Cascaded Boost-Buck Converter with Hysteresis Controller

Vipul Agarwal  
E, E&I Department  
Moradabad Institute of Technology  
Moradabad (U.P.)  
e-mail: vipul.agarwal85@gmail.com

Ritu Rajan  
E, E&I Department  
Moradabad Institute of Technology  
Moradabad (U.P.)  
e-mail: riturajan11@gmail.com

Devesh Kumar  
E, E&I Department  
Moradabad Institute of Technology  
Moradabad (U.P.)  
e-mail: mit.devesh@gmail.com

INTRODUCTION

The title of this paper is Cascaded Boost-Buck Converter with Hysteresis Controller. Here the two DC-DC converters are required to be designed separately and form a cascaded structure, this structure is required to be connected to the hysteresis controller for the power factor correction of the rectifier unit. A PID controller is used with buck converter so as to regulate the voltage and also a PID controller is used along with the hysteresis controller so as to reduce the effect of error. The basic block diagram of the required model is shown in Figure 1.

ABSTRACT

This paper introduces improved performance of Buck & Boost converters along with hysteresis controller. Buck & Boost converters need to be designed separately constituting a sub-system, cascaded and then connected along with hysteresis controller to constitute a system for power factor correction.

Keywords: Buck, Boost, Hysteresis, PWM Converter.

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PRINCIPLE OF OPERATION

The basic aim of this paper is to improve the performance of DC converter and this operation is performed by hysteresis controller. Thus it utilizes the basic principle of hysteresis controller that the output current produced at the output terminal of hysteresis controller is compared with reference current, applied at the input of hysteresis controller so as to produce the difference i.e. error and then that error compared with the hysteresis width so as to produce the desired voltage pulse. It will be more clear after having a look on modelling part.

Modelling of Buck Converter

In State space the equations for buck converter can be written as follows:
Inductor Current:
\[ I_L = \frac{dV_i - V_o - I_L R_L}{sL} \]

Output Voltage:
\[ V_o = \left( \frac{1}{sC} + R_C \right) I_C \]

Where, \( V_i \) is input voltage, \( I_L \) is the inductor current, \( V_o \) is the output capacitor voltage, \( L \) is the inductance, \( C \) the output capacitance, \( R_L \) is the resistance used in series with inductor \( L \), and \( d \) is the switching function corresponding to the controlled switch.

Modelling of Boost Converter

![Figure 3: Basic circuit diagram of boost converter](image)

In State space the equations for boost converter can be written as follows:

Inductor Current:

\[ I_L = \frac{dV_i - V_o - I_L R_L}{sL} \]

Output Voltage:
\[ V_o = \left( \frac{1}{sC} + R_C \right) I_C \]

Where, \( V_i \) is input voltage, \( I_L \) is the inductor current, \( V_o \) is the output capacitor voltage, \( L \) is the inductance, \( C \) the output capacitance, \( R_L \) is the resistance used in series with inductor \( L \), and \( d \) is the switching function corresponding to the controlled switch.

Modelling of Hysteresis Controller

![Figure 4: Basic circuit diagram of Hysteresis controller](image)

In State space the equations for Hysteresis Controller can be written as follows:

Modelling of Hysteresis Controller

![Figure 4: Basic circuit diagram of Hysteresis controller](image)

FEATURES

Cascaded Boost-Buck PFC Regulated Supply
A Boost-Buck PFC regulated supply is considered here. The front-end rectifier is a hysteresis controlled boost converter. The power stages are shown in Figure 5. The input boost stage provides power factor correction & buck is used for voltage regulation at the load.

![Figure 5: Cascaded boost-buck PFC regulated supply](image)

SIMULATION
All the models are simulated on Simulink. The waveforms shown are actual output.

![Figure 6: Waveform for buck converter at simulation stop time=3*10^-6](image)

![Figure 7: Waveform for boost converter at simulation stop time=3*10^-6](image)
CONCLUSION

The topic proposes a simple, low-cost harmonic analogue controller to modulate the duty cycle of the cascaded boost-buck switch such that the harmonics of the input current is reduced and the overall THD is improved.

The duty cycle need to be varied within a fixed switching period such that the low-order harmonics of the input current get attenuated.

From the waveforms shown above, it is clearly seen that by using hysteresis controller the harmonics as well as ripples are reduced.

REFERENCES