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EE 360

Design of DC Motor Starter

In order for a dc motor to function properly, it must be protected from physical damage during the starting period. At starting conditions, the motor is not turning, and so E_A = 0 V. Since the internal resistance of a normal DC motor is very low, a very high current flows. It is possible for a motor to be severely damaged by such currents, even if they last for only a moment.

A solution to the problem of excess current during starting is to insert a *starting resistor* in series with the armature to limit the current flow until E_A can build up to do the limiting. This starting resistor must not be in the circuit permanently, because it would result in excessive losses and would cause the motor's torque-speed characteristic to drop off excessively with an increase in load.

In modern practice, a starting resistor is made up of a series of pieces, each of which is removed from the motor circuit in succession as the motor speeds up, in order to limit the current in the motor to a safe value while never reducing it to too low a value for rapid acceleration.

Two actions are necessary in order to make a working motor starter. The first is to pick the size and number of resistor segments necessary in order to limit the starting current to its desired bounds. The second is to design a control circuit that shuts the resistor bypass contacts at the proper time to remove those parts of the resistor from the circuit.

In this design problem, the first action only is addressed. An automatic starter circuit is to be designed for a shunt motor rated at 15-hp, 240-V, and 60-A. The armature resistance of the motor is (0.15 + 0.X) Ohm, and the shunt field resistance is (40 + X) Ohm. The motor is to start with no more than (250 + 5X) percent of its rated armature current, and as soon as the current falls to rated value, a starting resistor stage is to be cut out.

Determine how many stages of starting resistance are needed, and how big should each one be?

(Note that "X" is your serial number, e.g., 01, 02, 10, 12, 20, ..etc.)