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DESIGN OF MICRO CONTROLLER BASED SPEED CONTROL OF DC MOTOR USING PI CONTROLLER

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Abstract - *The objective of this paper is to speed control of DC motor using SEPIC converter. This paper using single ended primary inductor converter (SEPIC) with speed control of DC motor. It is used to improve the efficiency at low input voltage and reduce the switch-voltage stress. The absence of an input in the SEPIC converter results in less conduction losses. Lower switch voltage stress allows utilizing a MOSFET. The discontinuous conduction mode (DCM) operation has advantages such as zero-current turn-on in the power switches and simple control circuitry. Speed control of the DC motor is done using this SEPIC converter. Converter output is given to the input of the DC motor speed control. Today every industry becomes automated industry. To make the industry automation the equipment and machineries should be controlled automatically. In this project we control the PMDC motor automatically through controller. So we can control the machineries which involving this motor accurately. By making the industrial automation we can increase the production rate.*

The desired speed is entered to microcontroller through key board. Then controller sends the corresponding digital signal to MOSFET control unit. In many industrial applications like Transformer, diesel engine etc., there is needed to maintain the temperature to prevent the system from damage. Here the PMDC (Permanent Magnet DC) motor is used to drive the cooling fan in cooling system because they offer several advantages like no field winding, small in size, increase in efficiency .This study includes real time temperature control using a PI controller. The terminal voltage of the motor is controlled by using chopper, here MOSFET is used as a switching device in which the on and off time depends on the temperature variation. PI controller and PWM technique are used to control the speed which is described. The temperature variation and speed of the motor can be monitored in LCD display. The power saving can be done by automation in the speed control of the motor

***Key Words*: Single ended primary inductor converter (SEPIC), Permanent Magnet DC motor, Metal oxide filed effect transistor (MOSFET), switch-voltage stress, Pulse width modulation (PWM).**

1. INTRODUCTION

Direct Current motors are one of the motor types rapidly gaining popularity. DC motors are used in industries such as Appliances, Automotive, Aerospace, Consumer, Medical, Industrial, Automation, Equipment and Instrumentation. DC motors have many advantages over brushed DC motors and induction motors. A few of these are Better speed versus torque characteristics, High dynamic response, High efficiency, Long operating life, Noiseless operation, Higher speed ranges. In addition to that the ratio of torque delivered to the size of the motor is higher making it useful in applications where space and weight are critical factors.

1.1 Block Diagram

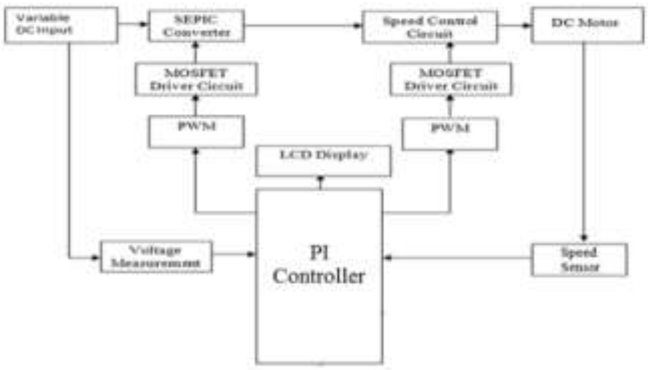

Fig-1: Block diagram of micro controller based speed control of dc motor using pi controller

In above the fig-1 is the Block diagram of micro controller based speed control of dc motor using pi controller, It consist of single ended primary inductor converter (SEPIC) with speed control of DC motor, PI controller, speed sensor, MOSFET driver circuit, PWM and LCD display.

1.2 Single-Ended Primary-Inductor Converter

Single-ended primary-inductor converter (SEPIC) is a type of DC-DC converter allowing the electrical potential (voltage) at its output to be greater than, less than, or equal to that at its input; the output of the SEPIC is controlled by the duty cycle of the control transistor. A SEPIC is essentially a boost converter followed by a buck-boost converter, therefore it is similar to a traditional buck boost converter, but has advantages of having non-inverted output (the output has the same voltage polarity as the input), using a series capacitor to couple energy from the input to the output (and thus can respond more gracefully to a short circuit output), and being capable of true shutdown: when the switch is turned off, its output drops to 0 V, following a fairly hefty transient dump of charge. SEPICs are useful in applications in which a battery voltage can be above and below that of the regulator's intended output. For example, a single lithium ion battery typically discharges from 4.2 volts to 3 volts; if other components require 3.3 volts, then the SEPIC would be effective.

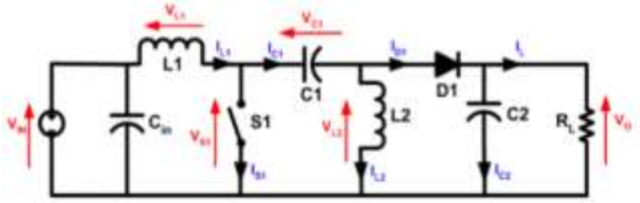

Fig-2: Single-ended primary-inductor converter

In above Fig-2 is Single-ended primary-inductor converter. The SEPIC exchanges energy between the capacitors and inductors in order to convert from one voltage to another. The amount of energy exchanged is controlled by switch S1, which is typically a transistor such as a MOSFET; MOSFETs offer much higher input impedance and lower voltage drop than bipolar junction transistors (BJTs), and do not require biasing resistors as MOSFET switching is controlled by differences in voltage rather than a current, as with BJTs).

Continuous mode

A SEPIC is said to be in continuous-conduction mode in fig-3 ("continuous mode") if the current through the inductor L1 never falls to zero. During a SEPIC's steady-state operation, the average voltage across capacitor C1 (VC_1) is equal to the input voltage (V_i). Because capacitor C1 blocks direct current (DC), the average current across it (IC_1) is zero, making inductor L2 the only source of load Current. Therefore, the average current through inductor L2 (IL_2) is the same as the average load current and hence independent of the input voltage. Looking at average voltages, the following can be written: VIN = VL1 + VC1 + VL2 because the average voltage of VC_1 is equal to VIN, $VL_1 = -VL_2$. For this reason, the two inductors can be wound on the same core. Since the voltages are the same in magnitude, their effects of the mutual inductance will be zero, assuming the polarity of the windings is correct. Also, since the voltages are the same in magnitude, the ripple currents from the two inductors will be equal in magnitude.

The average currents can be summed as follows: ID1 = IL1+ IL2 When switch S1 is turned on, current IL_1 increases and the current IL_2 increases in the negative direction. (Mathematically, it decreases due to arrow direction.) The energy to increase the current IL_1 comes from the input source. Since S1 is a short while closed, and the instantaneous voltage VC_1 is approximately VIN, the voltage VL_2 is approximately −VIN. Therefore, the capacitor C1supplies the energy to increase the magnitude of the current in IL_2 and thus increase the energy stored in L2. The easiest way to visualize this is to consider the bias voltages of the circuit in a D.C. state, then close S1.

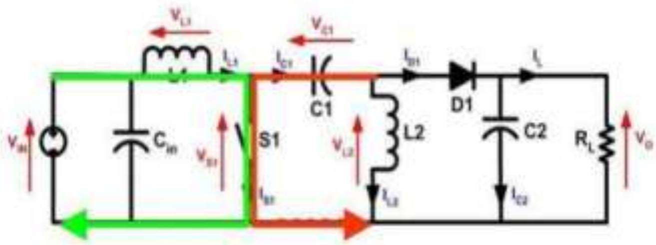

Fig-3: Continuous mode Single-ended primary-inductor converter

When switch S1 is turned off, the current IC_1 becomes the same as the current IL_1, since inductors do not allow instantaneous changes in current. The current IL_2 will continue in the negative direction, in fact it never reverses direction. It can be seen from the diagram that a negative IL_2 will add to the current IL_1 to increase the current delivered to the load. Using Kirchhoff's Current Law, it can be shown that $ID_1 = IC_1 - IL_2$. It can then be concluded, that while S1 is off, power is delivered to the load from both L2 and L1. C1, however is being charged by L1 during this off cycle, and will in turn recharge L2 during the on cycle.

Because the potential (voltage) across capacitor C1 may reverse direction every cycle, a non-polarized capacitor should be used. However, a polarized tantalum or electrolytic capacitor may be used in some cases,[1] because the potential (voltage) across capacitor C1 will not change unless the switch is closed long enough for a half cycle of resonance with inductor L2, and by this time the current in inductor L1 could be quite large. The capacitor CIN is required to reduce the effects of the parasitic inductance and internal resistance of the power supply. The boost/buck capabilities of the SEPIC are possible because of capacitor C1 and inductor L2. Inductor L1 and switch S1 create a standard boost converter, which generates a voltage (VS_1) that is higher than VIN, whose magnitude is determined by the duty cycle of the switch S1. Since the average voltage across C1 is VIN, the output voltage (VO) is VS_1 - VIN. If VS_1 is less than double VIN, then the output voltage will be less than the input voltage. If VS_1 is greater than double VIN, then the output voltage will be greater than the input voltage.

1.3 Simulation diagram and results:

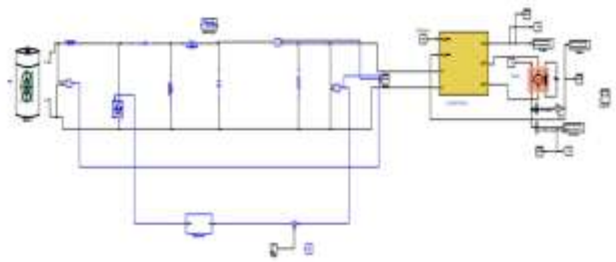

Fig-4: Simulation diagram of micro controller based speed control of dc motor using pi controller

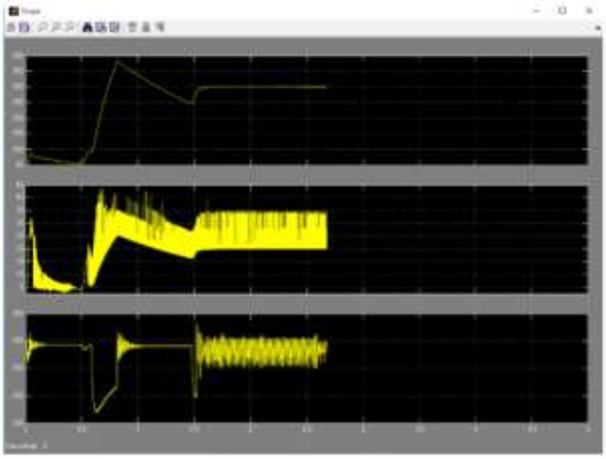

Fig-5: Voltage output waveform

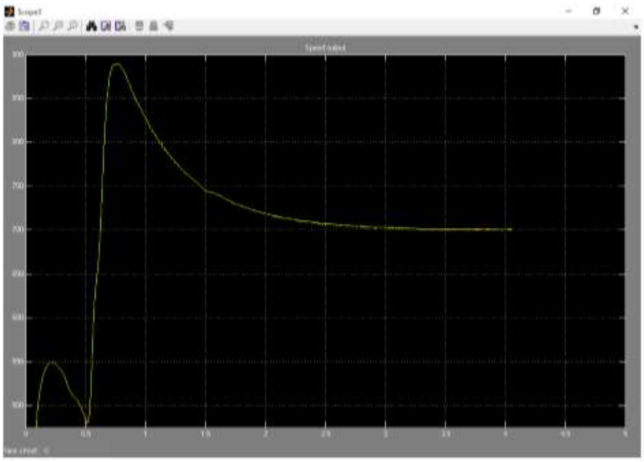

Fig-6: Speed output waveform

3. CONCLUSION

The progress in science & technology is a non-stop process. New things and new technology are being invented. As the technology grows day by day, we can imagine about the future in which thing we may occupy every place. The proposed system based on Atmel microcontroller is found to be more compact, user friendly and less complex, which can readily be used in order to perform. Several tedious and repetitive tasks. Though it is designed keeping in mind about the need for industry, it can extended for other purposes such as commercial & research applications. Due to the probability of high technology used this" SPEED CONTROL OF PMDC MOTOR USING SEPIC CONVERTER" is fully software controlled with less hardware circuit. The feature makes this system is the base for future systems.

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