

CHAPTER 8

CONCLUSIONS AND SUGGESTIONS FOR FURTHER WORK

8.1. Conclusions

An interior permanent magnet machine operating in generator mode was tested and analyzed. The modeling of the IPM machine included the effects caused by the changing saturation and armature reaction dependent axes inductances and magnet flux linkage. Experimental data were recorded for the following types of loads presented to the PM machine: an impedance load, a rectifier load, a rectifier-PWM-boost-resistive load, a rectifier-PWM-buck load, and a one horsepower induction motor.

A closed form solution, which avoided iterative techniques, was developed to model the impedance load for the cases when there is and is not capacitive shunt compensation. The experimental data for the impedance load strongly corroborate the closed form model.

The simulation of the IPM machine feeding the rectifier, rectifier-buck, and rectifier-boost loads took into account the effects due to commutation overlap. Matlab's Simulink was found to be an excellent tool to model the passive switches of the rectifier and the externally controlled switches of the buck and boost converters. The steady state models developed for the rectifier, rectifier-buck, and rectifier-boost loads made use of switching function theory to model these loads as an effective resistance at the terminals of the PM machine.

The steady state solution for the IPM feeding the induction motor (IM) was corroborated by the experimental data taken. The simulation of the IPM-IM topology feeding three different types of loads was also presented.

8.2 Suggestions for Further Work

There are several things which could have improved the accuracy of the model used to describe the IPM machine. Using finite element analysis for the determination (and/or corroboration) of the parameters would have been useful. In addition, finite element analysis would have provided the opportunity to determine the value of the rotor leakage inductances. Also, a more accurate method of measuring the torque angle (such as using a commercially available torque angle meter) would have almost certainly improved the accuracy of the model.

Also, both the IPM machine and the steady state rectifier model could have been modeled in the abc reference frame. In modeling the IPM machine in the abc reference frame, the magnetic nonlinearities and the space harmonics in the flux density waveforms and winding flux linkages could have been included. This, however, would have necessitated making the parameters of the machine not only functions of either the stator current or mutual flux linkage, but also as functions of the rotor position. The steady state model of the rectifier in the abc reference frame would have allowed the inclusion of the effects caused by commutation overlap.

Finally, it would be instructive to implement a control system for the IPM-rectifier-buck and IPM-rectifier-boost systems. The ultimate goal of the control system would be to maintain a desired load voltage over a range of frequencies and load impedance values.