**Design Discrete PID Controller For Advanced DC To DC Voltage Converter**

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**Abstract**—Positive output voltage converter technique has been designed for dc to dc converters and power electronics devices. Output voltage increases in arithmetic and geometric progression. PID controller read a sensor, then compute the desired output by calculating P, I, D responses and summing those three components to compute the output. There are two types of DC to DC conversion method, linear conversion and another switched mode Conversion. A method of converting one voltage to another voltage is known as linear conversion. Switched mode converter is similar to a switched mode power supply. Positive output converter totally are depends on boost converter. A boost converter is a power converter with a DC output voltage is larger than its DC input voltage. So we proposed to design triple lift voltage converter to increase the output voltage at stages with variable load.

**Keywords**—Triple Lift Voltage Converter, PID Controller, Arithmetic progression, Geometric progression, DC to DC converter.

I. INTRODUCTION

Voltage converter technique is a popular method widely used in electronic circuit design. It has been successfully working on DC/DC converter applications and in opened a way to design high voltage gain converters. There are two types of voltage converter 1) Positive output voltage converter 2) Negative output voltage converter. We have successfully designed Triple-lift voltage converter. This paper gives the brief introduction of the voltage converter method that implements the output voltage increases in step by step along with arithmetic progression.

Proportional-Integral-Derivative is mostly used in design of continuous-time control system. PID controller has the combination of both PI & PD controller. PD controller which is used as for improving system stability and increasing system bandwidth, it is a special case of phase-lag-controller. PI controller which reduces steady-state error is a special case of the phase-lag controller.

There are two sub-series of positive output voltage converter:  
1) Main series;  
2) Additional series.

The main series circuit has one switch(S), inductors (n), capacitors (2n), and diodes (3n-1). Each circuit of additional series has one switch(S), inductors (n), Capacitors 2(n+1) and diodes (3n+1). The conduction duty ratio is (K), switching frequency is (time T=1/f), the load is applied variable load. If the input voltage and current are V<sub>in</sub> and I<sub>in</sub>, output voltage and current are V<sub>o</sub> and I<sub>o</sub>. DC to DC converter processes no power losses. Input (VI) = Output (VI). The voltage transfer gain is G then G = V<sub>o</sub>/V<sub>in</sub>.

II. MAIN SERIES

The first three stages of positive output voltage converter A) Elementary circuit.  
B) Triple-lift circuit.

A. Elementary Circuit

The single stage converter circuit and its equivalent circuits during Switching-on and off are shown in Fig. 1. The voltage across capacitor C<sub>1</sub> is charged to source V<sub>in</sub>. The current I<sub>L1</sub> flowing through inductor L<sub>1</sub> with input voltage V<sub>in</sub> during switching on period kT and decreases with voltages (V<sub>o</sub>-2V<sub>in</sub>), switching off period (1-T) T. There for flow of the inductor current (IL1) is

\[
\Delta I_{L1} = \frac{V_{in}}{L_1} (kT)
\]  

(b) Switch closed Condition.  
(c) Switch open Condition.

\[
\Delta I_{L1} = \frac{V_{o} - 2V_{in}}{L_1} ((1 - K)T)
\]
\[ V_0 = \frac{2-k}{1-k} V_{in} \]  
(3)

Then voltage transfer gain is given by
\[ V_0 = G = \frac{2-k}{1-k} V_{in} \]  
(4)

### B. Triple-Lift Converter Circuit.

The triple circuit is a combination of elementary circuit, re-lift circuit. Which contains a loop of \((L2-D3-D4-D5-C3-C4)\) is repeated as shown in fig. (a), equivalent circuit for on and off is shown in fig. 2 (b), fig. 2 (c) respectively.

Its circuit diagram and equivalent circuit of switching on and off are shown in fig. 2. The voltage across capacitor \(C1\) is charged due to input voltage \(V_{in}\). Then voltage \(V1\) across capacitor \(C1\) is given by
\[ V1 = \left( \frac{2-k}{1-k} \right) V_{in} \]  
(5)

Voltage \(V2\) across capacitor \(C3\) is given by
\[ V2 = \left( \frac{2-k}{1-k} \right) 2V_{in} \]  
(6)

The voltage across capacitor \(C5\) is charged due to voltage \(V2\). The flow of current through inductor \(L3\) is increasing with voltage \(V0\) during switching-on period \((kT)\) and decreases with voltage \((V0 - 2V0)\) with switching-off period \((1-kT)\). Therefore, the flow of the inductor current \(I_{L2}\) is given by
\[ \Delta I_{L2} = \frac{V0 - 2V2}{L3} ((1-k)T) \]  
(7)

Then voltage transfer gain,
\[ V0 = \left( \frac{2-k}{1-k} \right) V2 = \left( \frac{2-k}{1-k} \right)^2 V1 \]  
(9)

\[ V0 = G = \left( \frac{2-k}{1-k} \right)^3 V_{in} \]  
(10)

### III. CLOSED LOOP SYSTEM

![Fig.3.Closed Loop System.](image)

The closed loop system main objective is to achieve a robust control of the output voltage, and maintains the output voltage a constant irrespective of the input supply voltage variations. The block diagram of the closed loop system is shown in fig. 3.

#### A. PID CONTROLLER

PID controller is used everywhere due to simplicity. PID controller is 95% efficient. It is also used in a closed loop system. In this paper closed loop step response method are used. The simple step response diagram is shown below.
In Fig. 6 is a graphical demonstration of Table I. It shows the variation of values single, two, and three stage converters at different input values. In a graphical figure Y-axis indicates output voltages and X-axis indicates input voltages.
VI. CONCLUSION
In experimental work with the help of Triple-Lift DC-DC Converter we reached up to 97% efficiency for variable load and if the load is fixed we are getting the result up to 99%. PID controller modified the output voltage through feedback loop system applied to control the output voltage at different stages. At the end of the experimental work output voltage increased by step by step the result is 99.5%. Through this we come to conclude triple lift DC-DC voltage converter designed gives the maximum performance up to 99.5% efficiency for gain. Thus, this is better converter which has more voltage transfer gain, maintaining its efficiency.

VII. REFERENCES