

This paper presents the steady-state mathematical model of a five-phase induction machine with a combined star/pentagon connection. The connection splits the stator winding into two five-phase windings displaced in space by $\pi/10$ and connected in a combined star/pentagon configuration. Recent work limited to an experimental investigation demonstrated that the connection possesses improved fault tolerance when compared to a conventional star-connected stator, as well as avoids the pentagon connection problems. Although the machine has five-phase terminals, it is intrinsically an asymmetrical ten-phase machine, which introduces additional subspaces in the machine's mathematical model. In order to theoretically investigate and thoroughly assess this connection against conventional connections, this paper introduces the steady-state mathematical model based on vector space decomposition and symmetrical component theory. Finite-element analysis is first used to investigate the different harmonic current components induced in the cage rotor circuit, upon which the effect of different subspaces can be clarified and the required transformation matrix from phase variables to their sequence components can be derived. The model is verified using a 1-kW prototype five-phase induction machine.