

1 / Introduction

The focus of this monograph is on the design and control of permanent magnet synchronous machines drives, otherwise known as brushless dc machines. Permanent magnet synchronous machines (PMSMs) can be constructed to be operated from a three – phase fixed frequency ac source. In this case, the machine is equipped with damper circuits in the rotor and starts as an induction machine until it pulls into synchronism. This is not the type of machine considered herein. Instead, this monograph will concern itself with PMSMs which are designed to be operated from an inverter. In this class of machine, the excitation is correlated with rotor position and so there is no need for damper windings. In this mode of PMSM operation, we will refer to the inverter/PMSM together as a brushless dc machine.

This nomenclature is not universal. In many cases, authors will make a distinction between inverter fed machines with sinusoidal back emf waveforms and inverter fed machines with, for example, trapezoidal back emf waveforms, referring to them as PMSM drives and brushless dc motor drives, respectfully. However, it is the opinion of the authors that it is the distinction of rotor position feedback in the excitation which is most important, not the shape of the back emf waveform. Indeed, no PMSM machine has a back emf waveform which is a perfect sinusoid or a perfect trapezoid, and so this would seem to be a poor criterion on which to make a classification. Henceforth, we will use the term PMSM to describe any permanent magnet synchronous machine (regardless of the shape of the back emf) and brushless dc machine to describe the combination of an inverter fed PMSM with rotor position feedback (either actual or estimated).

This work will proceed as follows. First, in Chapter 2, the focus will be on the modeling of PMSMs. This description will start with the machine geometry, and proceed with the development of a variety of qd0 models. Next, in Chapter 3, the control of the PMSM is considered. With the basic models and control algorithms set forth, the design of a PMSM is considered in Chapter 4. In Chapters 2-4, work will focus on PMSMs with sinusoidal back emf waveforms. In Chapter 5, machines with non-sinusoidal back emf waveforms will be considered. Finally, in Chapter 6, high speed brushless dc machines will be considered.