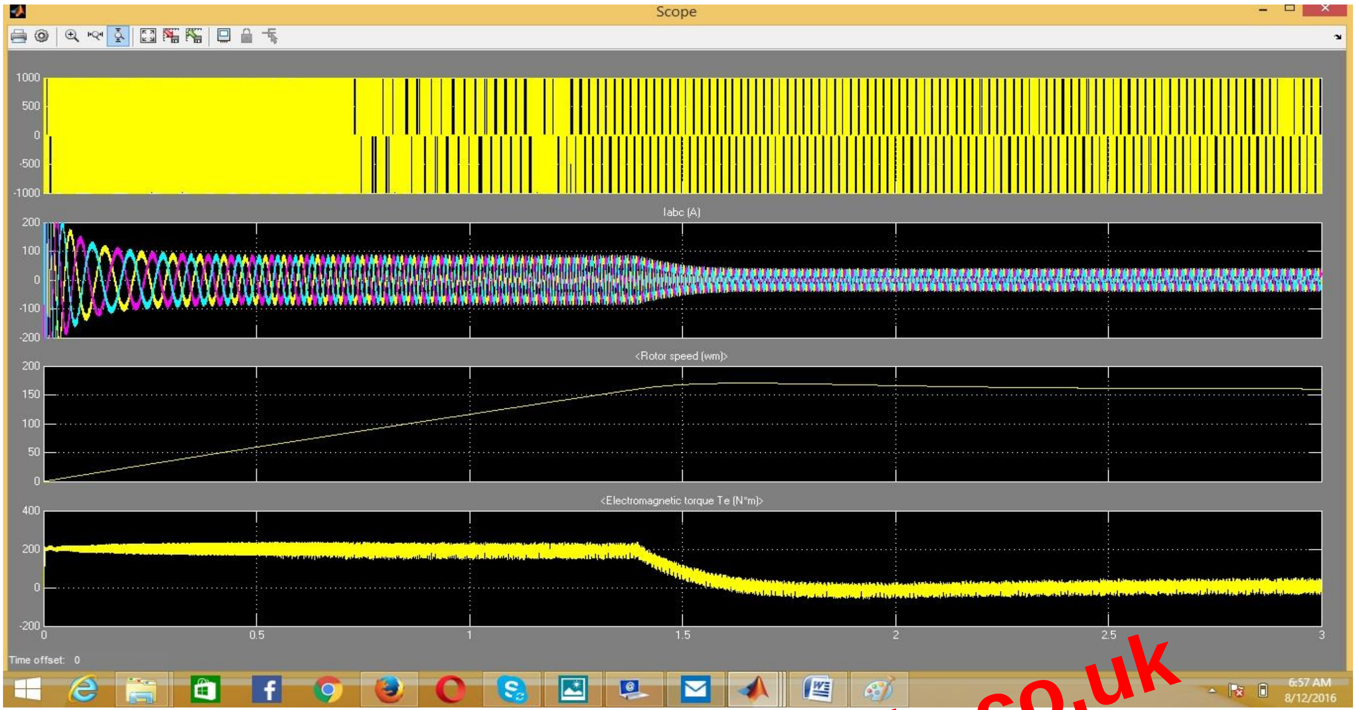

Figure-10 for speed reference 160radian/second and torque 200nm.

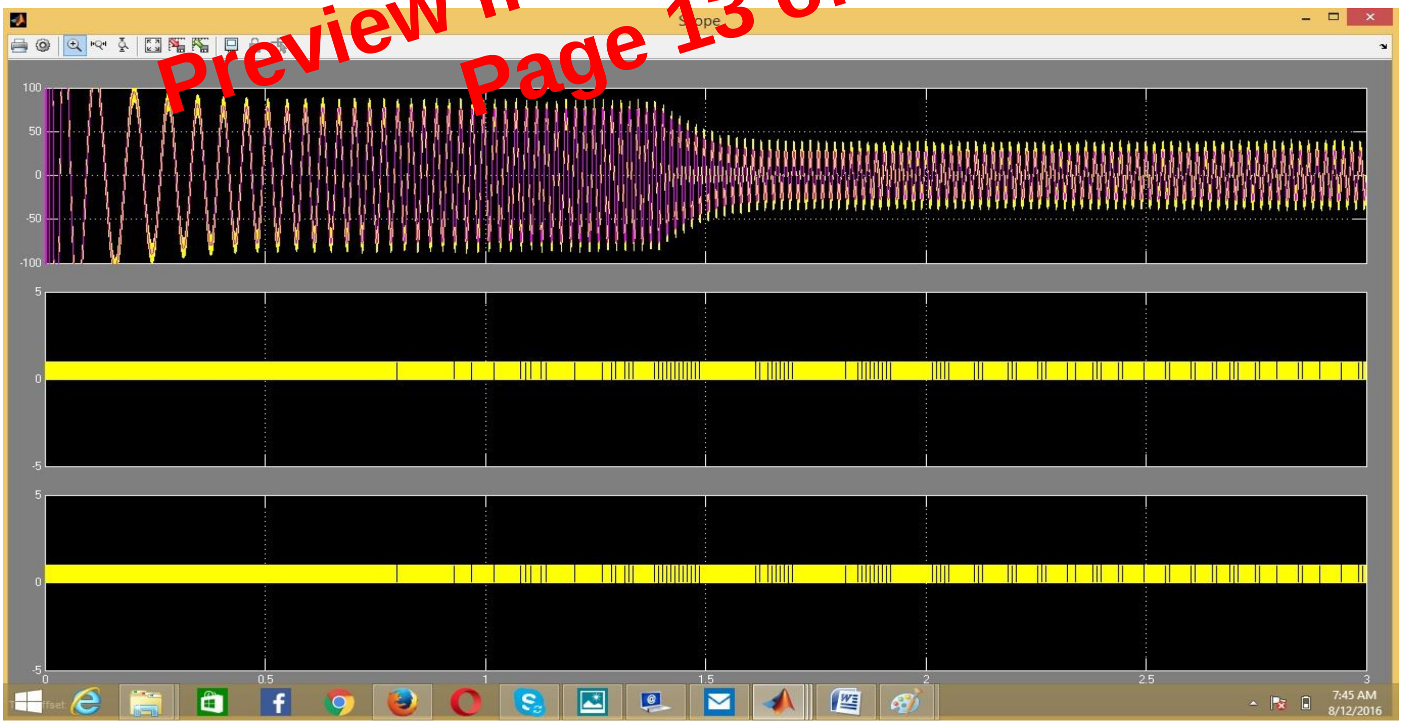

figure-11 signal scope for above torque speed