EE 56◎ – Electric Machines and Drives

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Homework #2 – Due November 16th, 2020

Analysis of DC Current Regulators for High Performance Drives

You are the controls engineer for XYZ Company and your boss has asked you to analyze and "tune" a current controller for a DC motor drive system. Not having a lot of experience tuning current regulators, you decide to systematically analyze the system and simulate its dynamic response.

To do:

a. Given the two different DC motors from HW1, determine the values of K_p and K_i to yield a 1000 Hz bandwidth at locked rotor (zero speed). Assume that there is a voltage amplifier gain $K_v = 680\frac{V}{V}$. See figure 1. Note: the current regulator gain formula in the notes don't assume there is a voltage amplifier gain so you will need to account for this additional gain when calculating the values of K_p and K_i.
b. Implement proportional plus integral (PI) control in PLECS.
c. Using PLECS, simulate the motors at locked rotor conditions using an ideal voltage source. Use a saturation block to limit the maximum voltage to +/- 680V.
d. Given a current command of $i^*(t) = I_o \sin(2\pi f_c t)$ where $I_o = 5A$ and $f_c = 1, 10, 100,$ and 1000 Hz, plot the command and response of the current regulator as functions of time.
e. Evaluate the performance of the system when the rotor is free to rotate. What improvements can be made to enhance this performance?
f. Repeat steps c-e with an H-bridge inverter with a 680V bus.
g. Provide a highly organized report with very clear figures and equations. The report should detail the design and analysis of the current regulator and list observations. (Keep main body of report to four pages or less.)

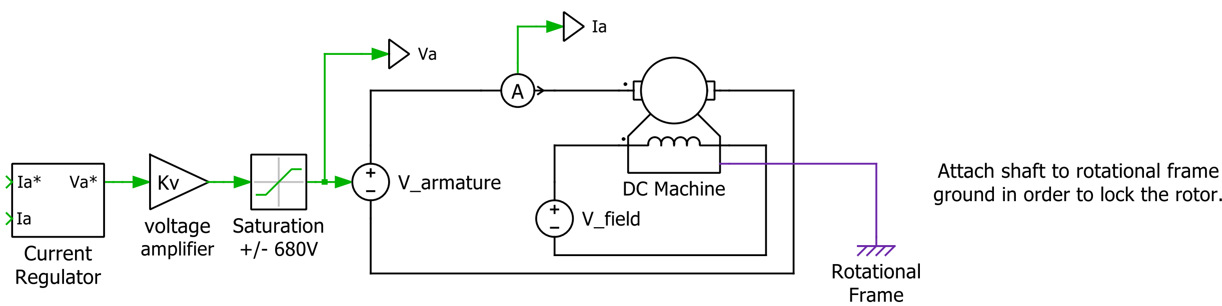

Figure 1: Implementation of Locked Rotor DC Motor in PLECS