Scholars Journal of Engineering and Technology
Abbreviated Key Title: Sch J Eng Tech
ISSN 2347-9523 (Print) | ISSN 2321-435X (Online)
Journal homepage: https://saspublishers.com

Research on Modeling and Control Method of DC-DC Converter

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DOI: 10.36347/sjet.2021.v09i09.003 | **Received:** 11.09.2021 | **Accepted:** 18.10.2021 | **Published:** 21.10.2021

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Abstract **Original Research Article**

Since mankind entered the industrial society, DC-DC converters have been used in many industries. The function of the DC-DC converter is a module that converts DC voltage into DC voltage, which can also be called a power processing system. The main content of this article is to explain the basic principles of Buck converters, and perform modeling and simulation on the MATLAB platform to prove the feasibility of expectations.
Keywords: DC-DC converter; Buck converter; MATLAB software; Modeling; control.

INTRODUCTION

The rapid development of various electronic devices now requires a stable power supply as a basis, and stable power supply relies on DC-DC converters to achieve. DC-DC converters are widely used in various electronic devices due to their small size, low loss, and high conversion efficiency.

The development of the new energy industry is the general trend of the times. The renewal and replacement of DC-DC converters is an important research direction at present, and the reforms are studied in terms of improving integration, improving resource utilization efficiency, and reducing energy consumption [1]. The most prominent research in this area in my country is the two professors Wang Zhaoan and Liu Jinjun, headed by the Electric Power Laboratory of Xi'an Jiaotong University in my country, who have made outstanding contributions to the research of control methods [2].

Foreign scholars have proposed a digital control method for PI control to improve the conversion efficiency, and through actual simulation verification and combined actual research and analysis, the Buck converter has completed the simulation verification and actual control [3]. Nowadays, in terms of the digital technology control of DC-DC converters in the international market, the core position is mainly the American Microchip Technology Company, which is not only relatively mature in digital technology, but also more prominent in PWM integrated circuit technology [4] and in the management and control of DC-DC, led by TI company, achieved the advantages of smaller size, low research cost, and higher conversion efficiency [5].

Buck Converter

The working principle of the Buck converter is as follows: In the control pulse whose output period of the switch drive regulator is T, the frequency is f, and the duty cycle is D, when controlling the turning on and off of the power switch tube: Assume that in a certain period, the power tube The turn-on moment is t_0, the turn-off moment is t_1, and the next turn-on moment is t_2. Then in this cycle, the on time and off time of the power switch is $t_{on} = t_1 - t_0$, Off time is $t_{off} = t_2 - t_1$, $T = t_{on} + t_{off}$, $D = t_{on}/T$. Figure 1 shows the topology of Buck switching power supply:

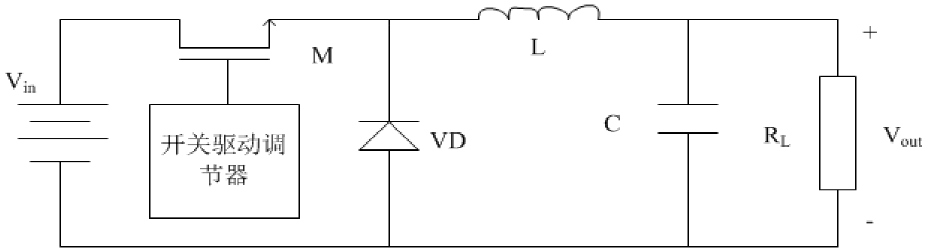

Figure 1: Buck converter topology

The main commonly used control methods of Buck converters are the following, one is voltage control, the oter current control [6]. Among them, the voltage type system method is relatively simple, and the anti-interference ability is relatively strong compared with the current type control, but the current type control has a faster response speed [7]. As shown in Figure 2 below:

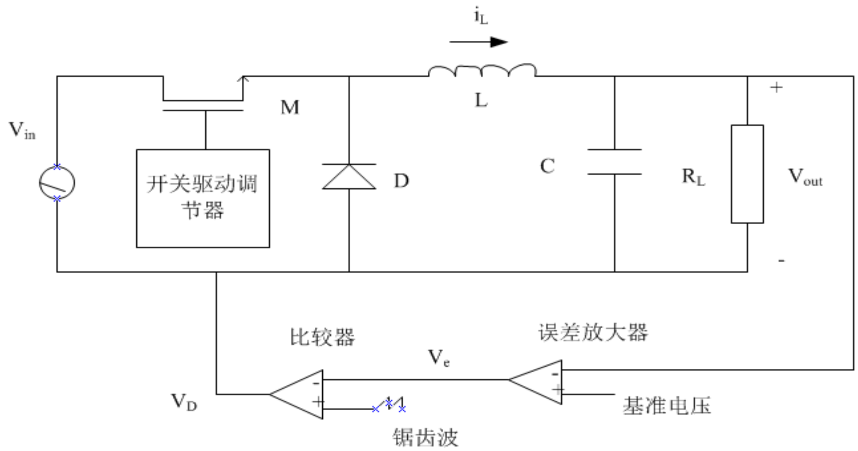

Figure 2: Voltage type control

Simulation of Buck DC-DC Converter

Simlink is used on the MATLAB platform to model the Buck converter [8]. In the simulation, the main circuit parameters are: input voltage is 600V, filter inductance is 2mH, capacitance parameter is 1mF, load is 10Ω, reference voltage is 450V, and control parameters are $h_1 = 10$, $h_2 = 1000$, η=2.5, $c = \frac{1}{RC}$. The switching frequency is 2kHz. The simulation diagram is shown in Figure 3:

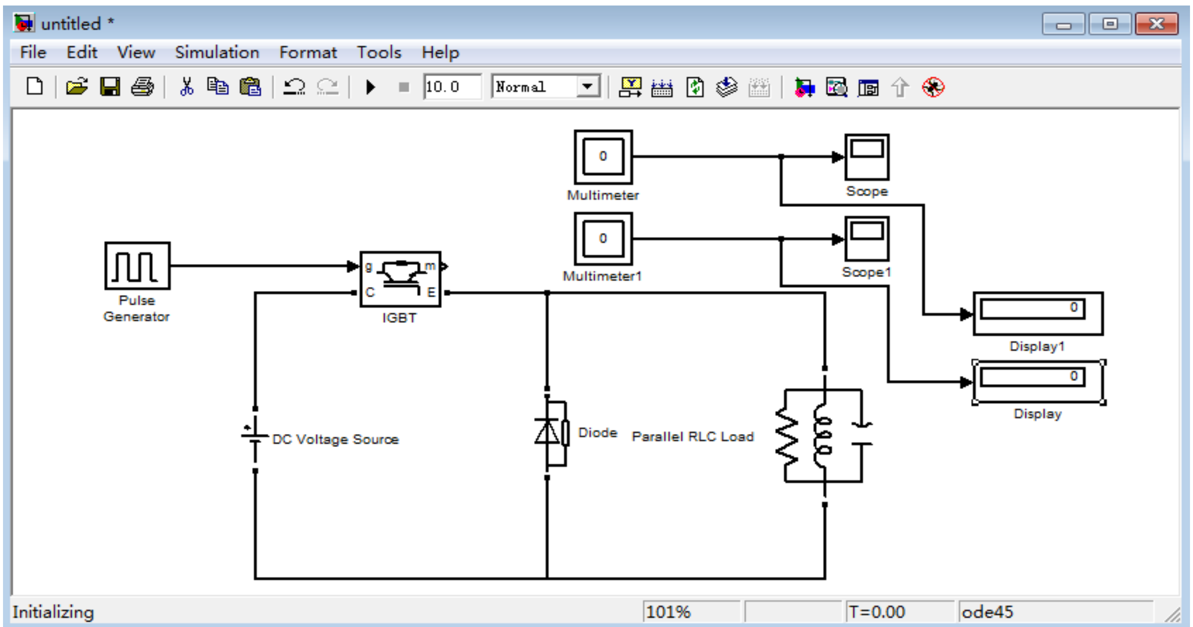

Figure 3: Simlink simulation diagram

The capacitor voltage waveform after operation is shown in Figure 4, and the steady-state voltage value V=29.74V. MATLAB gives an overshoot of 46.905% at startup.

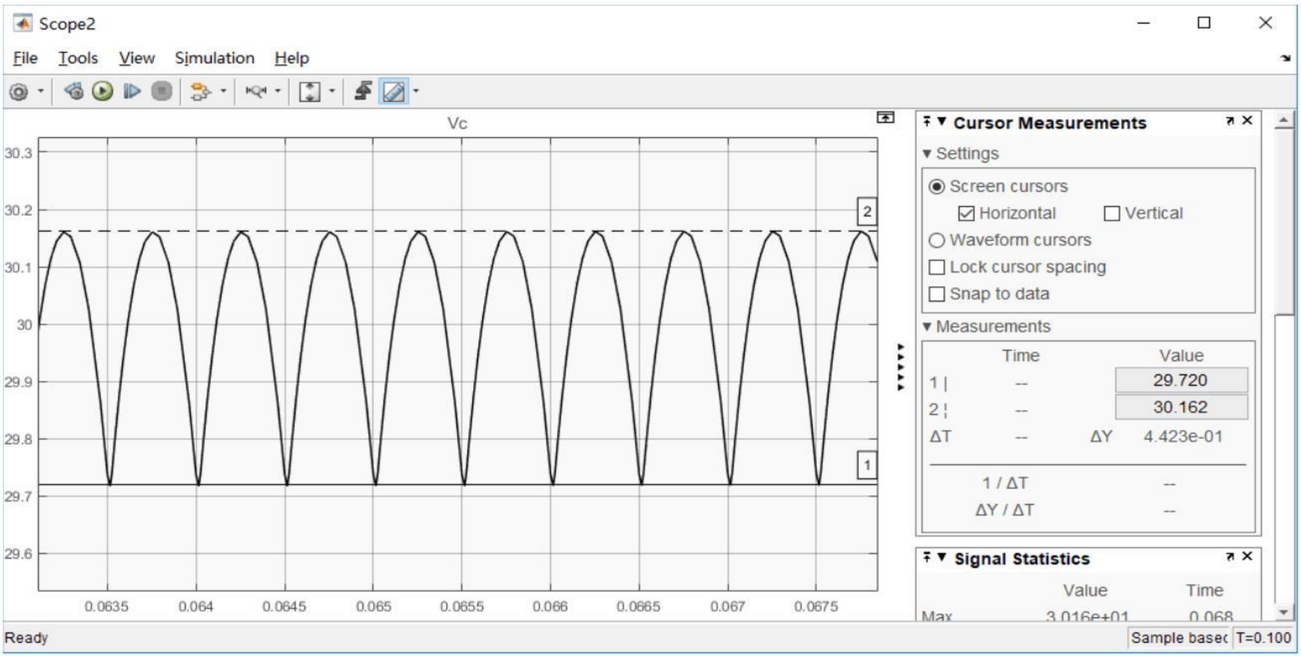

Figure 4: Capacitor voltage waveform

The maximum voltage is$U_{max} = 30.162V$ in Figure 5; the minimum voltage is$U_{min} = 29.720V$.

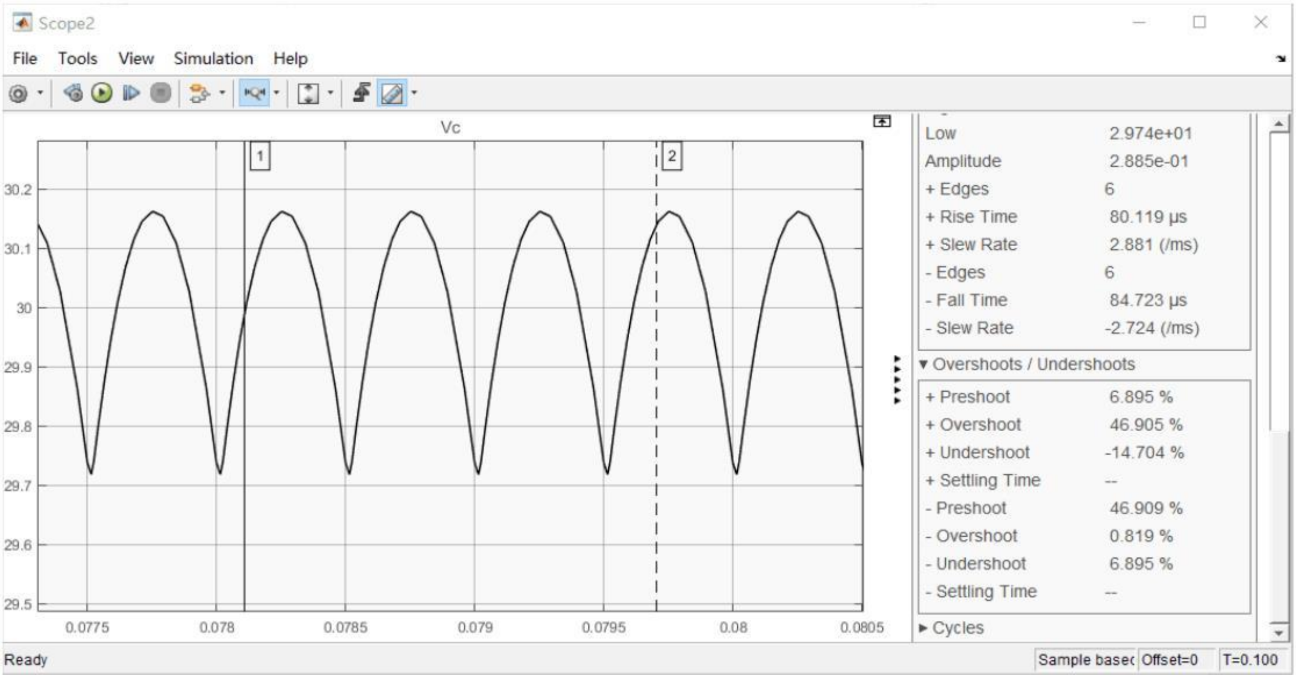

Figure 5: Ripple voltage waveform

The maximum current in is I_{max} =13.568A Figure 6; the minimum current isI_{min} =6.479A.

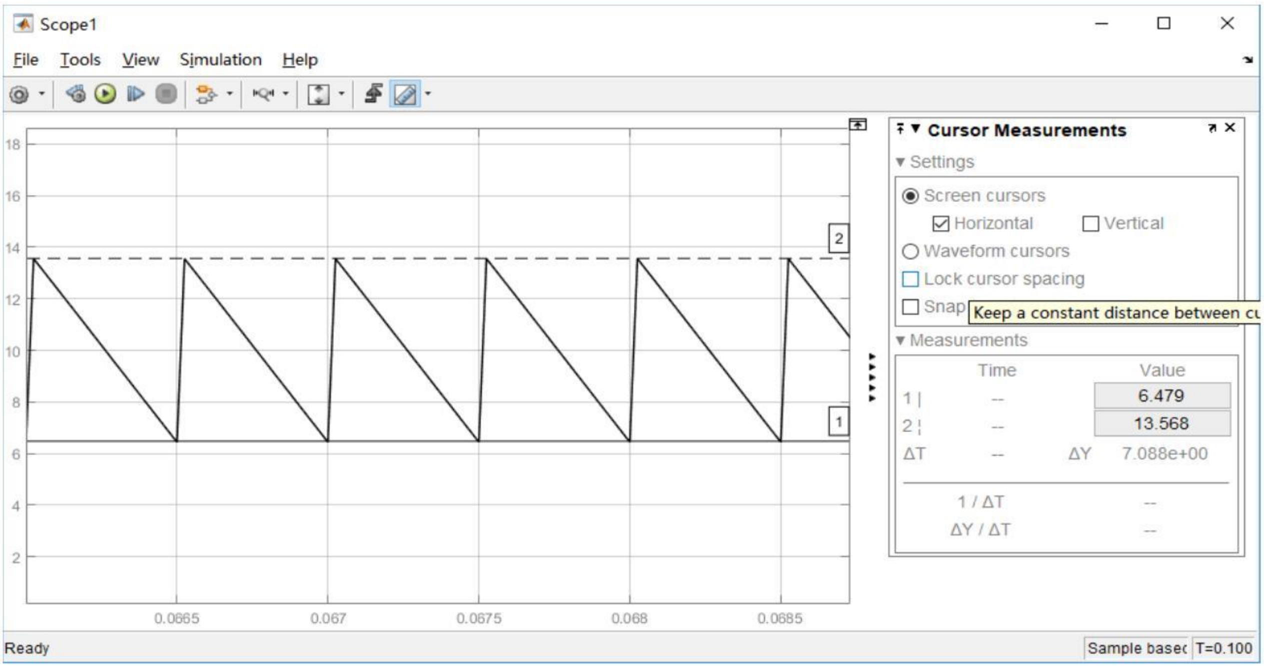

Figure 6: Ripple current waveform

SUMMARIZE

In this paper, the main sub-modules of Buck converter are designed and modeled, Through the simulation results, the correctness and feasibility of the Buck converter modeling has been verified, and we can find that the modeling can track the given value in a very short time without overshoot, and the control method is faster In the steady state of the system, the ripple of the output voltage is smaller and the accuracy is higher [9]. Through modeling under ideal conditions, the accuracy of the conjecture was verified, and a certain contribution was made to the development of actual DC-DC converters.

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