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To Control Speed of BLDC Motor using FPGA

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***Abstract*—Development of advanced motor drives has increased in efficiency and reliability of residential and commercial appliances such as refrigerator and air-conditioning systems which use conventional motor drive technology. The mechanics found in these applications are characterized by low efficiency and high maintenance. A brushless DC (BLDC) Motor drive is characterized by higher efficiency, lower maintenance and high cost. In a market driven by profit margins, the appliance industry is reluctant to replace the conventional motor drives with the advanced motor drives (BLDC) due to their higher cost. Therefore, it is necessary to have effective BLDC motor controller. The main and the most significant difference between the microcontroller and the FPGA is that the FPGA does not have a fixed hardware structure on the contrary it is programmable according to user application however processors have a fixed hardware structure. Since the user can determine the hardware structure of FPGA, you can program FPGA to process larger data with little clock cycle. Thus it is possible to define and use processor and user-specific hardware functions on only one chip by using FPGA. Logic converter is used to generate variable speed signals.**

This solution gives opportunity to control the hardware because of its great flexibility. This project gives the design for the development of new efficient control of BLDC motor. The idea behind this project is to implement a motor controller for a BLDC motor which gives better efficiency and precise output than conventional method .Particularly in industrial as well as military oriented applications.

Keywords—BLDC Motor, FPGA ,Logic converter, MOSFET inverter.

I. INTRODUCTION

Many industrial, commercial, and domestic applications require variable speed motor drives. Traditionally, DC machines have dominated this application area. The main disadvantages are its commutators and brushes because; DC motor operates various of electro-mechanical commutators, which is a major source of unreliability. In practice, DC motor requires frequent maintenance to ensure trouble free commutation. Furthermore, the sparking associated with the action of a commutator makes a DC motor drive unsuitable for use in certain industrial location, since the sparks can ensure radio interference or ignite flammable gases. In addition the relative orientation of brushes and commutator bars are fixed and cannot be changed during operation.

The requirement from industry for reliable, low maintenance and controlled drives has therefore led to considerable work in recent years on various ―brushless‖ drive systems. This controlled drive achieves the desired performance by the combination of a machine and power electronic. Brushless DC motor (BLDC) have enjoyed an increasing usage in disk drives, laser printer and other equipment where a uniform speed is required. The primary reason for their popularity are the absence of commutators and brushes as found in ordinary DC motors and their ability to respond to digital input pulses. The absence of commutator and brushes offer several advantages. Since a BLDC motor has no mechanical contact with a moving member (rotor), there is no debris generation, a critical aspect in the disk drives that demand a particle-free environment. By varying the average voltage across the winding, the speed can be altered. This is achieving by altering the duty cycle of base PWM signal. The use of PWM in power electronics to control big energy with maximum efficiency and power saving is not new but, interesting is to generate PWM signal using HDL and implement it in FPGA.

The main and the most significant difference between the microcontroller and the FPGA does not have a fixed hardware structure on the contrary it is programmable according to user applications however processors have a fixed hardware structure of FPGA you can program FPGA to process larger data with little clock cycle. Thus it is possible to define and user-specific hardware functions on only one chip by using FPGA.

A. Bldc motor working principle

A brushless dc motor is the type which is most suitable for applications that requires high reliability, high efficiency, more torque per weight. Commutator helps in achieving unidirectional torque in typical dc motor. In Bldc motor there is an no commutator and no brush arrangement so it will used inverter circuit to achieve unidirectional torque in a typical dc motor. And therefore arrangement of commutator and brush are eliminated in brushless dc motor. The working principle of brushless dc motor is stator winding of a BLDC are connected to a control circuit and that control circuit energizes proper winding at proper timming in a pattern which rotates around the stator The rotor magnet tries to align with the energized electromagnets of stator when it is aligned electromagnet get enerzised.

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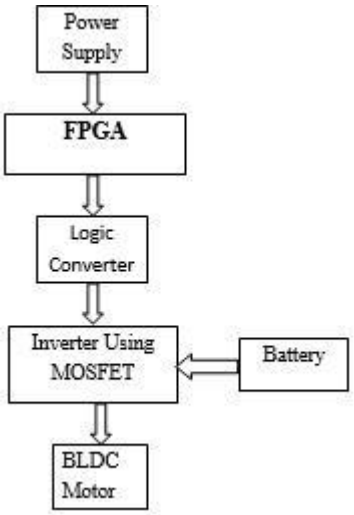
B. Block diagram



C. Specifications

[1] BLDC motor: Structure: 12N14P

- Lipo battery: 3S
- Turns: 14Turn
- Cable: 3-strand 0.23mm
- Rotation speed: 920RPM/VOLT
- Empty current: 0.4A@10V
- Outer diameter: 28mm
- Max.continuous current: 10.3A
- Max.continuous power: 114W
- Inner resistance: 180mÎ©
- Weight: 51g
- Size: 27.9*40.7mm(D*H)

[2]FPGA:

- 16 Nos. Point LEDs (Logic Output)
- 2 Nos. of Push Buttons
- Two UART(RS232)
- 12-Bit SPI ADC (2 channel)
- 12-Bit SPI DAC
- Temperature Sensor LM35
- 5V SPDT Relay

[3]LOGIC converter:

[4] Inverter using MOSFET (IRF540, IRF540S)

- Trench technology
- Low on-state resistance
- Fast switching
- Low thermal resistance
- VDSS = 100 V
- ID = 23 A
- RDS(ON) £ 77 mW

[5] MOSFET Driver (IRS233)

- VOFFSET - 600V max.
- IO-+/- 200 mA / 420 mA
- VOUT 10 V – 20 V (233(0,2)(D))
- ton/off (typ.) 500 ns

D. Design result

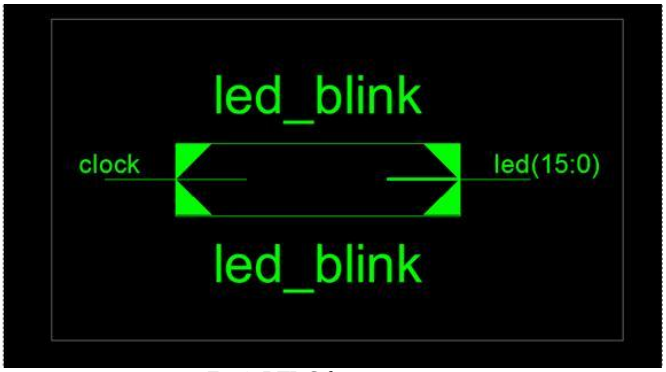


Fig.1 RTL Schematic

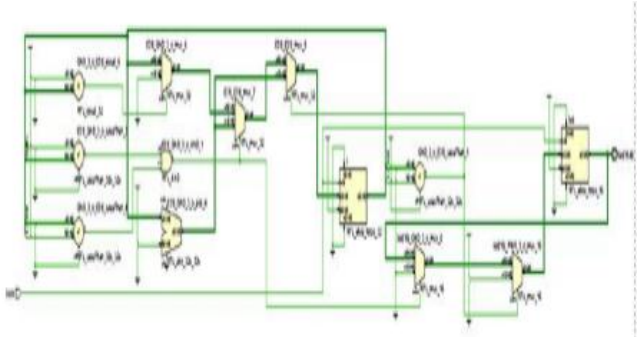


Fig2. RTL Schematic

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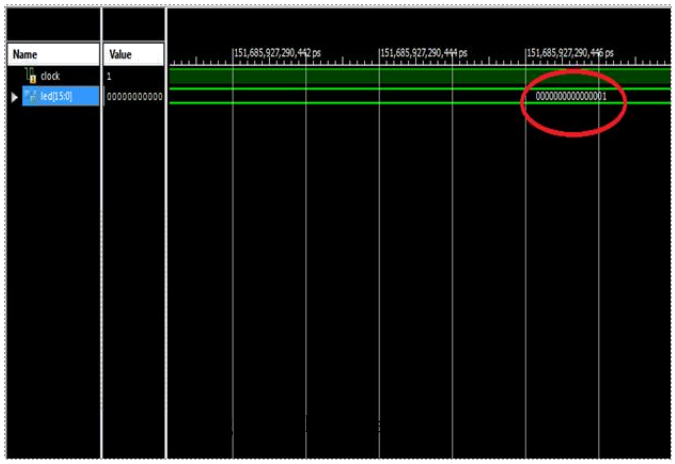

Fig 4. Simulation result2 s

E. CONCLUSION

In this project, have demonstrated the importance and advantages of controlling BLDC motor by the mean of FPGA over the conventional motor, because of programmable structure of FPGA. It is possible for making user modifications as per requirements.

At the output of logic converter, we get the variable speed waveforms . Thus motor gets rotating on a different speed, so it is helpful for developing advance aplications. The use BLDC motor is beneficial for this project because of its better efficient and less lossy operations. Hence the motor gets controlled by FPGA.

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