

# One-line Detection of Rotor Position for Vector Controlled IPMSM

## *Abstract-*

Interior Permanent Magnet Synchronous Motors (IPMSMs) are receiving increased attention for drive applications such as; robotics, rolling mills, traction and spindle drive, because of their high torque to inertia ratio, superior power density, high efficiency, low noise and robustness. In order to control IPMSM, position and speed sensors are indispensable because both current and voltage should be controlled depending on the rotor position. On the other hand, the vector control drive provides a wide range of speeds, high torque capability and high efficiency. However, conventional vector control of IPMSM requires a motor position sensor to correctly orient the current vector orthogonally to the flux because the rotor flux is obtained from permanent magnets. In such a way, it is possible to directly control the torque by acting simply on the amplitude of the stator current. Thus, a high degree of torque control over a wide speed range including the standstill can be achieved. The zero reference position is usually taken such that the d-axis (North Pole), where the magnetic flux exists coincides with phase-A. Therefore, any error in determining the actual rotor position will affect the overall drive system performance. In such case, the speed is measured using the shaft encoder which is fixed manually on the rotor such that the positive the edge of the home signal per one revolution Z of the shaft encoder coincides with the zero edge of phase-A. However, in fact, shaft encoder placement may be significantly inaccurate due to human mechanical error during fixing. Therefore, there will be a degree of uncertainty in the determination of the rotor position. This paper shows that misplaced the shaft encoder not only lead to unbalance operation of the inverter and motor phases, which increases the low frequency harmonics in torque ripple and degrades the overall drive performance but also, reduces the overall torque obtained from the vector controlled drive system due to the reduction of the quadrature-axis component of current. However, in this paper a novel technique has been theoretically proposed and experimentally applied to determine on-line the

value of the error angle  $\theta_{\text{error}}$  between the positive edge of the home signal Z of the shaft encoder and the zero position (North Pole) of phase-A, where it is shown to achieve better dynamic performance of a vector controlled IPMSM. The proposed method can be implemented on-line and does not require any additional or special circuitry or hardware.