Comparative study of two sliding surfaces to control a double boost converter

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Abstract

To keep up with the progress of the technology in invention's world and electric installation, there is a vital part which is needed to be developed and improved, this one is the conversion of energy or more precisely the power electronics which steel pose many problems in term of stability, response time and circuit's harmonics etc.

To overcome those problems, we focus on the automatic control of the electronic systems with chosen the most appropriate method and parameters, about the methods there is plenty as backstepping, passivity, flatness and sliding mode approach, whose give good and satisfying results.

In this paper, we study and control a double cascade boost converter, this system is just a cascading of two identical elementary simple boosts which allows us to improve the voltage gain without using systems with high frequency. The system dynamics have been described by the averaged 4th order nonlinear state space model (1). Based on such a model and taking account the non-minimum phase nature of the converter, two robust non-linear controllers are synthesized using the sliding mode approach, where each controller use a different surface and a different structure, and as the converter comprise two stages we will control each stage separately.

The first controller is elaborate with the traditional surface proposed by UTKIN, moreover because of the non-minimum phase of the double boost converter the regulator must comprise two nested loops, where the inner currant loop is designed with the sliding mode approach and we used the famous PI linear controller to design the outer voltage loop, in the other hand a second controller is also designed with the sliding mode approach, but this time with different sliding surface, this surface which is proposed by Alaa HIJAZI, allows us to use a single control loop to regulate the currant and the voltage in the same time. The simulation results have been performed through Matlab/SimPowerSystems environment and show that the designed controllers meet their objectives.

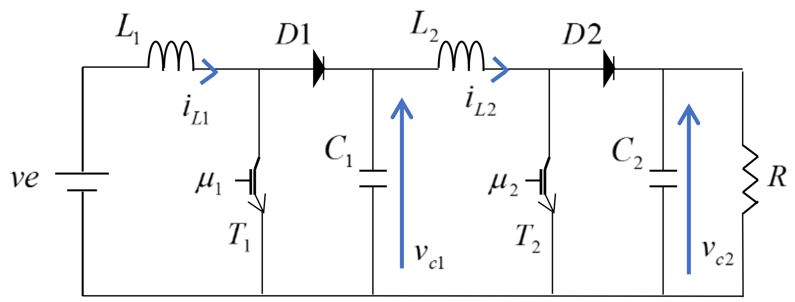

Figure 1 the structure of double boost converter

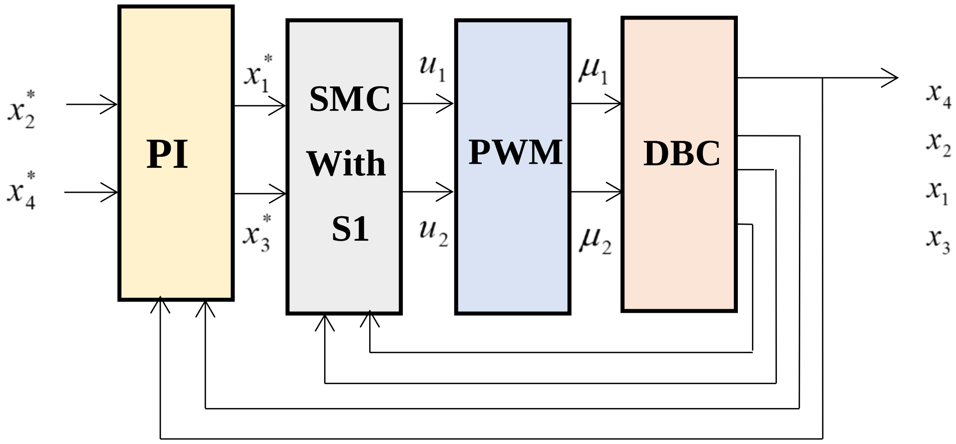

Figure 2: structure of the system with a regulator designed with two loops

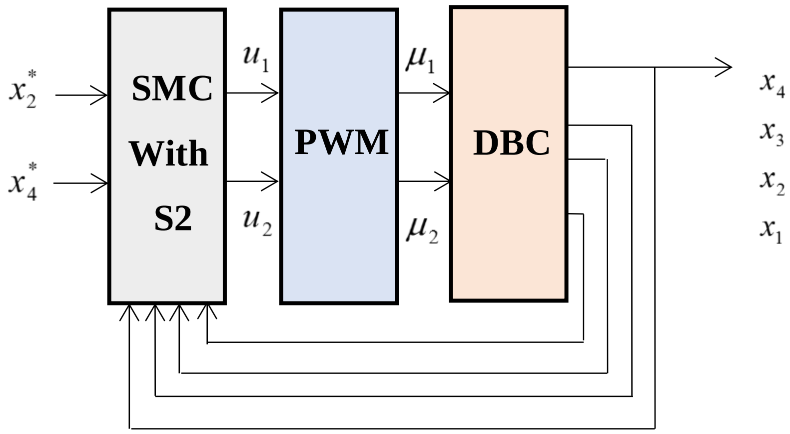

Figure 3: structure of the system with a regulator designed with single loop

Where i_{L1} and i_{L2} are respectively the currents in inductors L_1 and L_2. v_{c1} denotes the voltage in capacitor C_1 and v_{c2} is the output voltage. μ_1 and μ_2 are denoted the duties ratio functions:

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

And x_1, x_2, x_3 and x_4 denote the average values over cutting periods, of the signals i_{l1}, v_{c1}, i_{l2} and v_{c2} . 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 μ_1, μ_2.

x_1^* and x_3^* denote the corresponding currant's references signals, x_2^* and x_4^* denote the corresponding voltage's references signals.

Keywords

Sliding mode approach, DC-DC converter, double cascade boost, non-minimum phase.