Speed Control of BLDC Motor Drive using LUO Converter

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ABSTRACT: This project is especially used to Speed control the BLDC motor by Luo converter. The LUO converter is employed to boost (step-up) the input dc voltage. The Luo converter output voltage is directly proportional to the converter's duty cycle. The BLDC motor has high efficiency, high reliability, high torque, low radio frequency, and less maintenance.

Keywords: -Luo Converter, BLDC Motor

I INTRODUCTION

The Luo converter exhibits the advantages over the buck, boost, buck-boost, and Cuk converter when employed in SPV-based applications. The Luo converter voltage is applied to a three-phase inverter. The three-phase inverter converts the dc voltage into three-phase ac voltage. The Luo converter work to increase the output voltage.

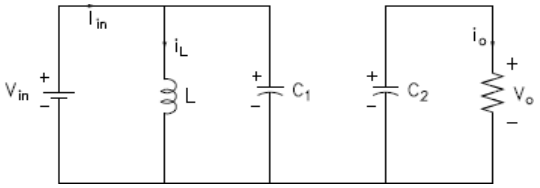
Home appliances like washing machines, refrigerators, AC, vacuum cleaners, freezers, etc., are expected to be one of the fastest-growing products in the market. In these appliances, conventionally DC motor techniques are used. But it suffers from a lot of disadvantages like sparking, high maintenance. Adding to that, it requires a DC input power supply. The drive cost is also high. So DC motors are being replaced with the help of AC induction. These motors work as stable speed motors with the help of Alternative current power supplies.

The Luo converter gives high output voltage with several ripples. A mathematical and simulation study of PV fed Cuk, Sepic, Zeta and Luo DC-DC boost converters has been carried out and is observed that the Luo DC-DC converter is best in terms of transient response among all DC-DC boost converters.

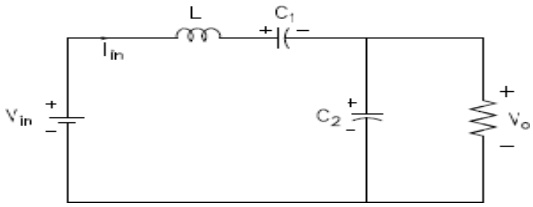
The output of this converter is fed to the inverter of the BLDC motor. The recent trend has been using brushless D.C (BLDC) motors to make the operation more reliable, efficient, and noisy. Compared to brushed motors with the same power output, they're also lighter. BLDC motors are being used in most of their devices. Effie efficiency BLDC motor is around 85- 90%, whereas the conventional brushed motors have only 75% -80% efficiency. BLDC motors are also very suitable for high-speed applications, 10000 rpm or above. These motors are also known for their good speed control. BLDC motors can be used in high-end white goods (like refrigerators, washing machines, dishwashers, etc.),high-end pumps, fans, and other appliances that require high reliability and efficiency. In this paper, a rive is proposed that is suitable for high and

II LUO CONVERTER MODELLING

The positive affair Luo converter positive



input voltage to positive affair voltage.



There are colorful types of Lo transformer Viz tone lift re lift, triadic nlift, quadruple lift and super lift all of this being deduced from the abecedarian circuit Luo transformer have low switching losses and the loftiest efficient among other the low efficient among the other DC Zc transformer voltage lift fashion has been employed to design high voltage gain transformer. It reduces the value to the duty rate and also the effect of parasitic rudiments LUO bettered affair current characteristic due to the inductor in the affaire stage. The value of the Luo motor is designed by considering the ON/OFF switching period

TABLE 3. DESIGN VALUES OF LUO CONVERTER

Parameters	Value
Input Voltage, V in	144 V
Output Voltage, Vo	320 v
Duty Ratio	.18
Inductor, L	8.64mH
Capacitors, C1=C2	524μF
Load resistance	50 Ω
Switching Frequency	10 kHz

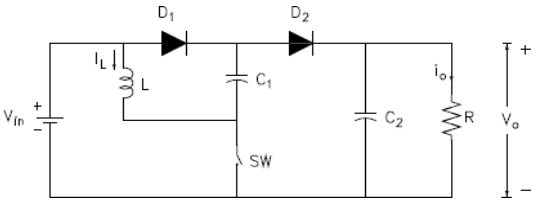


FIG 4. CLASSICAL LUO CONVERTER

FIG.5.LUO CONVERTER WITH SWITCH CLOSED

FIG.6.LUO CONVERTER WITH SWITCH OPEN

III BLDC MOTOR MODELING

BLDC motor is fed from a three-phase voltage source. The model of the architecture winding for the BLDC motor is expressed as follow

$V_a=R*i_a+L(di_a/dt)+e_a$ ..... (4)

$V_b=R*i_b+L(di_b/dt)+e_b$ ..... (5)

$V_c=R*i_c+L(di_c/dt)+e_c$ ..... (6)

L is armature self-inductance (H), R is armature resistance (Ω), Va, VVb Vc are terminal phase voltages (V), ia, ib, ic are motor input currents (A) and ea, eb, ec is motor back -EMFs(V).

back-EMF is related as a function of rotorposition and the back-EMF of each phase has a 120º phase angle difference. The equation of each phase is given as:

$e_a=K_e f(\theta_e) \omega$ .....(7)

$e_a=K_e f(\theta e-2\pi/3) \omega$ .....(8)

$e_a=K_e f(\theta_e+2\pi/3) \omega$ .....(9)

$\theta_e=P/2* \theta_m$..... (10)

1. Ke is the back EMF constant of one phase (V/rad/s)
2. $\theta_e$is the electrical rotor angle (° el.),
3. ω is the rotor speed(rad/s).
4. θ_m is the mechanical rotor angle (rad)
5. P is the number of poles.

Total torque output and torque equation are given:

……..(11)

$$T_e = \frac{e_a * i_a + e_b * i_b + e_c * i_c}{W}$$

$$T_e - T_l = J\frac{d\omega}{dt} + B\omega \quad \text{.....(12)}$$

1. T_e is total torque output (Nm),
2. T_l is load torque (Nm),
3. J is the inertia of the rotor and coupled shaft (kgm^2),
4. B is friction constant (Nm/. rad/s).

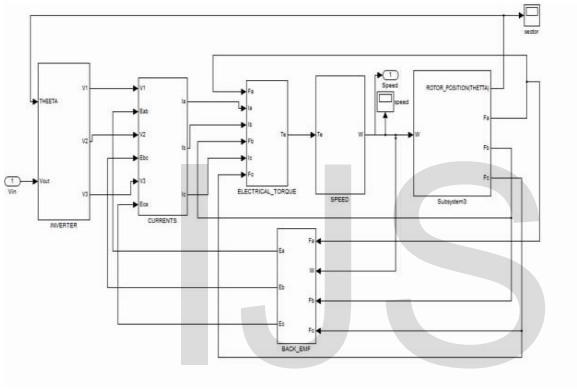


Fig 4. SIMULINK Model of BLDC Motor

Parameters	Value
Rated Power	1 kW
Rated Voltage	320 V
Rated Speed	1800 rpm
Phase Resistance	4.35 Ω
Phase Inductance	12.4 mH
Inertia	.002505 kgm^2
Damping Ratio	.0003035
No. Of Poles	8

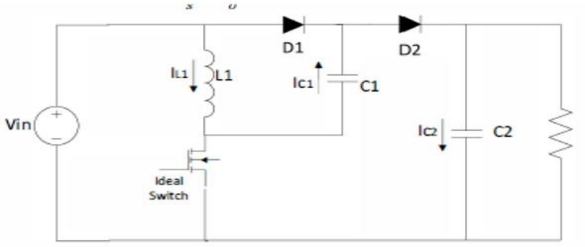
TABLE 5. BLDC MOTOR SPECIFICATIONS

IV PROPOSED SYSTEM

The proposed system consists of a Luo converter and a BLDC motor. This is a drive that is suitable for high voltage system. A schematic diagram is shown that depicts the overview of the system.

FIG.5. SCHEMATIC DIAGRAM OF PROPOSED SYSTEM

The output voltage of the DC power supply is fed to the Luo converter where the voltage lifting takes place to the required rating of the BLDC motor. Since the atmospheric conditions are not the same all through the day, we need to use the maximum power point tracking.



Constant Voltage method. is used in which the reference voltage is compared with the DC output voltage to yield the duty ratio. The gate pulses to the Luo converter have this duty ratio. The output voltage of the converter is fed to the BLDC motor.

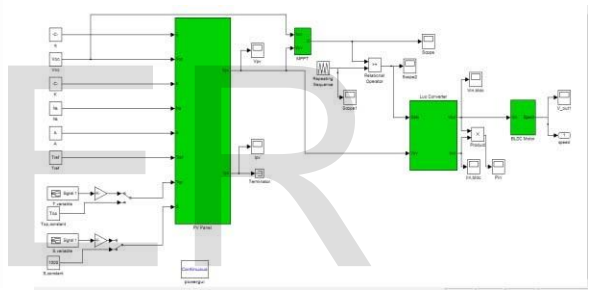


FIG.6. MATLAB/SIMULINK MODEL OF THE PROPOSED SYSTEM

V SIMULATION RESULTS AND DISCUSSION

The simulated system outputs the speed of 1800 rpm which the design was done. The Luo converter voltage has resulted in obtaining the required value. Output power is also obtained.

The theoretical simulation is Practical implementation can change due to variations in atmospheric, environmental changes, etc. The implementation of an online tracking mechanism can improve the present system.

The simulation results are shown in the following

figures.

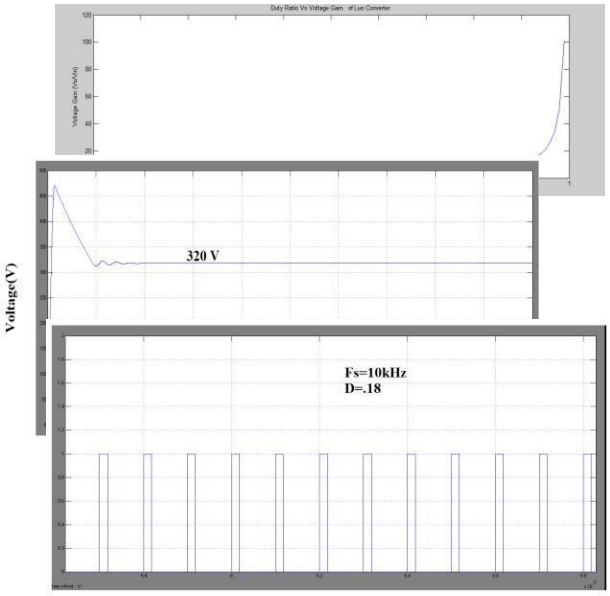


FIG. 7. DUTY RATIO VS VOLTAGE GAIN OF A LUO CONVERTERIt is seen that the gain almost follows a linear relationship with the duty ratios at values below 0.7 but at higher values the gain is unstable.

FIG 8. OUTPUT VOLTAGE OF LUO CONVERTER INTHE PROPOSED SYSTEM

In Fig. 8, the voltage output of the Luo converter shows an initial overshoot.

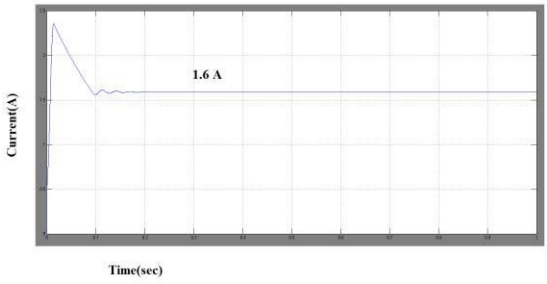


FIG.9.OUTPUT CURRENT OF LUO CONVERTER

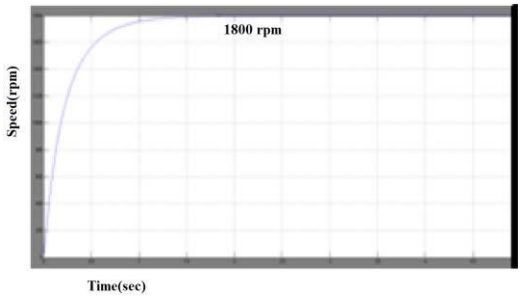


FIG 10. OUTPUT SPEED OF BLDC MOTOR IN THE PROPOSED SYSTEM

FIG.11.GATE PULSES TO THE LUO CONVERTER

The gating pulses provided by working out the CV MPPT are shown in Fig.11 at 1000 W/m^2 solar irradiation. The duty ratio is set at 0.18 and the switching frequency is 10kHz.

VI CONCLUSION

Solar energy is a renewable energy source that is incorporated into numerous operations in recent times. Photovoltaics is the direct conversion of light into electricity at an infinitesimal position. Rather than DC power supplies, for an effective prisoner, we use solar PV arrays. For the efficient capture of DC Supplies, appropriate DC-DC converters are needed to be chosen and installed. Here we have used Luo converters which are best suited for these types of applications. The proposed system deals with an outage of random speed that is well suited for operations similar to air conditioners, water pumps, refrigerators, etc. This can be bettered further by incorporating an online MPP tracking mechanism. The closed-loop control of BLDC motors can further advance applications.

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References

1. Bhim Singh, Rajan Kumar," Solar photovoltaic array fed water pump driven by brushless DC motor using Landsman converter,".IET Renewable Power Generation, Volume: 10, Issue: 4, 4 2016

2. Ali F.Murtaza, Hadeed Ahmed Sher, Marcello Chiaberge, Diego Boero, Mirko De Giuseppe, Khaled E. Addoweesh, "Comparative Analysis of Maximum Power Point Tracking Techniques for PV applications,". 16th International Multi-Topic Conference (INMIC), 2013

3. Qiuxia Yang, Qi Wang" An Improving Control Method of CTV +P&O on Photovoltaic Power Generation Maximum Power Point Tracking," Fifth International Conference on Intelligent Human-Machine Systems and Cybernetics, IEEE,2013

4. Deepak, Rupendra Kumar Pachauri, Yogesh K. Chauhan," Modeling and simulation analysis of PV fed Cuk, Sepic, Zeta and Luo DC-DC converter," International Conference on Power Electronics, Intelligent Control and Energy Systems (ICPEICES), IEEE .2016

5. Rutuja A Bhat, Pallavi S. Jadhav," Modeling and simulation of BLDC motor in electric power steering by using MATLAB," International Conference on Intelligent Systems and Control (ISCO), IEEE, 2016

6. M. Látková, M. Baherník, P. Braciník, M. Höger," Modelling of dynamic cooperation between a PV array and DC boost converter", 5th International Youth Conference on Energy (IYCE), IEEE, 2015

7. Abhishek Kumar Gupta, Ravi Saxena, "Review on widely- used MPPT Techniques for PV Applications," International Conference on Innovation and Challenges in Cyber Security (ICICCS-INBUSH), IEEE,2016

8. A. Tashakori, M. Ektesabi, and N. Hosseinzadeh, "Modeling of BLDC Motor with Ideal Back-EMF for Automotive Applications," Proceedings of the World Congress on Engineering Vol II WCE 2011, London, U.K., 2011

9. Ming-Fa Tsai, Tran Phu Quy, Bo-Feng Wu, Chung-Shi Tseng, "Model Construction and Verification of a BLDC Motor Using MATLAB/SIMULINK and FPGA Control," 6th IEEE Conference on Industrial Electronics and Applications (ICIEA), 2011

10. Balogh Tibor; Viliam Fedák; František Durovský, "Modeling and Simulation of the BLDC Motor in MATLAB GUI," IEEE International Symposium on Industrial Electronics,2011