University of North Carolina at Charlotte
Department of Electrical and Computer Engineering
ECGR 4143 Electrical Machinery Fall 2009

Supplement for Problem Set 5
Experimental Motor

We have constructed a small machine that can serve as either a permanent magnet synchronous machine or as an induction motor. We do not pretend that this machine offers particularly high performance nor that it would be a good motor or generator for any application. It is, however, fairly easy to understand and you can see all of the parts.

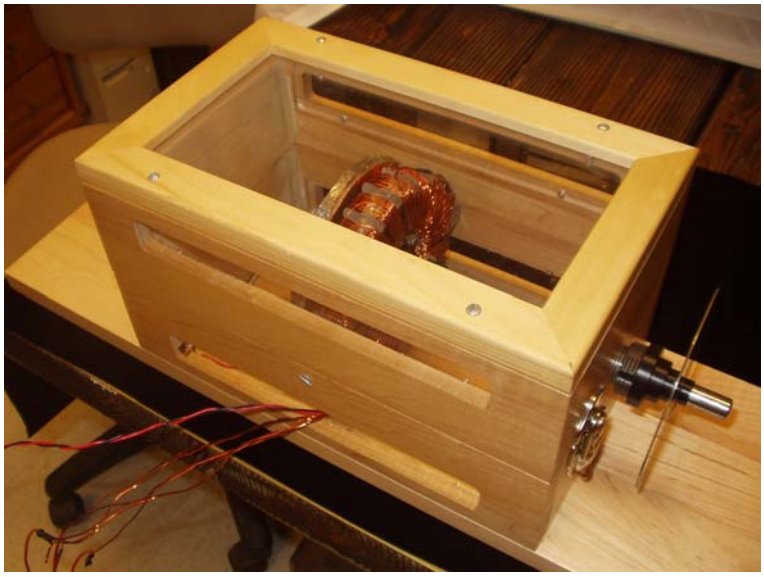

Figure 1: Experimental Motor Apparatus

The machine is shown in its case in Figure 1. The lid of the wooden case is mounted on hinges and latches closed. When you open the case you can see the actual apparatus. The machine stator is mounted firmly to the case. The rotor of the machine turns in bearings that rest in cavities in the ends of the box. When the lid is closed and latched the bearings are held firmly and the machine can be made to rotate.

Some important details about external connections:

- Three phase leads are provided. Each of this is connected to one side of one of the phase coils.
- An additional neutral or “star point” where are all of the windings are connected is also provided

- At one end, visible to the right hand end of Figure 1, is provision for mounting a disk to be used as a position or speed sensor (actually, we use a CD: they are inexpensive and of just the right shape for our purposes).

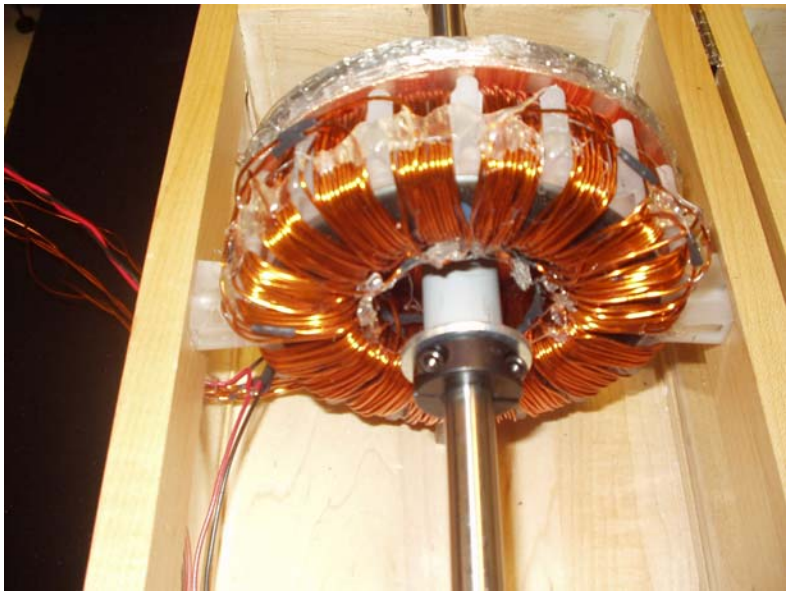

Figure 2: Stator

The machine stator is shown in Figure 2. The stator has a three-phase, six pole winding wrapped around it. Note that there are 18 coils wrapped concentrically around a toroidal core made of powdered iron. There are also plastic formers that hold the coils in place.

Figure 3 shows the rotor disks that are available for the machine. The rotors both employ a steel disk that is keyed to fit onto the shaft. One side of that disk has twelve pockets into which can be fit small circular permanent magnets. The other side of the disk is smooth. Since there are twelve magnet pockets in each of the disks, to make a six pole motor the magnets are mounted in pairs: two ‘north’ then two ‘south’ then repeat

Figure 3: Permanent Magnet Rotor Disk

Figure 4 shows the setup for a permanent magnet rotor. Note the rotors are held in place with locking collars which are clamped together using internal hex key type screws.

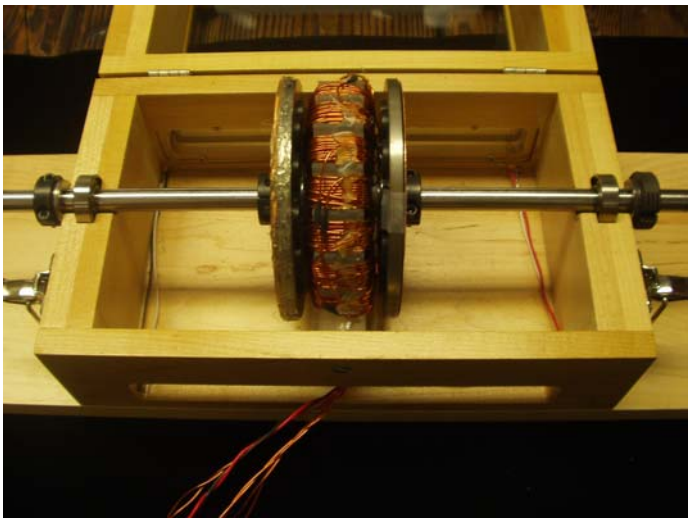

Figure 4: Motor with Permanent Magnet Disks

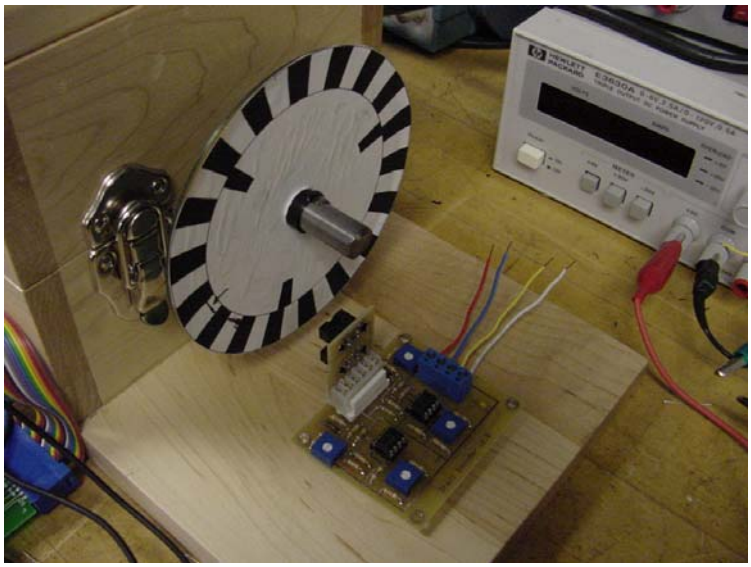

Figure 5: Position/speed Sensor

Pictured in Figure 5 is a pre-production version of our position/speed sensor. A photo-source/photo-transistor combination is mounted so that light reflects from a disk that rotates with the shaft of the machine. That disk is mounted on a plastic bushing that is in turn mounted on the shaft. Two channels of signals are available from the position sensor card, which is shown in more detail in Figure 6. You should examine this card and make sure you know how it works.

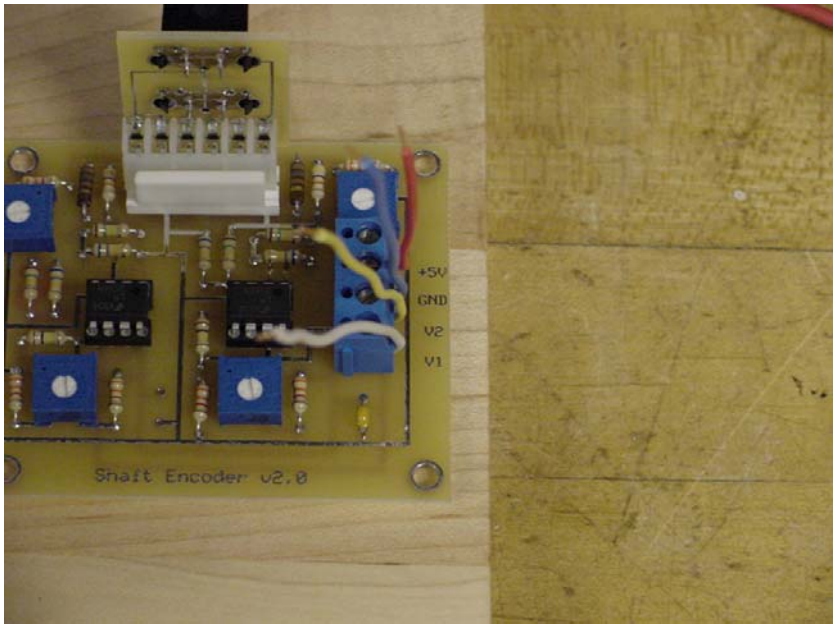

Figure 6: Details of Position Sensor Card showing connections.

Finally, when you are doing preliminary experiments on the machine in its Permanent Magnet configuration you will need to use a lever arm and spring scale to measure torque. These are pictured in Figure 7.

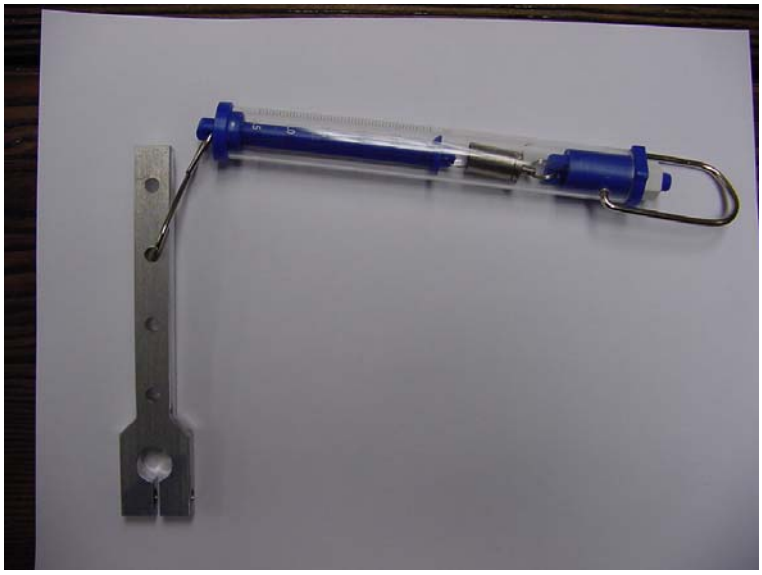

Figure 7: Lever Arm and Spring Scale