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Comparative Performance Analysis of Boost Converter and Luo Converter for controllinng of DC Motor speed

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Abstract —The paper proposes the advance DC-DC converter by Luo Converter. In conventional method Boost Converter (BC) complexity of DC link voltage level control.Speed control means intentional change of the drive speed to a value required for performing the specific work process. The dc motors are used in various applications such as industries, Robotics etc. DC drives are less complex for DC to DC conversion as compare to AC to DC conversion. A Luo converter is DC to DC converter used for speed control of DC motor due to its advantages over fundamental DC to DC converter.

Keywords-DC-DC Converter, Luo Converter, Speed control, DC Motor

I. INTRODUCTION

DC-DC converters convert electrical power provided from a source at a certain voltage to electrical power at a different dc voltage. Electrical energy, though available extensively from storage sources such as batteries, or from primary converters such as solar cells, distributed ac mains, is hardly ever used as such at the utilization end. The DC-DC conversion technique was introduced in the year of 1920s. During that period, simplest DC-DC converter was developed for low voltage applications like (potential–meter, rheostat, and etc.) the converter dos not performed well, because it has poor efficiency, high losses, and low voltage transfer gain.Therefore, they intend to develop the DC-DC converter with high efficiency as well as conversion of one voltage level to another voltage level. At the same time period the AC-AC conversion converts the one voltage level to another voltage level using transformer. Before the Second World War basic types of DC-DC converters was fed for industrial applications. After the world war, the communication system was enhanced to the maximum the technology needs the low voltage dc power supply for the application.The research where started for the growth of the DC-DC converter and it leads to invent the choppers circuits. Then step-by-step DC-DC converters were developed based on different generations. Recent years, the DC-DC converters inhabit all the field of power electronics and industrial applications. Each year, a new DC-DC converter topology was developed (above 500 DC-DC converters topologies offered in the world and it is continuous improvement since 1920s) [1].

In the year of 2001, the DC-DC converters have been classified into six generations, which was reported by Fang Lin Luo.In all DC-DC converters, the output voltage and power transfer efficiency are limited by parasitic element although in theory the traditional converter can produce high voltage and with high efficiency [2]. Luo converter is new developed DC-DC converter.In recent years, all modern electronic systems require power supply with high reliability, high efficiency, cheap topology in simple structure, low weight with high quality and capability of easy control [3].DC-DC Buck-Boost converter is used for step-up and step-down the voltage. Voltage transfer gain for Buck-Boost converter is low as compare to DC-DC Boost converter [4].

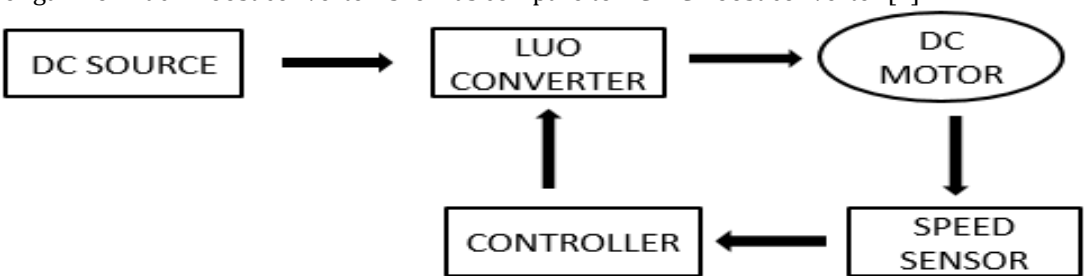

Fig.1.Block diagram for speed control of DC motor.

Block diagram for speed control of DC Motor is shown in Fig.1. The fix pure DC voltage is applied at the input of this Luo Converter and a variable DC voltage is obtained its output. These output voltage is applied to DC Motor, so motor will be rotted. Then speed sensor is used for sense actual speed of the DC Motor.

The actual speed and reference speed are compared and the error of the speed is given as input to PI controller. Based on the proportional gain valueand the integral gain value, the PI controller regulates an output. These output given to the PWM generator. PWM generator generate get pulses, these pulse are applied to switch and eliminating the constant speed of the DC Motor

II. IMPORTANCE OF DC-DC CONVERSION IN DRIVES

A DC-to-DC converter in which converts a source of direct current (DC) from one voltage level to another. Most DC to DC converters also adjust the output voltage. Some exceptions include high- efficacy drive sources, which are a type of DC to DC converter that control the current during the drive, and easy accuse pumps which twice or triple the crop voltage. Electronic switch-mode DC to DC converters change one DC voltage stage to one additional, by storing the input energy in the short term and then releasing that energy to the output of a dissimilar voltage. The storage can be in also magnetic field storage elements inductors, transformers or electric field storage elements capacitors. This conversion method is more power efficacy often 75% to 98% than linear voltage imperative, which dissipates surplus power as heat. DC-to-DC converters, energy are occasionally stored into and free from a magnetic field in an inductor or a transformer, classically in the range from 300 kHz to 10 MHz. By regulating the duty cycle of the charging voltage that is, the relation of on/off time, the quantity of power transfer can be controlled. Regularly, this is functional to organize the output voltage, while it could be practical to organize the input current, the output current, or maintain a constant power. Transformer-based converters may give isolation between the input and the output. In common, the term "DC-to-DC converter" refers to switching converters.

Boost Converter in drives: The Boost Converter is a step-up DC/DC voltage. It works in second quadrant operation. The output voltage increases in arithmetic progression. Boost converter which has the limitation over DC link voltage level and complexity of control circuit.

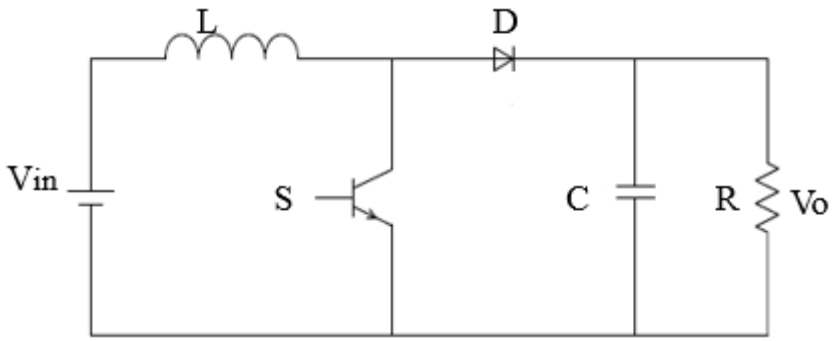

Figure 2.Boost Converter.

$$V_{out} = \frac{1}{1-D} Vin$$

$$I_{in} = \frac{1}{I-D} Io$$

From Equation, the output voltage can be adjusted by changing the magnitude of the signal duty cycle switching. This conditions can be maintained during the load under normal conditions. When the load changes, there will be a change at output voltage. If the load is too large (small resistance value), the output voltage will decrease.

Luo Converter in drives:Luo converter circuit is shown in figure-3 which performs boost operation.The Luo converters preferred due to high voltage gain, less ripple current, high power density. It has two mode [12].

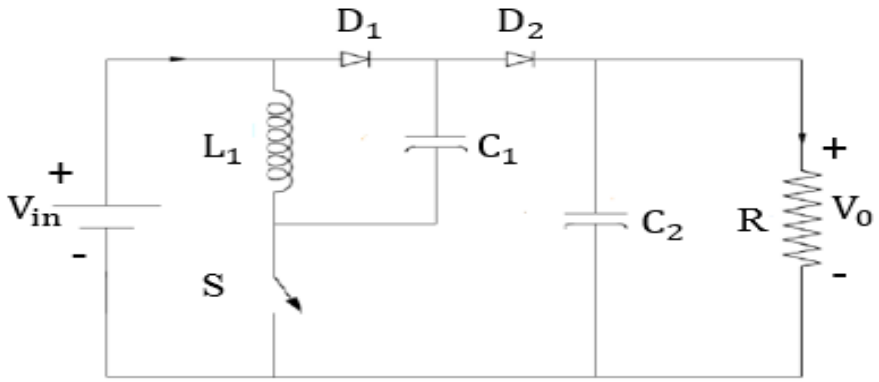

Figure 3.The basic circuit of Luo Converter.

The output voltage of converter is:

$$\frac{Vo}{Vin} = \frac{(2-k)}{(1-k)}$$

The voltage transfer gain is:

$$G = \frac{Vo}{Vin} = \frac{2-k}{1-k}$$

III. SIMULATION PARAMETERS

Parameter	Boost Converter	Luo Converter
Input Voltage	80 V	80 V
Switch 'S' used in DC-DC Converter	MOSFET	MOSFET
Duty cycle (k)	0.5	0.5
Inductor (L)	2.5 mH	2.5 mH
Capacitor (C)	100 µF	400 µF
		800 µF
Motor	5HP 240V 1750 RPM Field voltage=150 V	5HP 240V 1750 RPM Field voltage=150 V

IV. SIMULATION & RESULT

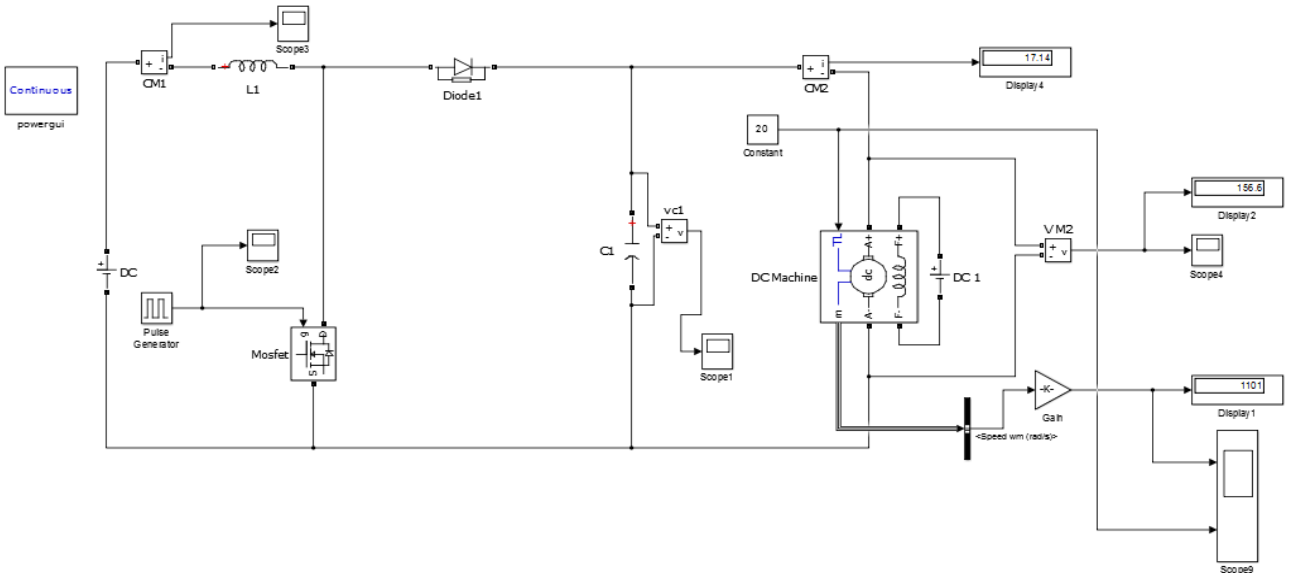

Figure 4.Open loop simulation of Boost converter with DC motor.

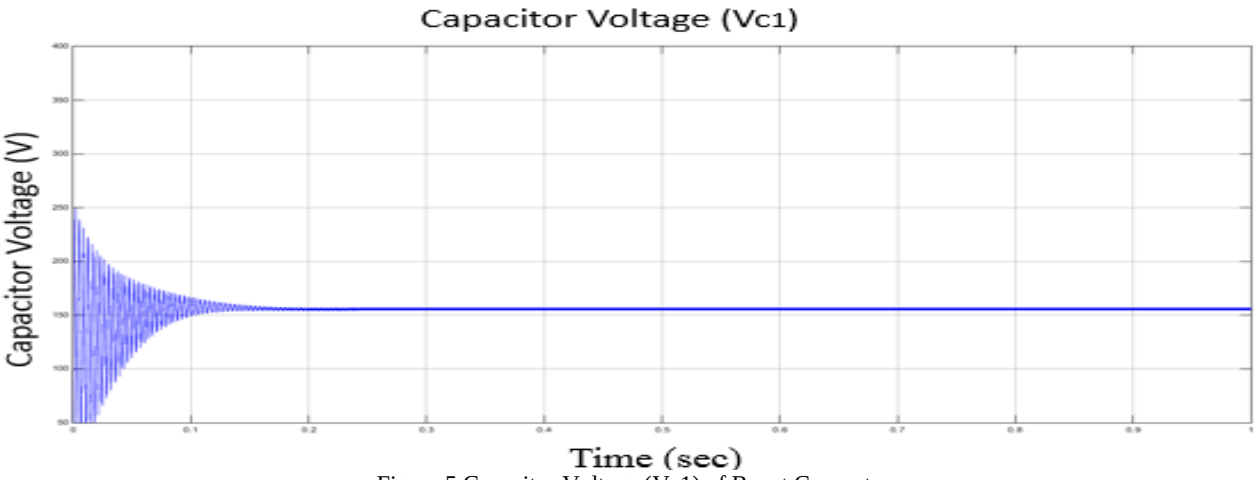

Figure 5.Capacitor Voltage (Vc1) of Boost Converter

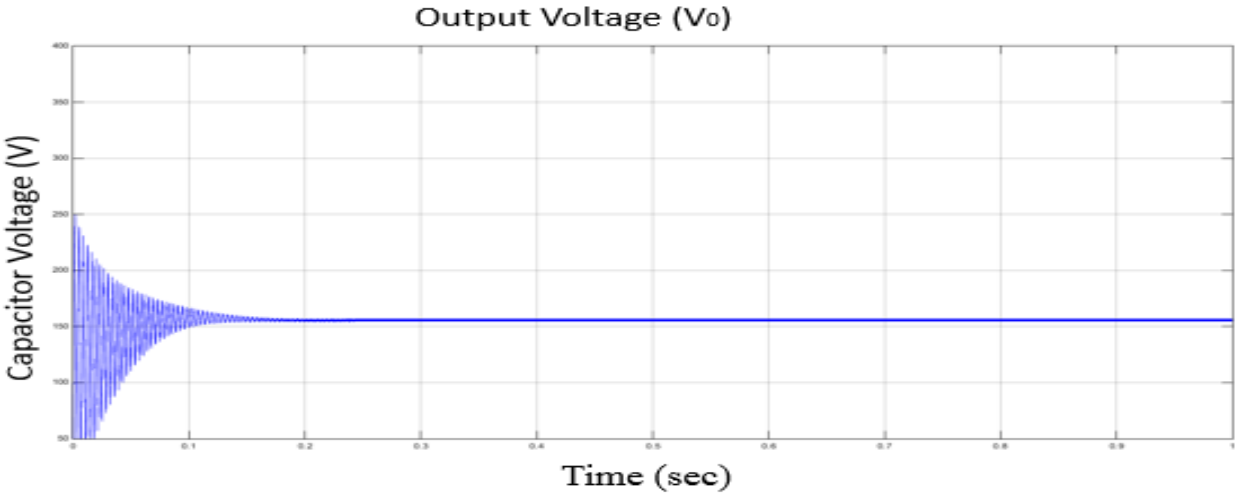

Figure 6.Output voltage of Boost Converter

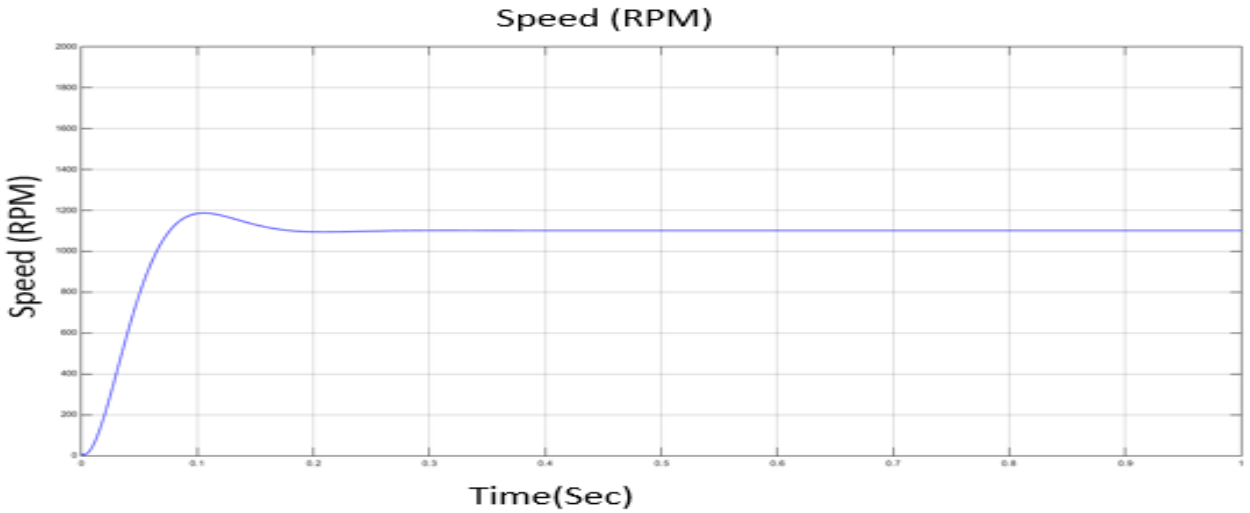

Figure 7.Waveform of speed(RPM) with Boost Converter.

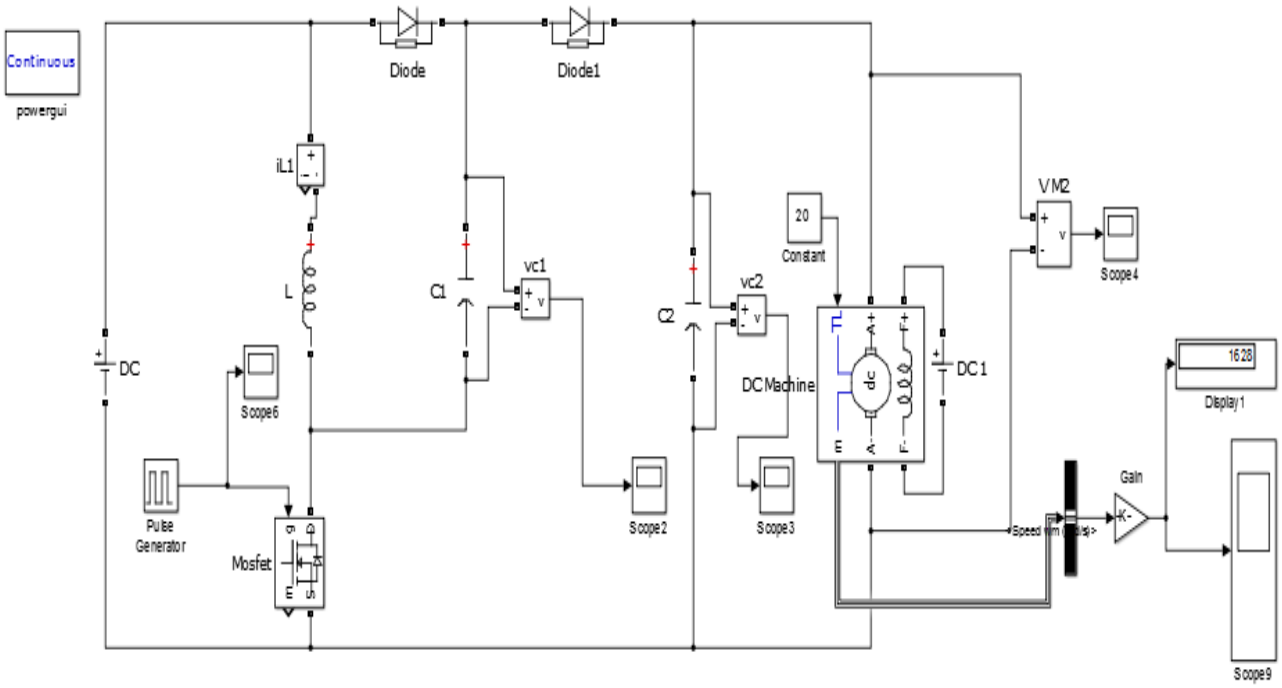

Figure 8.open loop simulation of Luo converter with DC motor

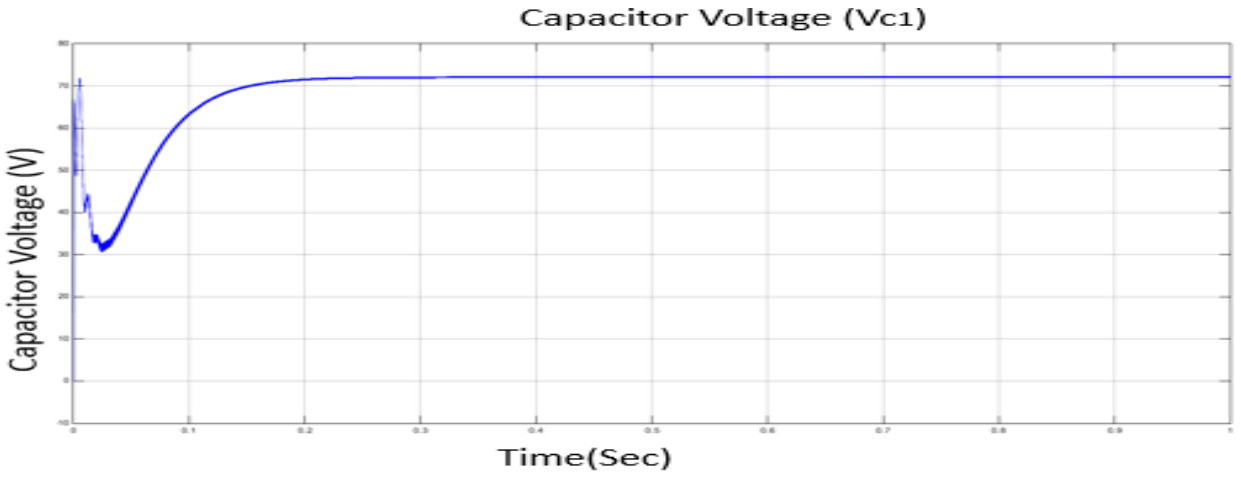

Figure 9.Capacitor voltage (VC1) of Luo converter.

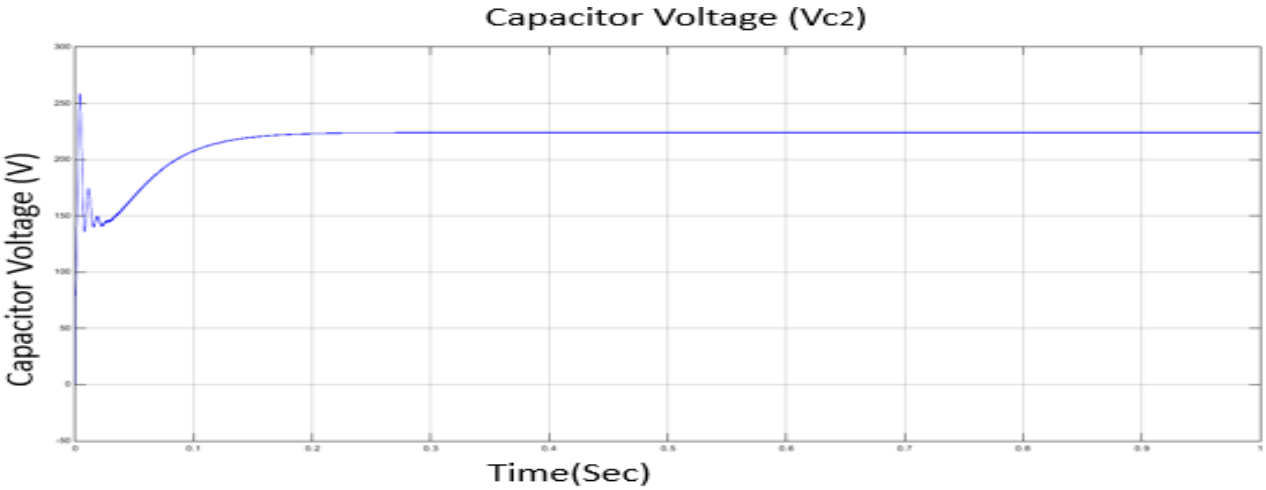

Figure 10.Capacitor voltage (VC2) of Luo converter

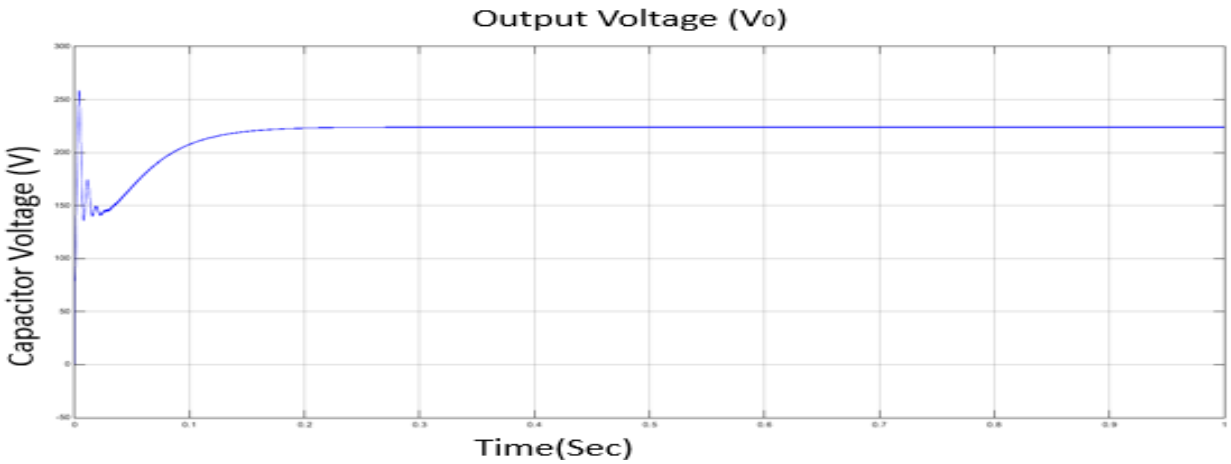

Figure 11.Output voltage of Luo converter

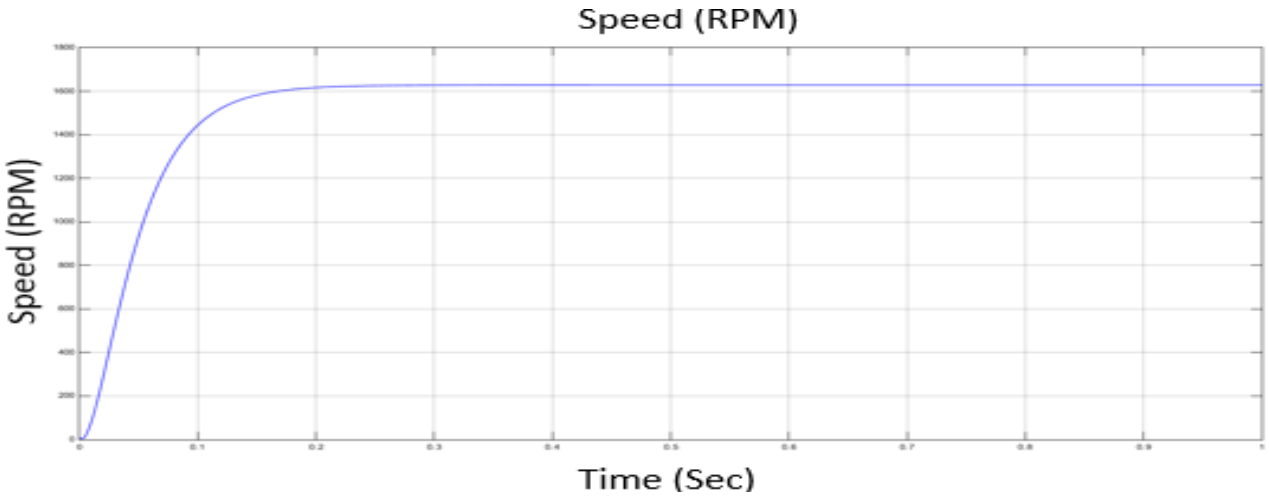

Figure 12.Waveform of Speed (RPM) with Luo Converter.

V. CONCLUSION

This paper presents the effectiveness of Luo Converter over Boost Converter (BC) in front end drives.The simulation work has been concluded and results demonstrated the efficiency of Luo converter over Boost Converter. Also, Luo Converter has high transfer voltage gain as compare to Boost Converter.Luo Converters that have very low ripple of voltage and output wave with high quality as compare to Boost Converter.

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