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Design and Development of Fly-Back Converter with Buck-Boost Regulator for DC Motor used in Electric Vehicle for the Application of Renewable Energy

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***Abstract* - This paper presents design and development of fly-back converter with buck-boost regulator for dc motor used in electric vehicle for renewable energy application. An electric vehicle working with DC motor energized from fly-back converter with buck-boost regulator, the energy generated by renewable sources like solar energy and wind energy. The present work depicts six phase generator to generate the power from wind fans, and then six phase converter (rectifier) is used to convert AC to DC. The use of fly-back converter in the power conversion system ripple voltages can be minimized and used to drive the electric vehicle.**

***Key words* - Fly-back converter, Six phase generator, Six Phase converter, Buck-Boost regulator.**

I. INTRODUCTION

Power is a precious commodity in power electronic system, the world facing too much global warming, this is due to consumption of energy more than 25% of worldwide greenhouse gas (GHG) generation, most of it for transport system. To reduce global warming we have to cut GHG emissions drastically and maximize renewable energy adoption, we have to replace the internal combustion engine (ICE) with hybrid system and the hybrid powered vehicles (PVs). The system must flip to the transportation system to electrified transportation. Electric vehicles are cleaner than petroleum-fuel vehicles and are seems to be appropriate solution to global warming. In future vehicles with renewable energy in the world will become promising commodity for transportation system to minimize global warming. The renewable energy system offers energy free of cost and reliable operation towards the growth of electrical energy system. Wind turbines convert the mechanical force into electrical energy. Therefore, source of mechanical force can widely use in internal combustion engine. The Fig.1 shows the block diagram of fly-back converter with buck-boost regulator for dc motor drive used in electric vehicle for the application of renewable energy. Each block is having their specific functions and operations, wind turbines convert the mechanical force into electrical energy and this will be free of cost and eco friendly.

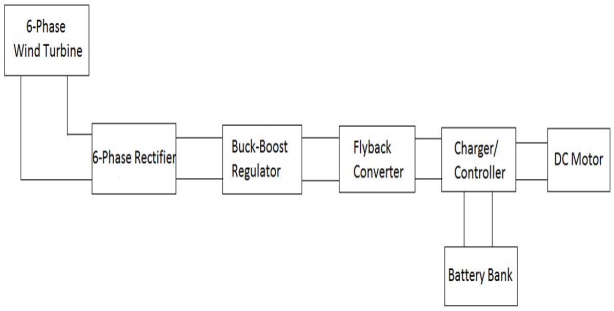

Fig. 1. Block Diagram of Fly-back Converter with Buck-Boost Regulator for DC Motor Used in Electric Vehicle for the application of renewable energy.

In this work the 6-Phase wind turbine is used to generate the power. The use of wind turbine is economical and high efficient than other renewable energies like solar cells, fuel, etc. The power generated from all sources are very effectively utilized for the applications, in power electronics system most of the 60 percent energy is wasted due to various conversion of energies for different applications, therefore the use of converters and inverters in transforming energies to the load will generates additional harmonics with fundamental harmonics, that does not contribute an extra energy for the load instead it is simply dissipated as heat in the devices, and loads, therefore the efficiency of the system will deteriorates. Six phase generator generate more power to weight ratio, these systems offers better voltage, frequency and improved reliability.

Six phase rectifier circuit is used to convert the generated AC into DC, the buck-boost converter circuit is constructed to provide buck and boost the output voltage. These circuits use a regulator which maintains the constant output. A Buck-boost converter is a switch

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mode DC to DC converter in which the output voltage can be transformed to a level less than or greater than the input voltage. The magnitude of output voltage depends on the duty cycle of the switch.

A fly-back converter is used to get the isolated and stabilized output in both AC-DC, AC-AC and DC-DC circuits. In this system a traditional fly-back converter is used with pulse generator to stabilize the available input to provide the isolated and stabilized output. The fly-back converter system is attached to the buck-boost regulator/converter system, this system has six electrical conductors working with alternating currents for a definite time offset power in each conductor. Six phase converters and inverters are used to provide power to linear and nonlinear loads. The output voltage can be control by varying pulse generator used in this power electronic drive system.

A charger/controller, charge regulator or battery regulator limits the rate at which electric current is added to or drawn from electric batteries. It prevents overcharging and may protect against overvoltage, which can reduce battery performance or lifespan. It may also prevent completely draining ("deep discharging") a battery or perform controlled discharges, depending on the battery technology to protect battery life. The advantage of charger/controller is battery aging adjustments, battery gassing and heating reductions, charge acceptance increase, drifting battery cell equalization, high battery capacity maintenance, lost battery recovery, self-regulation with drops in voltage or temperature.

Battery bank is the power source of the electric vehicle, which stores energy during wind fans start rotating and stored in the battery. Whenever it is required that time charger/controller supplies the stored power to the DC motor.

II. CIRCUIT DESIGN

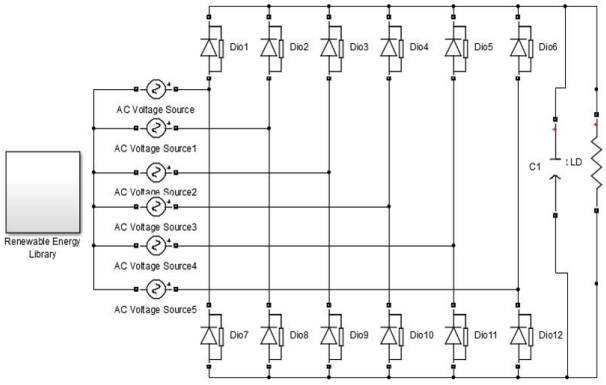

Fig. 2. Six phase wind energy generator system with rectifier circuit.

A six phase converter is constructed with Power Diodes with 6 legs. In each leg has two diodes, employed to convert the ac voltage generated by wind turbine to a DC output voltage. The practical use of wind turbine is complex for the power electronics system in generation of power, since the power generated by the wind turbine is depends on the capacity of the wind.

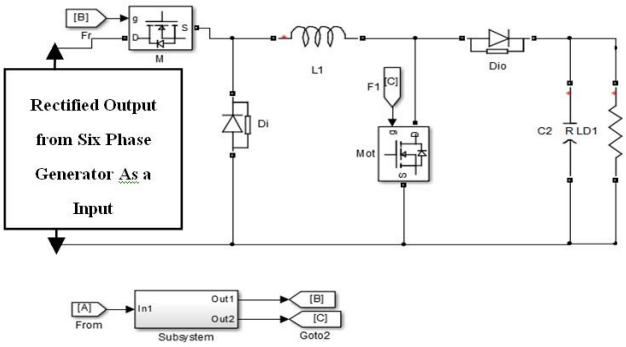

Fig. 3. Buck-boost converter and inverter circuit.

The generated wind is less the speed of rotation of wind turbine is slow down, hence the power generated by the wind turbine is minimum and also, in power electronic system it is most challenging situation to operate instantaneously with loads. Therefore, this situation can be overcome by designing buck boost converters and inverters.

The main working principle of buck boost converter is that the inductor in the input circuit resists sudden variations in input current. When switch is ON the inductor stores energy from the input power, and discharges this energy when switch is closed. The capacitor in the output circuit is assumed large enough to maintain the time constant of RC circuit in the output stage. The large time constant compared to switching period ensures that, in a steady state condition the constant output voltage Vo(t) = Vo(constant) exists across load terminals. But the output available from this circuit is not stable and there will be addition of ripple. In order to avoid ripple at the output of converter is to get the isolated and stabilized output from the input using fly-back converter.

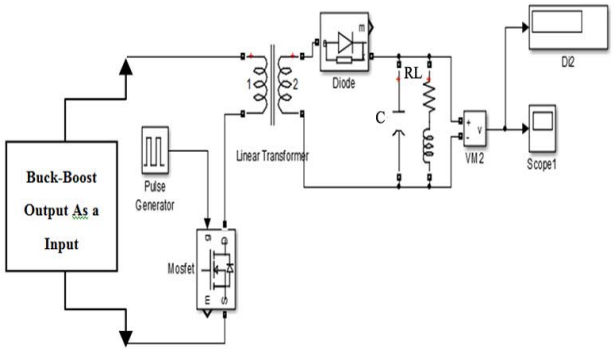

Fig. 4. Fly-back converter circuit.

The operation of the fly-back converter is described discussed in this work confined to minimize the ripple voltage, when the MOSFET turns on, the polarity of the transformer is reversed, a current flow to the primary winding of the transformer, where energy is stored, this results the diode will be off. When the MOSFET turns off, the stored energy flows through the diode from the secondary winding of the transformer, after undergoing

rectification and the voltage peaks obtained at the output of converter is smooth. Which reduce the ripple voltage and getting isolated and stabilized output, in this work the model has been created and simulated with Simulink/Matlab software.

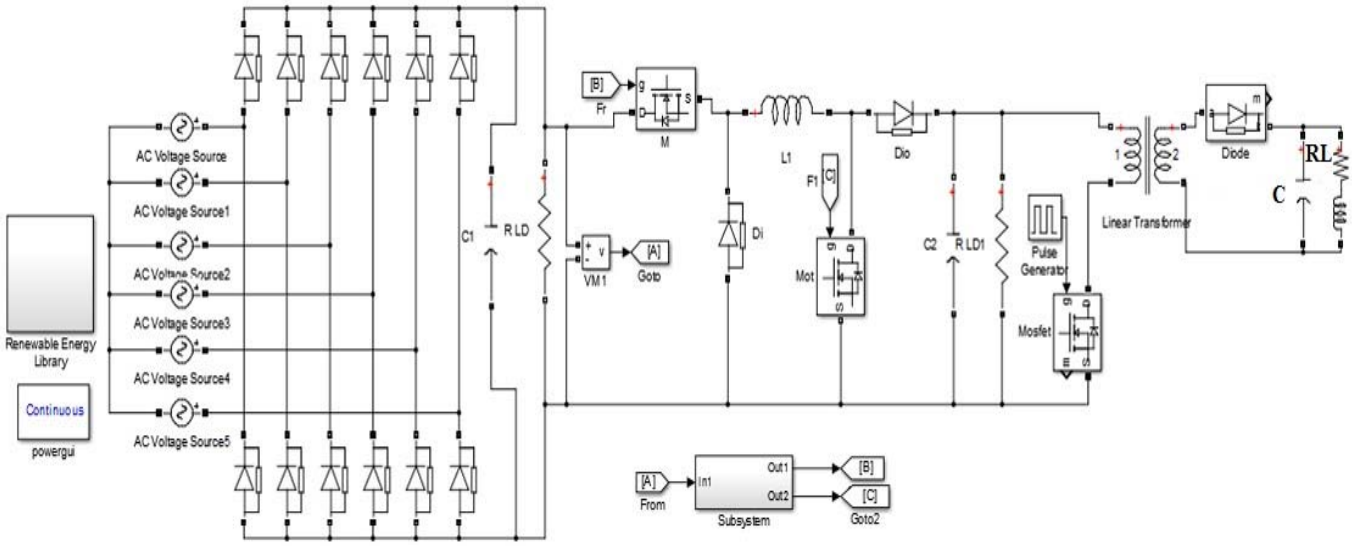

Fig. 5. Six Phase generator with Fly-back converter and Buck-boost Regulator for DC Motor.

The rectified output from rectifier is fed into buck-boost regulator, this buck-boost regulator is designed to work for the voltage between DC 150V to DC 250V. This means the subsystem which is designed to work in the input voltage is always greater than DC 150V and less than DC 250V. If the applied DC voltage is less than 250V and greater than 150V, it is required to boost the applied voltage to 200V, and if the voltage is greater than 250V, it is required to buck (regulate) the voltage for constant DC output for DC motor drive applications. The fly-back converter is used to get the desired, isolated and stabilized output from the input. The main advantage of this fly-back converter is to reduce the ripple voltage and gives stabilized constant output. The output is fed to Charger/Controller for proper transfer of energy to the battery bank, and also sends energy to run the DC powered loads.

III. RESULTS

Parameters used for simulation of circuit:

- Input voltage = AC 100V (from wind turbines to rectifier).
- Frequency = 50Hz.
- DC Input for Buck-Boost = 188.9V (from rectifier to buck-boost).
- DC Output from Buck-Boost = 209.4V (from buck-boost regulator).
- Stabilized DC Output from Fly-back = 205.9V.

For the fly-back converter with buck-boost regulator, the output voltage v/s time has been measured using Simulink and shown in Fig.6. Simulation carried out by initializing 50Hz as frequency. By the simulation we are getting DC 205.9V stabilized output.

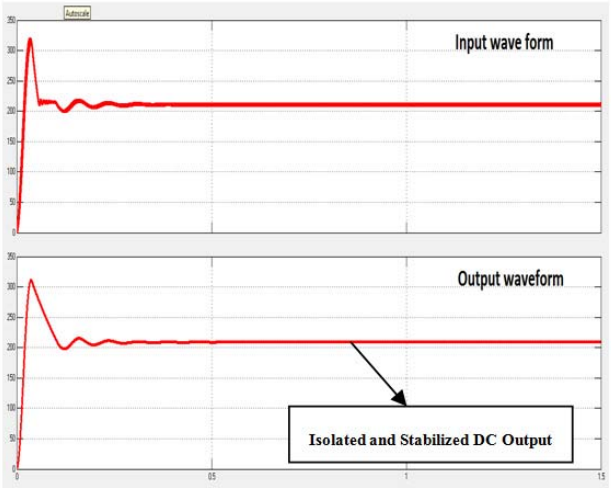

Fig. 6. Input and Output voltage waveform of Flyback converter.

IV. CONCLUSION

The output response of a Flyback converter with Buck-Boost Regulator for DC Motor application has been simulated by creating a power source of 6-phase generator. The simulated result is studied and this work is proposed to generate renewable energy for electric vehicles under low wind energy and high wind energy generation system, the ripple voltage at the output of the fly-back converter has been slightly minimized, this is one of the added advantage of generation of harmonics at the output of the inverter system in AC load applications.

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