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A Positive Buck Boost Converter with Mode Select Circuit and Feed Forward Techniques Using Fuzzy Logic Controller

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ABSTRACT:
The portable devices development of semiconductor manufacturing technology, conversion efficiency, power consumption, and the size of devices have become the most important design criteria of switching power converters. For portable applications better conveniences extension of battery life and improves the conversion efficiency of power converters .It is essential to develop accurate switching power converters, which can reduce more wasted power energy. The proposed topology can achieve faster transient responses when the supply voltages are changed for the converter by making use of the feed forward network .With mode select circuit the conduction & switching losses are reduced the positive buck–boost converter operate in buck, buck–boost, or boost converter. By adding feed-forward techniques, the proposed converter can improve transient response when the supply voltages are changed. The designing, modeling & experimental results were verified in MATLAB/ Simulink. The fuzzy logic controller is used as controller.
Keywords—Feed-forward techniques, mode select, positive buck–boost converter, Fuzzy logic control.

I. INTRODUCTION

Today we are using many portable devices such as LED products, notebooks, mobile phones, and car electronic products. And these products use the power converter for application. The challenges for the designer to provide consumers better conveniences are, to improve the conversion efficiency of power converters & to extend life of battery. Hence it is required to design a accurate switching power converters to reduce the more wasted power energy in the converter [1]. It is necessary to provide a regulated non-inverting output voltage from a variable input battery voltage to portable applications which suffer from the power handling problems. For example cellular phones, personal digital assistants (PDAs), wireless and digital subscriber line (DSL) modems, and digital cameras, need a regulated non-inverting output voltage because the battery voltage keeps on changing as it is charged &discharged. As the battery voltage can be greater than, less than or equal to the output voltage. Hence for this small scale application such as battery it is needed to regulate the output voltage of the converter with high precision & performance. Thus, a trade-off among cost, efficiency, and output transients should be considered [6]. For space-restrained application, the regulation of the output voltage in the midrange of a variable input battery voltage is a common handling issue [11].

There are various topologies which can be implemented to maintain a constant output voltage from a variable input voltage. For example inverting buck-boost converters, single- ended primary inductance converters (SEPICs), Cuk converters, isolated buck-boost converters and cascaded buck and boost converters. The output ripple, efficiency, space and the cost are the important points of concern for such low-voltage- range power supplies. The above mentioned topologies are generally not implemented for such power supplies due to their lower efficiency, higher size and cost factors.

Transitions will takes place during the charging & discharging of the battery .The converter to lose efficiency during the transition from buck mode to the boost mode & it leads to the spikes in the output voltage. The advantage of having higher efficiency is longer runtime at a given brightness level from the same set of batteries. While designing such power supplies the Cost, size, switching speed, efficiency and flexibility should be considered. Spikes occur during the transition from buck mode to the boost mode in the output voltage. This causes the converter to lose efficiency. To extend the battery life ,with increasing low-voltage portable devices and growing requirements of functionalities embedded into devices, efficient power management techniques are required .The dc-dc converters are designed in such a way that it need to supply the portable devices a regulated voltage over a wide battery voltage .So that it effectively use the remaining capacity of the battery. When the converter operates in the transition

region of the buck and boost mode, the limitations of standard analog pulse width modulator (PWM)

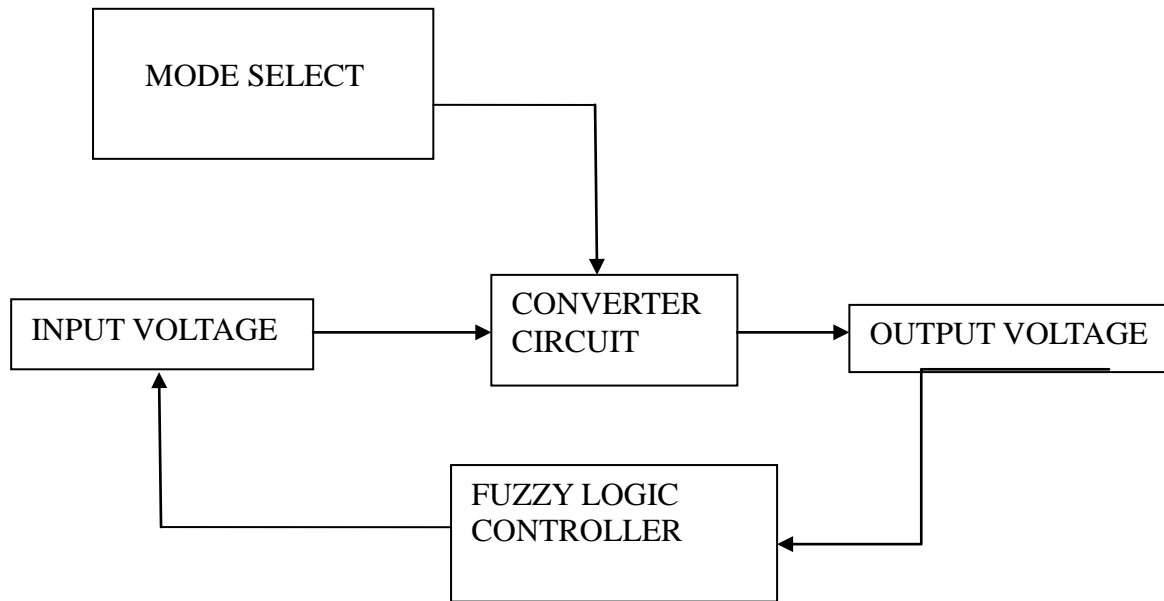causes uncontrolled pulse skipping and significantly increased output voltage ripples.

Fig. 1 Block diagram of proposed work.

Buck-boost mode is a buffer region which provides a smooth and stable transition between two modes. The converter can operate in buck, buck-boost and boost modes when the battery voltage decreases. Since the dc-dc converter has different operation modes, the system stability, the output ripple, and the accuracy of the regulated output voltage during mode transition need to be guaranteed [3]. Fig 1 shows the block diagram of proposed converter with fuzzy logic controller.

II. PROPOSED METHOD
With the mode select circuit such as buck, boost & buck boost operations can be performed by using the Mode select circuit. Fig 2 shows the proposed converter circuit .The positive buck-boost converter

can be operated in buck, boost, and buck-boost mode & in buck-boost mode the highest ratio occurs. Four power transistors cause more switching loss and conduction loss in the positive buck boost converter. So it is necessary to avoid power converters to operate in buck- boost mode to reduce the losses to as the positive buck-boost converter operates in wide-range of supply voltages. Therefore, we design a mode-select circuit to detect the battery energy and select the operation mode [1]. It switches only two power transistors when the converter operates in buck mode or boost mode. The conduction loss and switching loss of the proposed converter can be reduced by the mode select circuit mode select circuit. The proposed converter can operate in wide supply voltage range and extend the battery life.
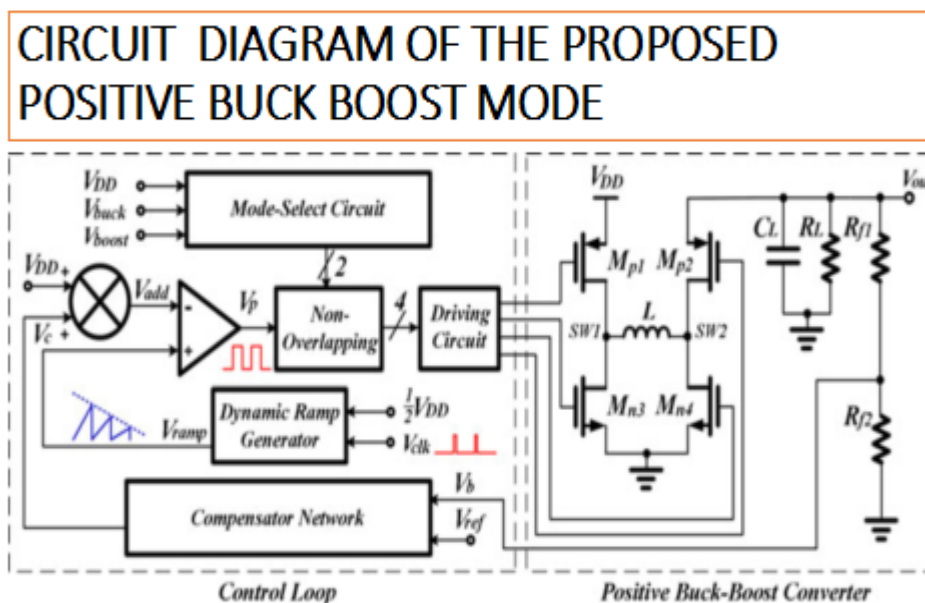
Fig 2.Proposed positive buck boost converter.

III. MODE SELECT

The losses can be reduced by making use of this Mode select circuit. When the proposed converter operates in the high frequency it uses all the four power transistors .And these switches produces more switching losses and conduction losses. To avoid those losses we utilize mode-select circuit and we can operate in three different modes as buck, boost and buck-boost mode. This Mode select circuit can decide the mode of operation & avoids the overlapping of modes when needed. The turning on the power transistors at the same time can also be avoided. Finally, it can determine the operation mode by a control signal from controller. By using this battery life can be extended and the converter can be operated in efficient way.

IV. MODES OF OPERATION:

The proposed converter operates in the two operating intervals for buck, boost & buck boost mode i.e. charging & discharging.

Fig 3(a) shows Power transistors Mp1 and Mp2 are switched ON proposed converter operates in the charging interval of buck mode; and the power transistors Mn1 and Mn2 are switched OFF. Fig.3 (b) the power transistors Mp2 and Mn3 are switched ON and the power transistors S1 and S4 are switched OFF.

Similarly the operation of the boost mode & buck boost mode takes place for the charging & discharging intervals.
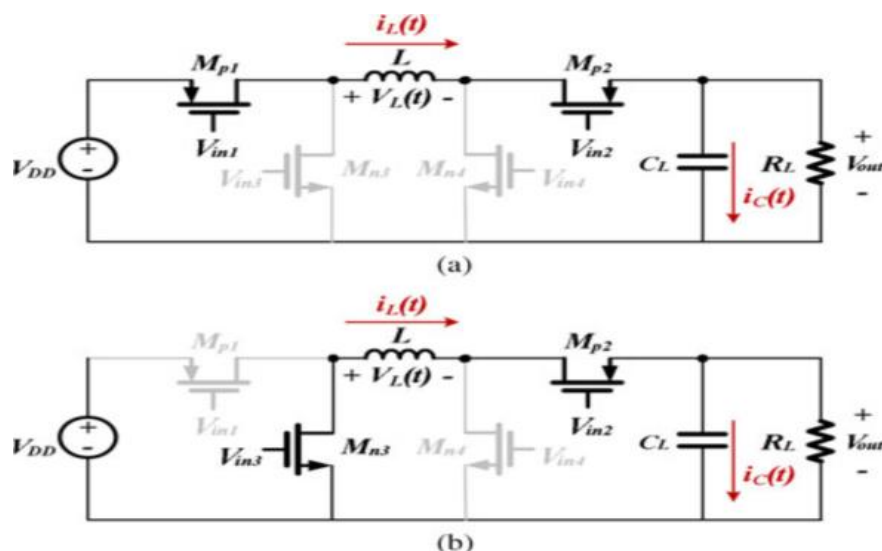
(a)

(b)

Fig 3 a. Power transistors Mp1 and Mp2 are switched ON Proposed converter operates in the charging interval of buck mode; and the power transistors Mn3 and Mn4 are switched OFF. Fig.3 (b) the power transistors Mn3 and Mp2are switched ON and the power transistors Mp1 and Mn4 are switched OFF.

V. FUZZY LOGIC CONTROLLER

Fuzzy controllers have got a lot of advantages compared to the classical controllers such as the simplicity of control, low cost and the possibility to design without knowing the exact mathematical model of the process. Fuzzy logic is one of the successful applications of fuzzy set in which the variables are linguistic rather than the numeric variables.
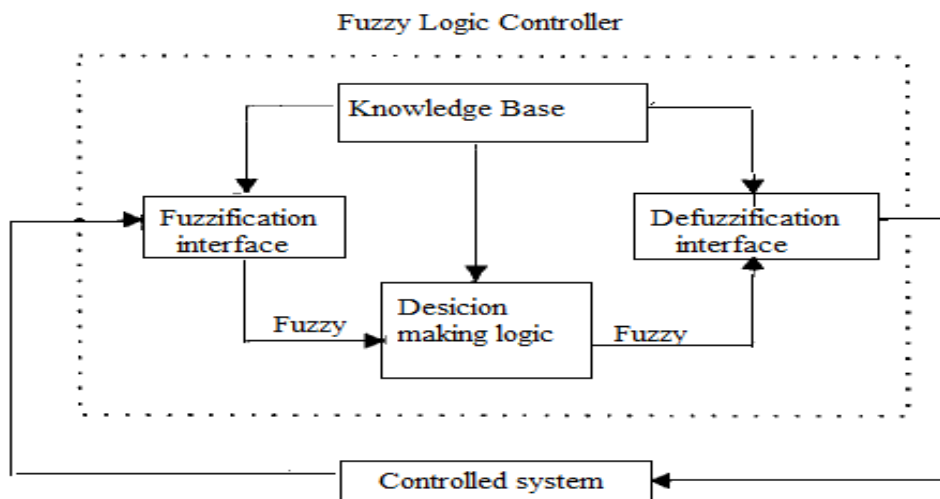

Fig 4.The general structure of an FLC.

The general structure of an FLC is represented in Fig. 1 and comprises four principal components:

1) a fuzzification interface which converts input data into suitable linguistic values; 2) a knowledge base which consists of a data base with the necessary linguistic definitions and control rule set; 3) a decision making logic which, simulating a human decision process, infers the fuzzy control action from the knowledge of the control rules and the linguistic variable definitions; and 4) a defuzzification interface which yields a nonfuzzy control action from an inferred fuzzy control action. [2] Design of fuzzy logic or rule based non-linear controller is easier since its control function is described by using fuzzy sets and if-then predefined rules rather than cumbersome mathematical equations or larger look-up tables; it will greatly reduce the development cost and time and needs less data storage in the form of membership functions and rules. It is adaptive in nature and can also exhibit increased reliability, robustness in the face of changing circuit parameters, saturation effects and external disturbances and so on.

VI) SIMULATION MODEL AND RESULT

A Positive buck-boost dc-dc converter with mode-select circuit using fuzzy logic controller has been simulated and results were obtained. The output voltage is same for all the three modes as 3.3v for buck, boost, and buck-boost mode. Fig.5 &5a. Shows the simulation circuit & results of proposed converter operating in buck mode. Supply voltage = 4.4v, output voltage = 3.3v for buck mode.. Fig.6 & 6a shows the simulation circuit & results of proposed converter operating in boost mode supply voltage = 2.7v, output voltage = 3.3v. Fig.7 & 7a. Shows the simulation circuit & results of proposed converter operating in buck- boost mode. Supply voltage = 2.7v, output voltage = 3.3v.
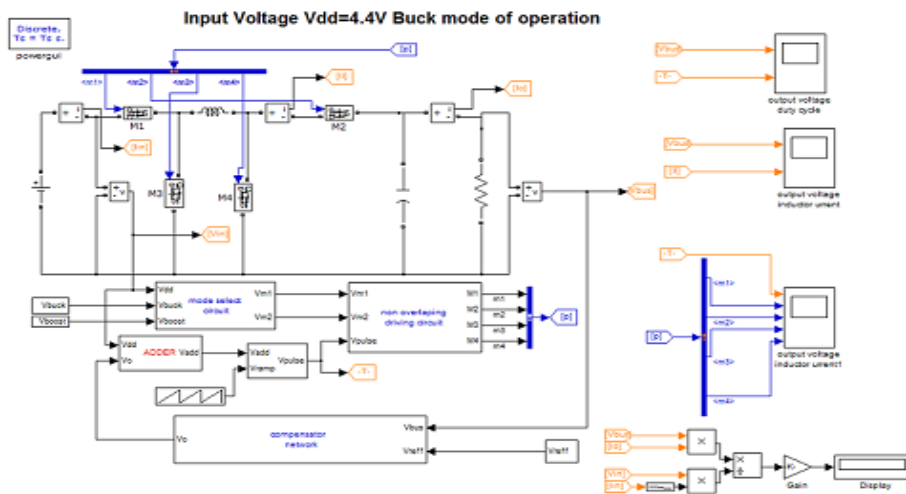

Fig 5.Simulation circuit for proposed converter operating in buck mode
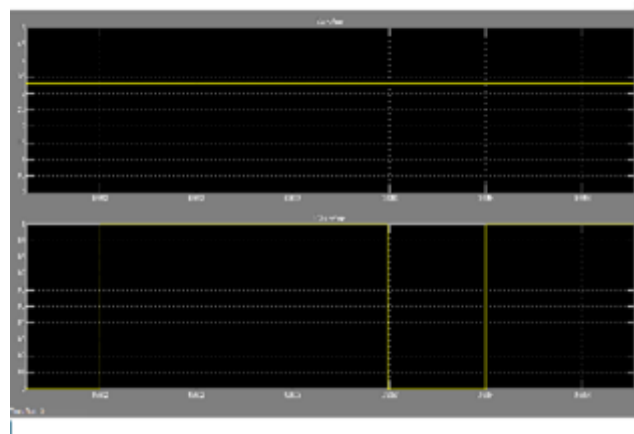

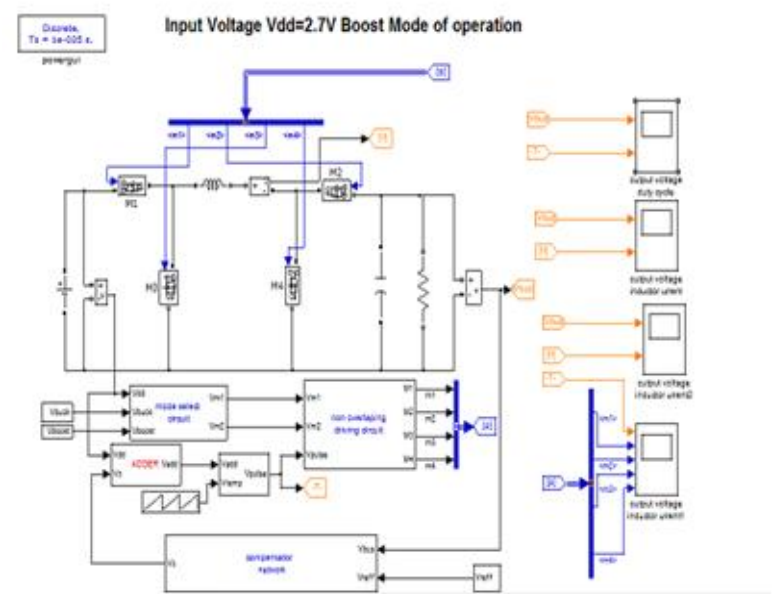Fig 5a shows the results of buck mode.

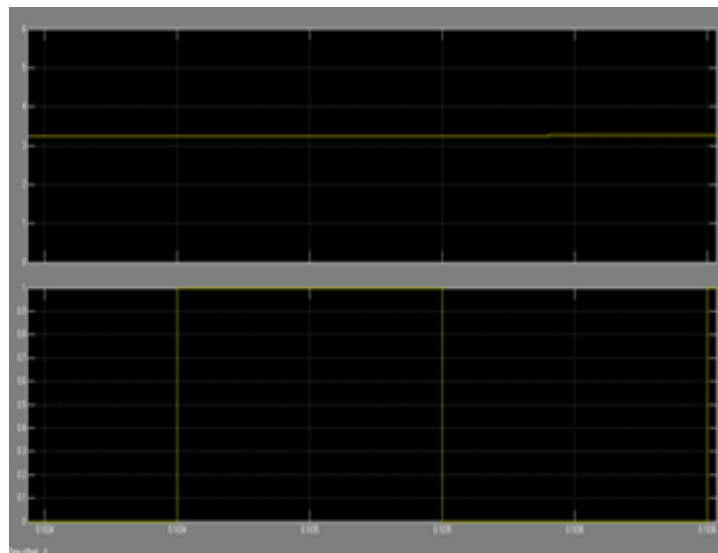Fig 6 shows the simulation circuit for the proposed converter for boost mode

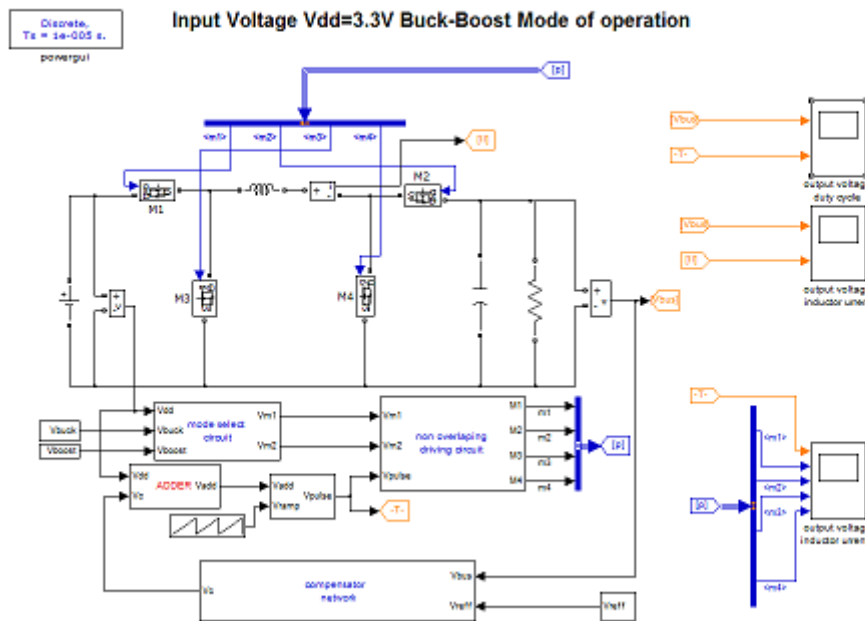Fig 6a shows the simulation results of boost mode.

Fig 7 shows the proposed converter for the buck boost mode

Fig 7a shows simulation results for the buck boost converter.

IV. CONCLUSION

The implementation of a positive buck-boost converter with mode-select circuit and with wide range of input voltages is proposed in this paper. By mode-select circuit losses are reduce. Four power transistors produce more conduction losses and switching losses when operated in high frequency By using mode-select circuit we can operate the converter in three different modes as buck, boost and buck-boost mode. To minimize the loss of switches, as the positive buck-boost converter operates in wide range of input voltages, it is necessary to avoid power converters operating in buck-boost mode. Therefore, the mode-select circuit is designed to detect battery energy and select the operating mode. The feed-forward techniques with fuzzy logic controller is used to improve its transient response when the supply voltage changes. It is typically used to compensate the input variations and provide tighter control response of the output voltage. By using the above mentioned techniques, the proposed converter improves power efficiency and extends the battery life.

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