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Regenerative braking of dc motor with renewable sources using bi-directional converter

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Abstract: *Our main objective is to design a system using various forms of energy like solar energy, wind energy, fuel cell, etc., A new technique called multiport is introduced to select a reliable source and direct the other sources for charging the battery. A bi-directional converter is used to boost the input voltage to the required voltage. Varying input voltage switches the bi-directional dc-dc convertor to boost or buck mode. In addition, a regenerative breaking system is used which uses the motor back emf developed during braking is used to recharge the battery. This leads to the efficient usage of the available fuel.*

Keywords: Regenerative Braking, Bi-directional DC-DC Converter, PIC Microcontroller, Buck, Boost.

1. Introduction

The latest trend in the society is the usage of the electric vehicles as they are pollution-free. There are many other existing electric vehicles but they don't use energy in effective manner. To overcome this multi-port switching among the sources is used. The microcontroller selects the required source. Regenerative breaking concept is also involved in the recharging of the battery.

Many companies are manufacturing electric vehicles which use battery as the only source. Other system using multiple source like wind energy, solar energy, or the fuel cell are connected to a power grid which supplies energy to the motor i.e. electrical vehicle engine. Abundant renewable sources go waste by this Method. Reliability is much reduced due to single input source. In this existing method the excess energy go wasted.

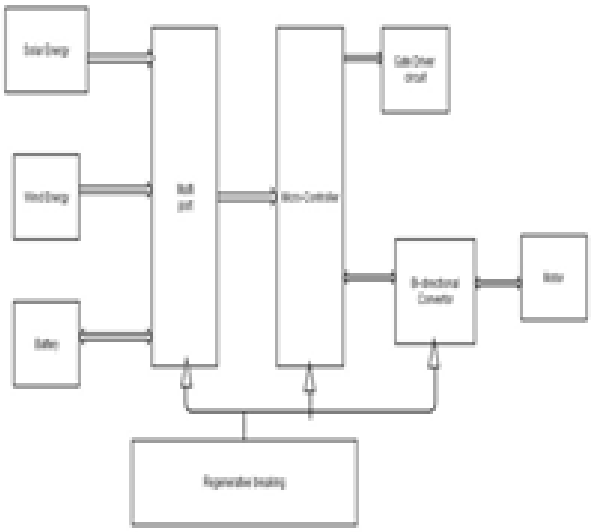
In our new system the concept of multi-port, regenerative braking does an excellent work and uses the energy effectively. Multi-port is the combination of comparator and selector circuits. Bi-directional converter step-down or step-up the input voltage according to the speed of the motor .This reduces the usage of energy. The regenerative braking concept uses the back emf of the motor to recharge the battery after stepping up using the bi-directional converter. The major advantage of our system is the storage of energy produced during braking using the regenerative braking and the multi-port concept make the motor more reliable. Using bi-directional convertor charging can also be done by connecting a direct ac line.

2. Methodology

Figure.1 Functional Block diagram

The figure.1 shows the functional block diagram of the Proposed System. It explain about the operation of individual Parts.

2.1 Multiport Selector Unit



The main function of the multiport selector is to select the source to be sent to the converter block, the source with high

Priority with required amount of voltage is connected to the converter block for driving operation.

2.2 CONCEPT OF SWITCHING BETWEEN THE INPUTS:

The comparator circuit does the work of comparing source voltages with the reference voltage and determines the greater one which is indicated as the output voltage. Comparator acts as the converter converting the input analog signal to the digital signal output. The output digital signal is given to the microcontroller which switches ON and OFF through relay. Comparator is the circuit with two input terminals the inverting and non-inverting. The standard reference voltage V_{ref} is

connected to the inverting or non-inverting terminal . When V_{ref} is connected to the inverting or non- inverting terminal the voltage V_{in} is connected to the other terminal of the comparator. Whatever be the input condition the output of the comparator have three possible values

When

$V_{in} > V_{ref}$ $V_0 = -V_{sat}$

$V_{in} < V_{ref}$ $V_o = +V_{sat}$

$V_{in} = V_{ref}$ $V_0 = 0$

These digital values are connected to the micro controller unit which is automatically switched between different inputs connected to the vehicle .With output of the comparator the input source with required voltage is determined by the micro controller unit .The source with required power is switched ON and connected to the convertor unit. At the time of regenerative breaking port selector is connected to the battery so as to get the battery charged.

2.3 Principle of Microcontroller in Multiport:

The microcontroller check whether regeneration breaking is applied if not it gets input from comparator unit and provides the selection.

Coding for prioritizing:

```
 /*program for prioritizing */

 if(solar_power>=needed)
{
    Solar_relay=1;
   }
else if (wind_power>=needed)
 {
    Wind_relay=1;
   }
else
 {
    Battery_relay=1;
  }
/*the end*/
```

The Microcontroller automatically switches in this part. if solar is available it is selected or else wind energy or battery.

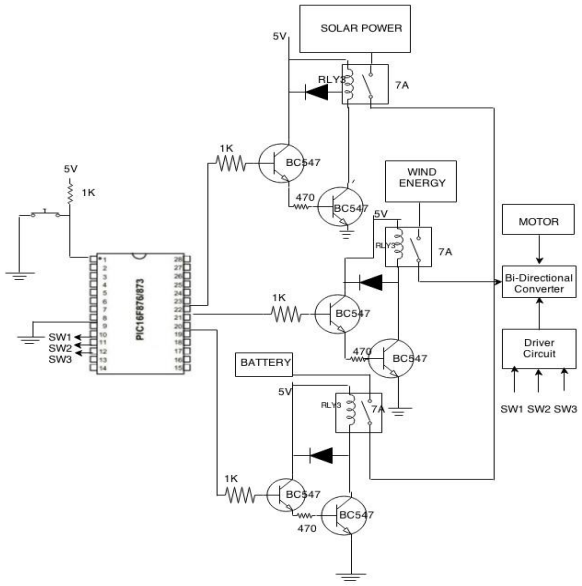


Figure.2 Working of Relay

2.4 Selector unit:

From figure.2 Selector unit consists of single pole single throw relay connected to the input sources. Relay connected to the other sources are normally open(NO) and the relay connected to the battery is normally closed (NC) .

2.5 Working of relay driver:

When the microcontroller gives the high signal the transistor conducts switching the relay from NO to NC .When the relay is switched ON device gets supply and works.

2.6 Bi-Directional Converter *:*

The converter from figure.3 is a fast switching device .Bi-directional converter has importance due to bi-directional energy transfer between two terminals.

Bi-directional converter works in four modes

1. Forward buck mode
2. Forward boost mode
3. Reverse boost mode
4. Reverse buck mode.

In our system we just use first three modes of operation .Forward buck mode and forward boost mode control the speed of the operation and the reverse boost mode is used in regenerative breaking.

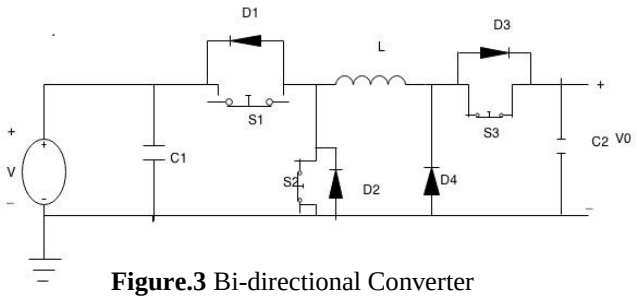


Figure.3 Bi-directional Converter

Duty cycle of the output is varied according to the formulae.

For buck mode,

$$V_0=D*V_{in}$$

For boost mode,

$$V_0=V_{in}/ (1-D)$$

2.7 Regenerative Breaking:

Electric breaking is the method of stopping the motor by an electric supply or using regenerative voltage .During regenerative breaking DC motor acts as the generator supplying power for storage through the bi-directional converter which bucks or boosts the generated power as per the requirements.

2.8 Microcontroller unit:

Micro controller unit used in our system is PIC I8F882 which is 28-pin flash-based , 8-bit CMOS micro controller with high performance RISC based CPU with operating speed of 20 MHZ/clock input and 5V as input. This microcontroller is much suited for this system.The input to the microcontroller varies the duty cycle according to the requirement.

3. RESULTS AND CONCLUSIONS

Table 1: Change of Bi-Directional Convertor Output With Change In Duty Cycle

S.no	*DUTY CYCLE*	*OUTPUT VOLTAGE DROP (V)*	*MODE OF OPERATION*
1	0.78	4.7	Buck
2	0.8	4.75	Buck
3	0.83	5	Buck
4	0.87	5.25	Buck
5	1	6	Normal
6	0.19	7.4	Boost
7	0.29	8.5	boost
8	0.38	9.7	Boost
9	0.47	11.5	Boost
10	0.5	12	Boost

From Table.1 if the voltage of the microcontroller varies, the duty cycle to the generator also varied which in turn varies the bi-directional converter output as shown in the figure.4..

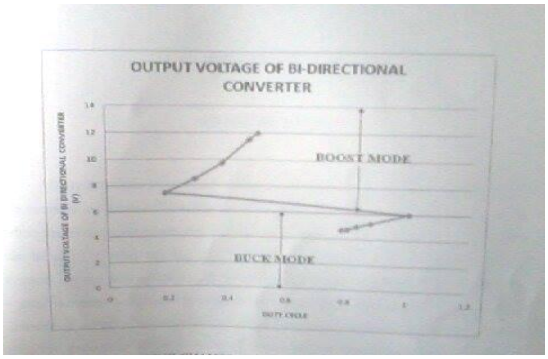


Figure.4.Graph Showing Change In Bi-Directional Convertor Output with Change in Duty Cycle.

Table 2: Variation of Bi-Directional Convertor Input With Respect to Change In Duty Cycle

SNO	INPUT VOLTAGE TO MICROCONTROLLER(V)	DUTY CYCLE	MODE OF OPERATION
1	0	0.78	Buck
2	0.5	0.8	Buck
3	1	0.83	Buck
4	2	0.87	Buck
5	2.5	1	Normal
6	3	0.19	Boost
7	3.5	0.29	Boost
8	4	0.38	Boost
9	4.5	0.47	Boost
10	5	0.5	Boost

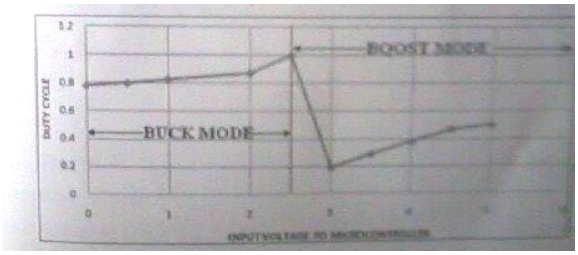


Figure.5 Graph Showing Change in Bi-Directional Convertor Input with Change in Duty Cycle.

From Table.2 if the input voltage of the microcontroller varies, the duty cycle to the generator also varied which in turn varies the bi-directional converter input as shown in the figure.5. Section headings come in several varieties:

4. CONCLUSION

This system using renewable sources by selecting the required mode and the reliability also increased by the usage of battery. When renewable sources are not available, The efficiency of the system is increased by the recharging of the battery with the extra available sources. The regenerative braking regenerates the small amount of the supplied energy which will be wasted during braking. The bi-directional converter uses the minimum energy by boosting it.By these methods the available minimum amount of renewable sources effectively and the system is made more reliable.

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