A Passivity-based Control and Simulation for double cascade DC/DC Converter with a fuel cell

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Abstract

The energy is the biggest world’s interest in our days for many reasons as the excessive consumption and the pollution due to this abuse of energy. Then many researches are done to overcome those problems, and several solutions are proposed which has led to a serious shift towards developing renewable sources as PEM Fuel cells to meet the need of the hour.

This paper treat a synthesis of a cascade of two BOOST converters used with a fuel cell, where we have begun by presenting a static model of a fuel cell, then we elaborate a nonlinear model of the whole system, the model can be derived using Euler-LaGrange (EL) system equations.

The second part of this work is about the controlling of the system, as there are many nonlinear methods developed to control the DC-DC converters we decided to use a passivity based control because it is a global defining and global stabilization control method, which is based on the viewpoint of the system energy. The controlling method is to modify the potential energy function and the required loss dissipation function of the close loop system by introducing a suitable stabilizing damping injection scheme. The simulation results have been performed through Matlab/SimPowerSystems environment and show that the designed controllers meet their objectives.

Figure 1: double boost converter with the passivity based controller
Where $i_{L_1}$ and $i_{L_2}$ are respectively the currents in inductors $L_1$ and $L_2$. $v_{c_1}$ denotes the voltage in capacitor $C_1$ and $v_{c_2}$ is the output voltage. $\mu_1$ and $\mu_2$ are denoted the duties ratio functions:

$$\mu_j( j=1,2) = \begin{cases} 
1 & \text{if } T_j \text{ is ON and } D_j \text{ is OFF} \\
0 & \text{if } T_j \text{ is OFF and } D_j \text{ is ON} 
\end{cases}$$

And $x_1$, $x_2$, $x_3$ and $x_4$ denote the average values over cutting periods, of the signals $i_{l_1}$, $v_{c_1}$, $i_{l_2}$ and $v_{c_2}$. The controls inputs for the above model is the functions $u_1$, $u_2$ called duty ratio function, which is the average values over cutting periods of signals $\mu_1$, $\mu_2$.

$x_2^*$ and $x_4^*$ denote the corresponding voltage’s references signals.

**Keywords**

Passivity based control, fuel cells, DC-DC converter, double cascade boost, non-minimum phase.