A control method of Boost converter

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Abstract- **In the scope of our investigation, we have solved the stability problem of the boost converter. Ouyang Changlian's doctoral dissertation made me realize the importance of duty cycle in control system.**

Index Terms—duty cycle,control system,boost converter

I. INTRODUCTION

We use a few special symbols, hoping to present the current instructions in a way that would be easier to understand.

$$i_{ref} = i_{ref} \uparrow + i_{ref} \downarrow = i_k^{\mu} \tag{1}$$

The above formula means that the current instruction gain in the inductor current down stage is different from the current instruction gain in the inductor current up stage.

i_{ref} appears as an intrinsic property.

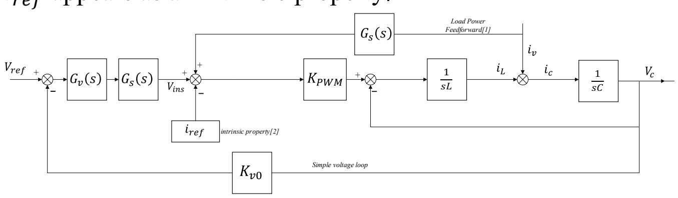

Fig. 0. Universal control topology.

At first, we tried to create a control method that naturally reflected the duty cycle, and put our hopes in the current loop.

Secondly,we may get the formulas below.

$$i_{ref} = k_{i0}(k_{i1}i_L + k_{i2}i_c + k_{i3}i_v) \tag{2}$$

$$i_{ref} = k_{i4}(2k_{i5}i_L - k_{i6}i_{MOS}) \tag{3}$$

As $k_{i2} > k_{i3}$, load power feedforward is not required.

Additionally,the control method also works fine for buck.

Obviously,from formulas (1) to (3), we can get formulas below.

$$\begin{gathered} i_{ref} = i_L + 3i_{Diode} \\ i_{ref} = i_{DC\_Source} + 4i_{Diode} \\ i_{ref} = -i_{DC\_Source} + 4i_L \end{gathered} \tag{4}$$

$$i_{ref\_FullBridge} = 4i_{Q2} + i_{Q4} \tag{5}$$

i_{Q2} is current of down leg in the inductor current down stage,i_{Q4} is current of down leg in the inductor current up stage

Finally, we get one of the control block diagrams.

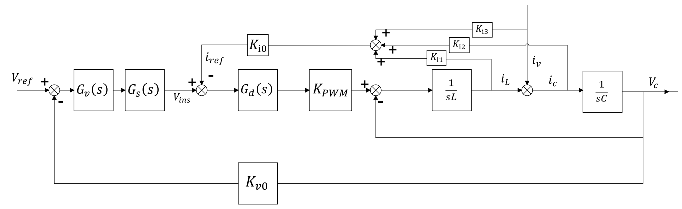

Fig. 1. Control topology.

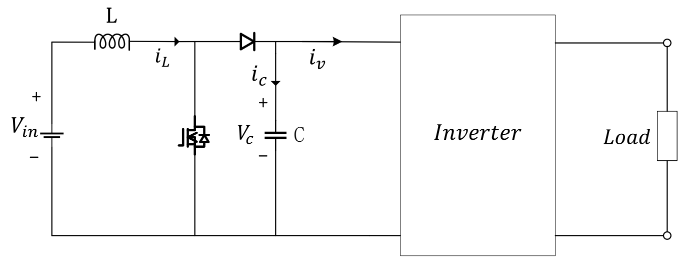

Fig. 2. Circuit topology.

II. DISCUSSION 1

Simulating on Simulink,the control method works well.

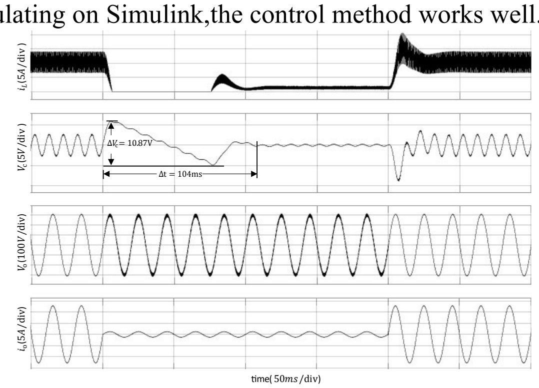

Fig. 3. Full view of the waveform.

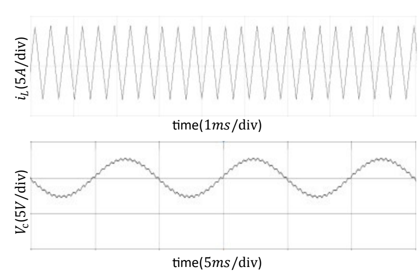

Fig. 4. Detail of Waveform.

First of all,after charging the capacitor to the supply voltage, increasing V_{ref} linearly to start converter softly.

From 200V boost to 400V, the power of inverter is 2 kW.The frequency of Switch is 2.7 kHz. $G_v(s)$ and $G_d(s)$ are PI controllers.$G_s(s)$ is a notch filter controller.When the system load is 50ms, it decreases from 100% load to 10% load, and increases from 10% load to 100% load at 250ms. When partial load is discarded, the bus voltage recovery time is only about 104ms, and the maximum bus voltage jitter is 10.87V. The system dynamic response characteristics are excellent.

There is a control method of us in 2022[1].There is a preprint in 2024.

III. Discussion 2

$$i_{ref1} = i_L + i_c + i_v - i_{ZVS} \tag{6}$$

$$i_{ref2} = 2i_L - i_{MOS} - i_{lr} \tag{7}$$

The above formula means that to compare the ZVS-Boost converter, the freewheeling/flyback diode branch current i_{ZVS} of the resonant circuit needs to be subtracted from i_{ref1}. The current i_{lr} of resonant inductance needs to be subtracted from i_{ref2}.

The amplitude of the PWM input signal should match the amplitude of the carrier.

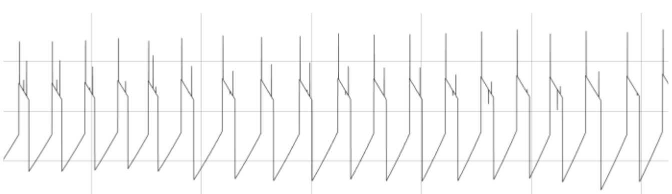

Fig. 5. Input side signal of PWM generator without i_{ZVS} in transient process.

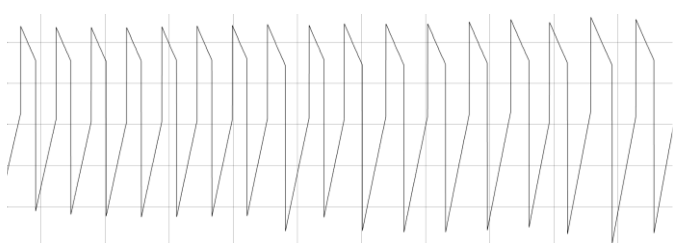

Fig. 6. Input side signal of PWM generator with i_{ZVS} in transient process.

References

[1] Xu Qinghan, Meng Xianhui, Yang Ling, Ye Meiting, He Jianglun. NF+QPR+LPF Dual-Loop Secondary Harmonic Current Suppression Method for Energy Storage System in DC Microgrid. Transactions of China Electrotechnical Society, 2022, 37(20): 5188-5200.

[2] He Jianglun. A control method of Boost converter [Z].chinaxiv,2024.