Abstract- As the development of the electronics in car and automatic parts the capacity of the current 14 volt voltage system no longer meets the demand of the on-board devices. An upgrade is imminent. In order to be backward compatible with the existing 14v system and to introduce extensive modifications, a dual 14v/42v is being developed as a compromising solution to the problem. Based on the new system this article is proposes a new bi-directional DC/DC converter. Extensive study on the stability, reliability and the capability indicate that under changing power direction, this new converter is able to do a closed circuit control depending upon the current value and the direction.

Keywords- Bi-Directional DC/DC Converter, Dual Voltage System.

I. INTRODUCTION

Bi-Directional DC/DC converter has gained interest in both the industry and in the academic world of the power electronics field, which can perform as a platform for the transaction between different voltage values and make management of power at the two level of power system. It has a promising prospect in application of automation electronics, photo voltaic cell, solar energy generation and wind power generation, etc.

The demands to improve the performance, fuel economy and passenger convenience and safety have grown drastically in the recent times. The standard 14 volt electrical power system can no longer meet the demand of the modern day automobiles. A German forum has come up with a proposal to boost present in car voltage level from 14 volt to 42 volt, which in turn Increases the power capacity of the 8 KW.

In this article, we introduce the bi-directional DC/DC converter. It contains control circuit which is able to determine the operating mode depending on the inductance current direction, it then stabilizes the closed loop system stable without changing the parameters. The DC/DC converter is used in automotive environment which has strict requirement for cost, volume and efficiency. A Buck/Boost converter is build for this purpose.

II. OPERATIONAL PRINCIPLE OF THE BI-DIRECTIONAL DC/DC CONVERTER

Implementing a 42v/14v, converter with a buck-boost topology using an active switch instead of a diode is more desirable. As bi-directional operation is possible without any additional requirements of the components and the efficiency is also very high than a typical buck-boost type converter using a diode. The figure given below shows a buck-boost type converter where A1 and A2 (B1 and B2) are the active switches. Which turns on and off alternatively through the main switches or the free wheeling diode according to the operation mode. The DC/DC converter is connected parallel with the batteries with 42volt and 14 volt loads on either side of the circuit.

The control method which is used is the current control method instead of the voltage control method, since the mode of operation is detected by the change in the inductor current, rather not by inductor voltage and more over current control method has a faster response than voltage control method. A current control loop is much more stable than a voltage control loop.
Three Modes of converter operation:

(i) The inductor current is above zero, the converter is operating in the buck mode, and the 42 volt bus provides energy to the sides, 42 v loads and charges the batteries as well.

(ii) The inductor current is below zero, the converter is operating in the boost mode. The 14 volt bus provides energy to the both side of the loads and charge the 36 volt battery.

(iii) When the inductor current repeat working through zero, the converter operates in the alternating mode.

The graph showing the working of the converter in the different modes depending on the value of the inductor current is given below:
III. PROPOSED CONTROL METHOD

A typical controller block diagram for the 14v/42v bi-directional DC/DC converter is designed. The closed loop operation is determined by using a general purpose PWM IC U3525. The whole control circuit consist of an inductor current measurement circuit, current regulator, voltage regulator and PWM generation unit. All the above mentioned devices worked under a stable condition.

The sensing signal of the inductor current goes through the measurement circuit. If the output signal is positive the converter operates in the buck mode and if the output signal is negative the converter operates in the boost mode. The Enabled signal is determined using the inductor current which is a digital signal according to the average value of the inductor current. VA and CA are the voltage regulator and current regulator respectively. The switches in the PWM generation circuit are selectors employed in the main power MOSFETs.

IV. EXPERIMENTAL RESULTS

The proposed strategy was verified by designing a 3v/12v buck-boost converter, which is a prototype of the original 14v/42v Bi-Directional DC/DC converter which is used in the automotive industries for in car power supply. The output waveforms are shown as below:
CONCLUSION

The Bi-Directional DC/DC converter has a promising prospect in the automation electronic area. This article proposes a double loop control system based on different inductor current directions and in different work mode as the system itself can separate out the buck mode and the boost modes. This proposed circuit design can further be reinforced by extensive experimentations and further research in this field.

REFERENCES


Fig VII: Output Inductor current for Buck mode