SINGLE-INDUCTOR BIPOLAR OUTPUTS POWER CONVERTERS

Yi-Ta Li*, Kuo-Bin Liu, Bao-Sheng Wang, Chen-Yao Liu, Yong Seng Wong
NSRRC, Hsinchu, Taiwan

Abstract

In the circuit design for electronic products, a bipolar power supply is essential. A non-isolated dual polarity power supply design is using two inductors to achieve this function. The number of inductors on the circuit would increase both the cost of products and space requirement. So using a single inductor bipolar power converter design can effectively reduce the cost and space to enhance product competitiveness. In this paper, the principle of a new single-inductor bi-polar power converter will be described and tested to prove the feasibility of this design.

INTRODUCTION

In the circuit design of electronic products, bipolar power supplies are used in the non-isolated bipolar power supply design, it is necessary to use two inductors design. The number of inductors on the circuit will increase the cost and space burden, so the use of a single inductor bipolar power supply, which can effectively reduce the cost and space burden, enhance product competitiveness.

The design specification as shown in Table 1, with a common ± 15 volts is the voltage demand output voltage. The input voltage is set to +5 volts, the output impedance of each of 15K ohms; Figure 1 is a non-isolated boost converter prototype that boosts the input voltage by +5 volts to + 15V volts. Because the output voltage is ± 15 volts in the design specification, it must be used with two boost converters [1].

Table 1: The Specifications of Designed

	Set point	Unit
Input voltage	5	Volt
Output voltage 1	+15	Volt
Output voltage 2	-15	Volt
Output impedance 1	15K	Ohm
Output impedance 2	15K	Ohm

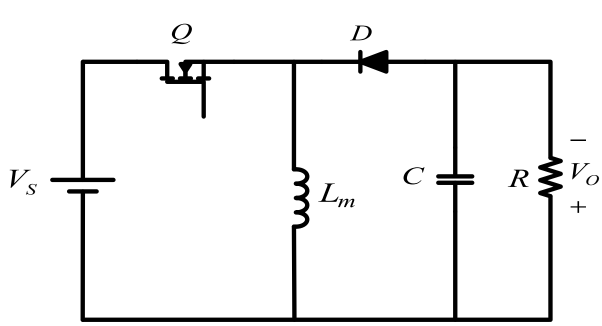

Figure 1: Non-isolated boost converter.

General non-isolated bipolar boost converter design is shown in Figure 2. The composition of the structure requires two non-isolated boost converter to do with the output voltage is responsible for the supply of positive voltage, while the output voltage is responsible for the supply of negative voltage. The advantage of this design is non-isolated bipolar boost converter can be used the control a single output voltage, in the control of the better design drawings.

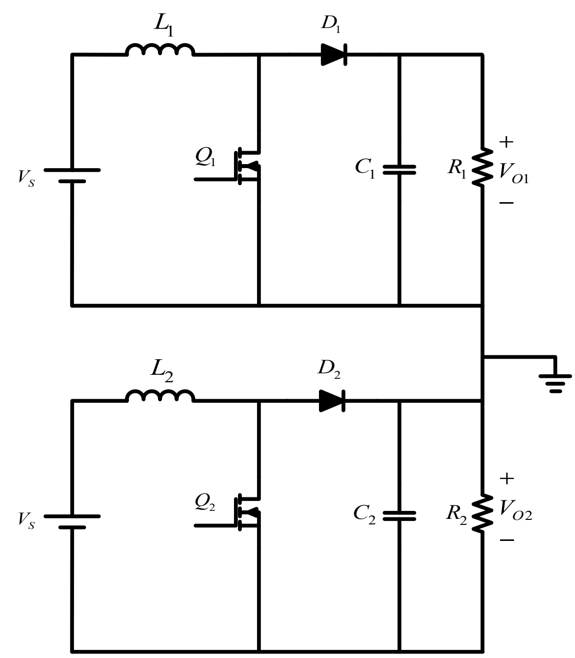

Figure 2: General non-isolated bipolar boost converter.

DESIGN OF SINGLE INDUCTANCE BIPOLAR OUTPUT POWER CONVERTERS

Single inductor bipolar output converter circuit diagram, is shown in Figure 3. The single inductor bipolar output converter is an updated design from the general non-isolated bipolar boost converter, which has the advantage of reducing the use of an inductor, space requirement and cost [2-3].

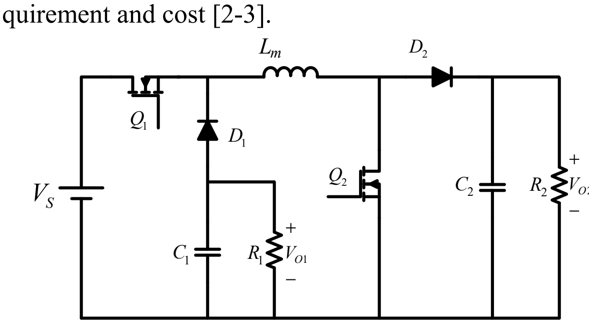

Figure 3: Single inductor bipolar output converter circuit diagram.

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Divided into four switching states are shown in Table 2. The first state is the power switch Q1 and Q2 are all conductive state, the equivalent circuit is shown in Figure 4. In this state, the positive and negative voltage output loads R1 and R2 are supplied with electric power from the capacitors C1 and C2, and the inductor Lm performs the charging operation in this state.

Table 2: Switch States

	Power Switch Q1	Power Switch Q2
State 1	ON	ON
State 2	ON	OFF
State 3	OFF	ON
State 4	OFF	OFF

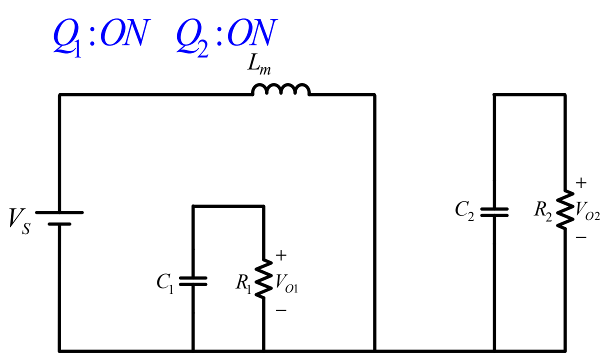

Figure 4: Switch State 1.

The second state is the power switch is turned on for the state, the equivalent circuit shown in Figure 5. In this state, the load is supplied by the capacitor, and the inductor is charged in this state.

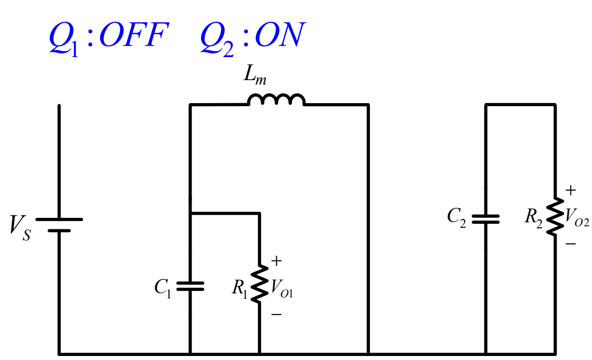

Figure 5: Switch State 2.

The third state is the power switch Q1 is turned off and Q2 is turned on, the equivalent circuit shown is in Figure 6. In this state, the load R2 is supplied with electric power from the capacitor C2, and the inductor Lm charges the capacitor C1.

The fourth state is both power switch Q1 and Q2 are turned off, the equivalent circuit is shown in Figure 7. In this state, the inductor Lm charges the capacitors C1 and C2.

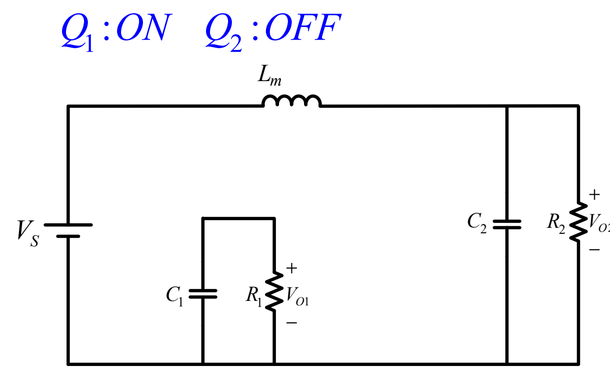

Figure 6: Switch State 3.

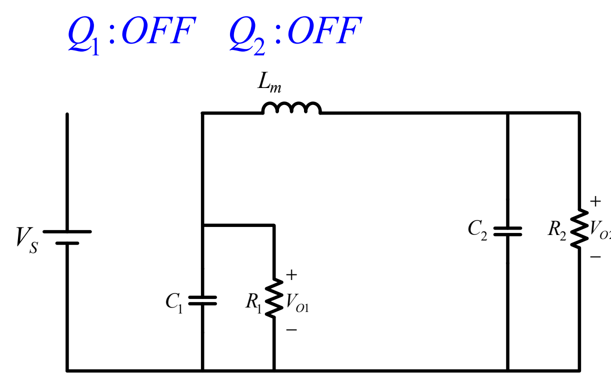

Figure 7: Switch State 4.

Through the use of the above four working conditions with each other, the charge on the capacitor and inductor, and the use of capacitors stored power when supply the elector power to the load. If the working condition is properly deployed, this architecture of the power supply can be stable supply of bipolar voltage.

EXPERIMENTAL ANALYSIS

In order to verify the feasibility of this design architecture, the actual circuit test is performed. The actual test circuit is shown in Figure 8, based on the Figure 3 for the circuit structure of the prototype, there are two switches, diodes, capacitors, and only one single inductor.

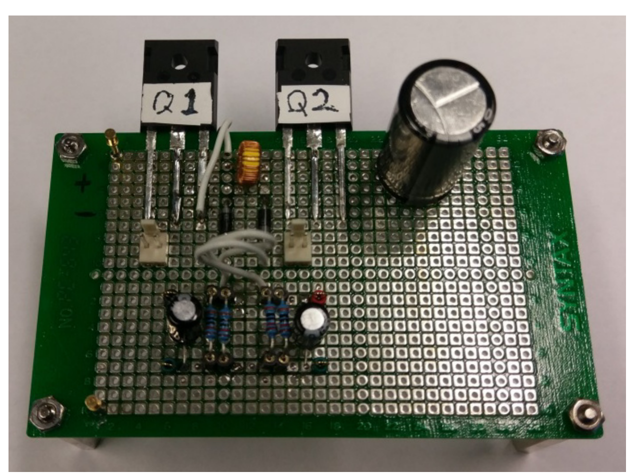

Figure 8: The actual test circuit.

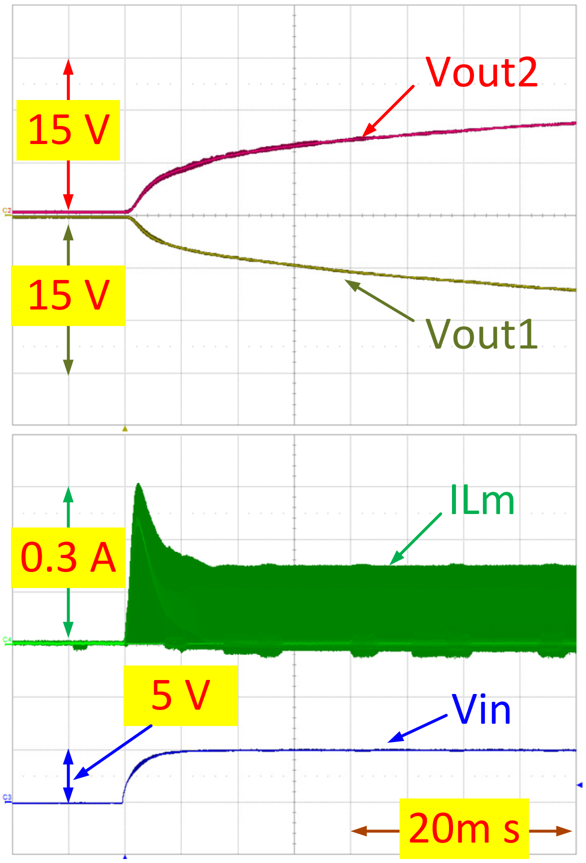

Figure 9: The waveforms in the start time.

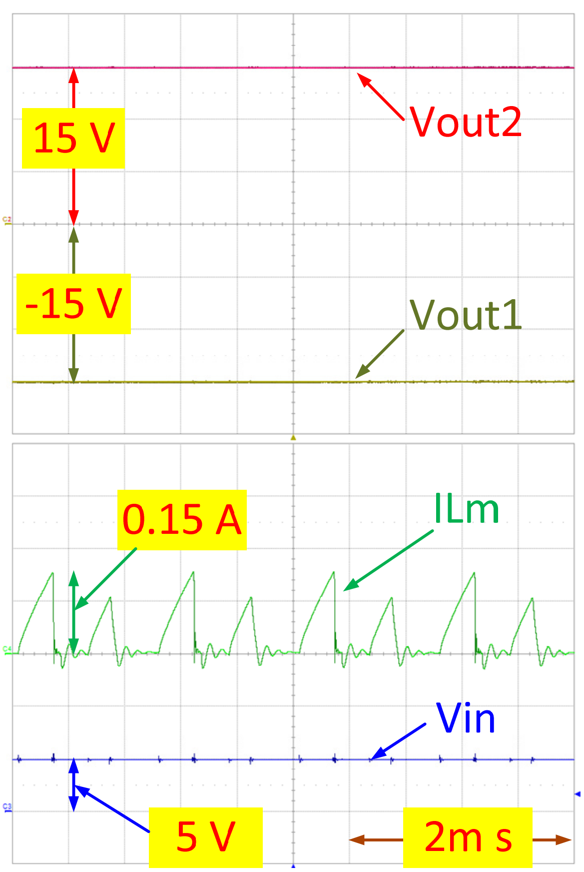

Figure 10: The waveforms in the steady state.

From table1, the input voltage is 5V, the output voltage is ± 15V, and supply load is 15KΩ. When the circuit is in start time, the input voltage, the inductor current and output voltage changes are shown in Figure 9. When the circuit is into the steady state, the input voltage, inductor current and the output voltage changes are shown in Figure 10.

CONCLUSION AND RECOMMENDATIONS

In the actual circuit test, the input voltage, the inductor current and output voltage waveform are observed. This circuit architecture can be applied to the actual power supply. In future studies, larger output power can be studied.

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