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Research Article

IMPROVED CONFIGURATION FOR DC TO DC BUCK CONVERTER

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ABSTRACT
Abstract-Buck dc to dc converter is used to change the input voltage level to a desired output voltage level less than the input voltage magnitude. This paper proposed a novel method for increasing output power by utilizing two storage elements (inductor and capacitor) for Buck converter. By analysing and simulating with Matlab software, the results are provided. Then it is compared with conventional buck inverter. In this improved converter, two inductors used for feeding the load by two switches of insulated gate bipolar transistor (IGBT) type. One inductor is charged by the source voltage while another inductor was discharging its energy into the load during the same time. With this novel structure, output power generation was almost double and the output voltage reduced to half.

Keywords: *Buck Dc-Dc Converter, Ripple Voltage*

INTRODUCTION
Using of renewable energy in the upcoming future seems unavoidable, so output of these sources should be utilized via following the maximum point of the power in sporadic products of production system. Output of these sources should be compatible with consumer and grid condition (Erickson, 1997). So, output energy should be in favorable form, by using suitable interface circuits.

Energy management of these sources will possible if there is comprehensive controls (Camara and *et al.*, 2010). In several power conversion applications, it is required to convert a constant dc voltage source to a variable output dc voltage.

This is performed by dc-dc converters. These converters are used in several applications such as renewable energy systems, distributed generation systems, and power factor correction process. In past decade, several studies have been done about reducing the output voltage ripple of dc-dc converters. A good design requires special attentions to many circuit parameters such as ripple voltage, power losse, and etc.

In this path these parameters usually act in such a way that improving one parameter might have a big effect on another parameter.

In a Buck converter with one switch, voltage ripple reduction is accomplished by selecting a bigger capacitor at the output but in low transient time, but cost will increase. In order to decrease power losses in the Power switches, one can decrease the switching frequency but this process will increase ripple voltage and will have an adverse effect on the output voltage waveform. Changing structure of the converter using new topology can improve the operation of the converter. In this configuration utilizing two storage devices will have lowest damaging effects on circuit parameters. This novel converter has two inductors and two switches which can improve several factors over conventional converter by considering a delay time between these two switches.

These factors are namely; output voltage ripple, transient time, and maximum of transferable power (Jahanmahin *et al.*, 1997).

Simulation and Improved Buck Converter Fundamental Operation
Figure (1) shows novel Buck converter which is simulated by utilizing Matlab software. In this simulation switches contains switching frequency of 40 khz and duty cicycle of 25 percent.

The only difference between these switches is delay time, it means (i.e) that delays time of one switch is zero and delay time of second switch is half of the switching period (T/2). Figures (2 - 3) show switches voltage and current.

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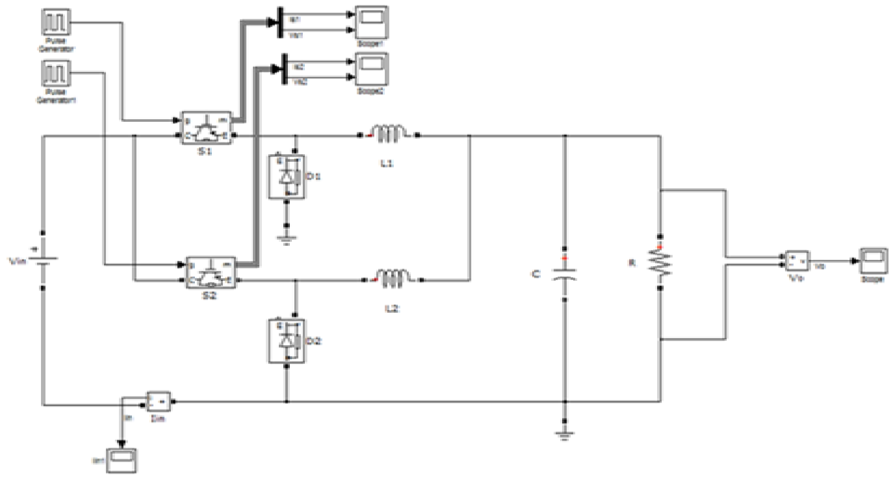

Figure 1: Improved buck converter

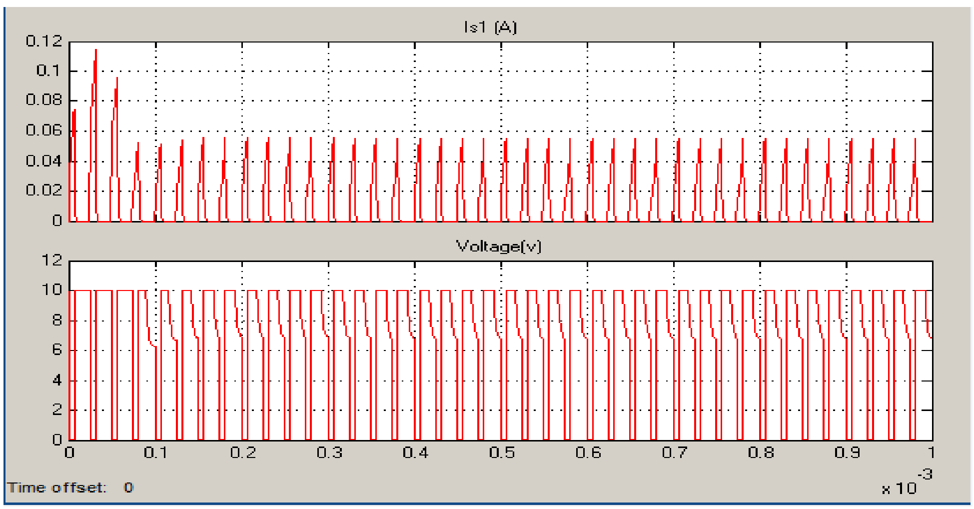

Figure 2: One switch voltage and current t(s)

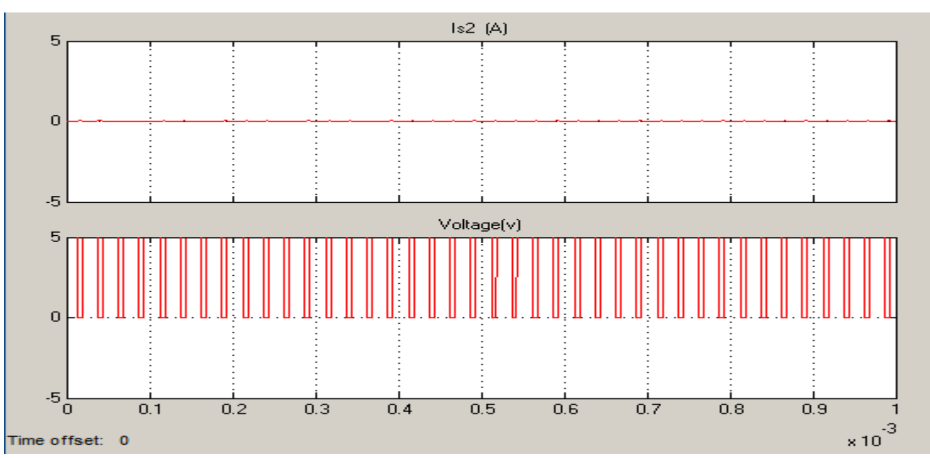

Figure 3: Two switch voltage and current t(s)

Simulation Results and Advantages

Figure (4) shows conventional Buck converter simulated circuit.

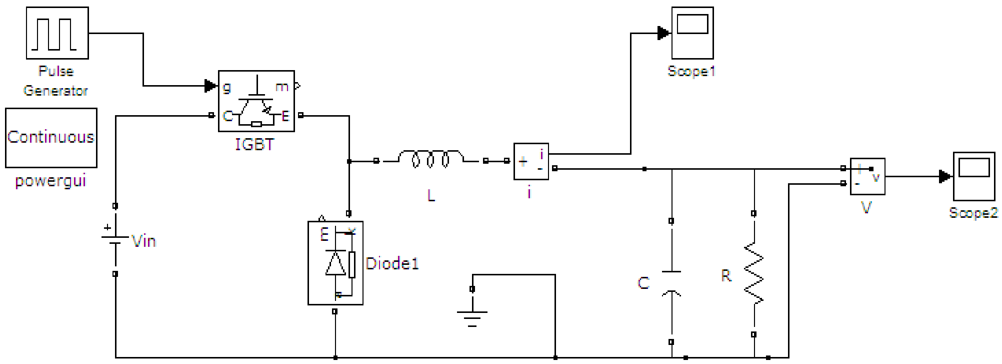

Figure 4: Conventional buck converter

Figures(5-6) respectively show conventional and improved Buck converter simulation output. Outputs are compared with each other and then novel converter advantages will be discussed.

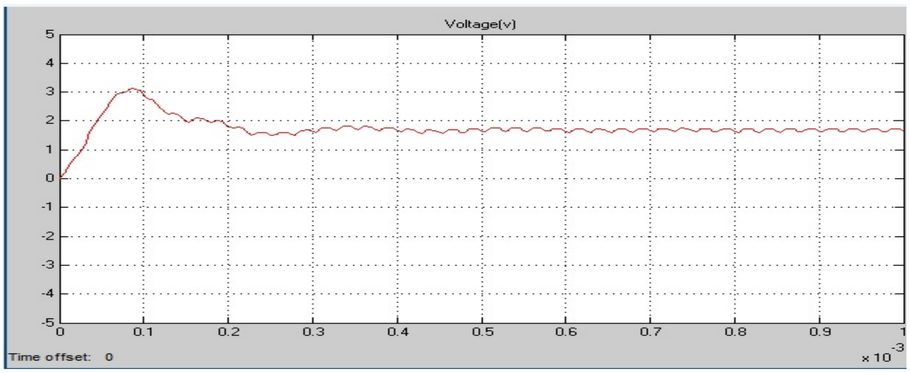

Figure 5: Conventional buck converter t(s)

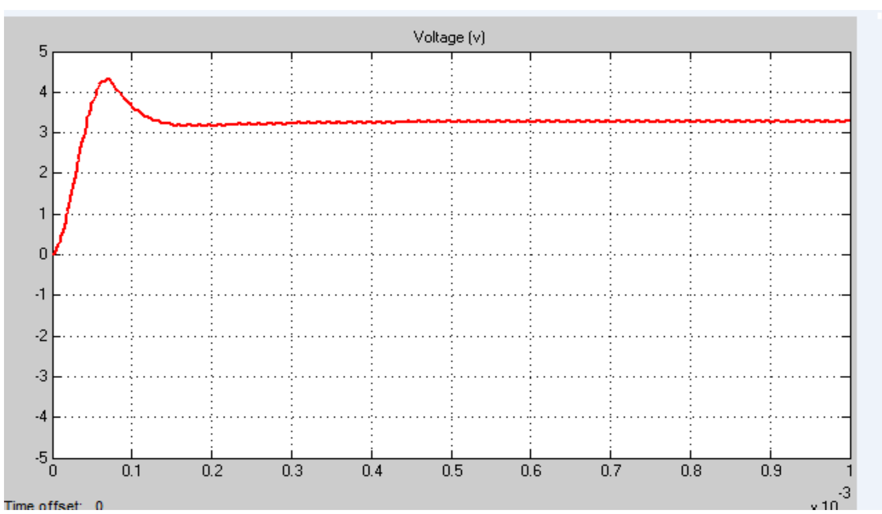

Figure 6: Improved buck converter t(s)

This novel Buck converter contains ripple voltage, transient response time and harmonic distortion amount which is less than conventional Buck converter. Tables (1-2) show respectively voltage ripple improvement percentage before and after configuration improvement and harmonic distortion amount before and after configuration improvement.

Table 1: Voltage ripple improvement percent

Number	Tape	Voltage ripple improvement percent
1	Improved buck	95 %
2	Conventional buck	85 %

Table 2: Harmonic distortion amont improvement percent

Number	Tape	Harmonic distortion amonut
1	Improved buck	78%
2	Conventional buck	63%

Analysis of the Novel Buck Converter

While IGBT1is switched on, a voltage drops on L1 with the magnitude of V_{in} -V_{out} in a DT seconds.When IGBT1 is switched off, a voltage drops on L1which measures -V_{out} and it will take (1-D)T seconds. So:

$(V_{in}$-$V_{out})$DT+V_{out}(1-D)T=0. (1)

Therefore the expression for the input voltage (V_{in}) and average of output voltage (V_{out}) can be summarized as:

V_{out} = D V_{in}. (2)

In Buck converter, the more the width of the pulse, the more will be the output voltage, and in the maximum width of pulse, the output voltage will be the same as input voltage. The results were obtained by comparison between outpout of simulated Buck converter and one reference Buck converter which the numerical results of this comparison are shown in tables (3-4).

Table 3: Ripple amount and transient time

Number	Tape Circuit	Ripple amount	response Transient time
1	Simulated Conventional buck converter	0.25 V	$0.2\times 10^{-3}\ S$
2	Conventional buck converter [1]	0.25 V	$1 \times 10^{-3} S$

Table 4: Ripple amount and transient time

Number	Tape circuit	Ripple amount	response Transient time
1	Simulated Improved buck converter	0.12V	$0.12\times 10^{-3}\ S$
2	Improved buck converter [1]	0.12V	0.5×10^{-3}S

Conclusion

Dc-dc converter successfully for improving Buck converter operation, The structure changed in a way that one IGBT switch and one inductor are added to the structure and a novel configuration of Buck converter is obtained. Novel Buck converter operation was based on dely time between these two switches. The first switch delay time was zero second and the second switch delay time was half of the switching period (T/2).

Improved and conventional Buck converter circuits are simulated by using Matlab software. Then the outputs of these simulations are obtained. The results showed that novel converter has less amount of harmonic distortion and transient response time and higher output power (almost twice as much) as well as lower ripple factor (half) when compared to the conventional converter.

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