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A Novel PDA Technique with Feedback Technique for Buck Boost Converter

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ABSTRACT*:* A buck–boost converter with high efficiency and small output ripple to extend the battery life of portable devices. moreover, the hybrid buck–boost feed forward (HBBFF) technique is incorporated in this converter to achieve the fast line response. The new control topology minimizes the switching and conduction losses at the same time even when four switches are used. Therefore, over a wide input voltage range, the proposed buck–boost converter with minimizes switching loss like the buck or boost converter can reduce the conduction loss through the use of the reduced average inductor current (RAIC) technique**.** In this technique to improve the efficiency of predictable switched capacitor converters. The voltage boost ratio of the proposed converter is 2*D*, where *D* is the duty cycle of the switching signal waveform. Furthermore, the proposed structure utilizes pseudo current dynamic acceleration (PDA) techniques, to achieve fast transient response when load changes between heavy load and light load. The switching frequency of the proposed converter is 1 MHz for 3.3-V input and 1.0–4.5-V output range application. the transient response to within 2 μs and the total power conversion efficiency can be as high as 90%.

KEYWORDS*:* Charge pumps, dc–dc power converters, pulse width modulation converter, Fast line transient response, feed forward technique, high efficiency, non inverting buck–boost converter.

I.INTRODUCTION

The dc–dc buck–boost converter is widely used in many applications, such as smart phones, PADs, laptop computers, and so on. As portable devices are becoming more popular, the need for high performance power management ICs for becoming grater, for used Conventional inductor step-up switching regulators, e.g., the buck–boost converter, boost converter, Cuk converter, and SEPIC converter, utilize the energy stored in an inductor and adjust the duty cycle to perform voltage level conversion. Therefore, the load may be connected to the inductor only when there is sufficient energy stored in the inductor. In addition, it is known that conventional buck–boost converters suffer from poor stability because of the right-half-plane zeroes (RHZs) in their transfer function, the transfer functions of their small signal models not only have RHZs but also have higher-order terms, thus making them much harder to control. Although a conventional switched-capacitor converter has the advantages of light weight and small size, its power efficiency is low . The ideal efficiency η of a conventional double-voltage switched-capacitor can be expressed as(1),

$$\eta = \frac{E_{\text{out}}}{E_{\text{in}}} = \frac{Q_T V_{\text{out}}}{2Q_T V_{\text{in}}} = \frac{V_{\text{out}}}{2V_{\text{in}}} \qquad \text{------(1)}$$

where *QT* is the total electric charge.

When not in double-voltage mode, even if the control circuit of a conventional switched-capacitor converter were lossless, the power efficiency is still poor for a conventional simple switched-capacitor voltage boost converters with

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regulated outputs. In an attempt to overcome the drawbacks mentioned above, a high efficiency flying-capacitor buck–boost converter is proposed in this brief. A double-voltage charge pump is designed to achieve high efficiency according to (1) for a conventional switched-capacitor converter, and the doubled voltage is sent to a LC filter to acts as a buck–boost converter. The proposed converter has a voltage boost ratio of $2D$.

where D is the duty cycle of the control switching waveform. To achieve faster transient response, a new pseudo current dynamic acceleration technique, which is based on the derivative of the output voltage is proposed. This technique does not require a large-ESR capacitor and is not affected by *L*ESL. The proposed flying-capacitor boost–buck converter which adopts this pseudo current dynamic acceleration technique has a transient response time of only 2 μs. The limitations of standard analog pulse width modulator (PWM) causes uncontrolled pulse skipping and significantly increased output voltage ripples when the converter operates in the transition region of the buck and boost modes . That is, a buffer region, which is buck–boost mode, is required to provide a smooth and stable transition between two modes . As shown in Fig. 1, 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.

This paper presents the hybrid buck–boost feed forward (HBBFF) technique integrated in the buck–boost converter to regulate the output voltage with fast line transient response. Good line regulation is guaranteed to get little output voltage variation in case of the input voltage variation. That is, the HBBFF technique can improve the static and dynamic performance of the buck–boost converter without being affected by the large variation of the battery voltage. The hybrid buck–boost feed forward (feedback technology) technique is integrated in this converter to achieve fast line response. The new control topology minimizes the switching and conduction losses at the same time even when four switches are used, A wide input voltage range, the proposed buck–boost converter with minimum switching loss like the buck or boost converter Can reduce the conduction loss through the use of the reduced average inductor current (RAIC) technique.

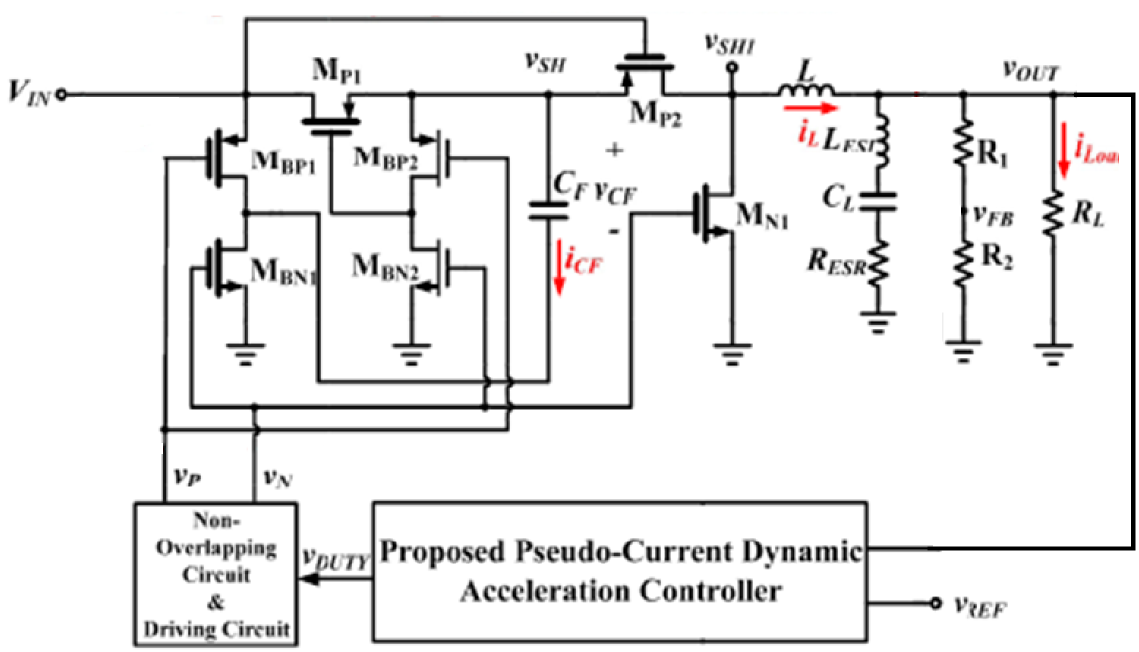

Fig.1.The flying-capacitor buck–boost converter with the Pseudo Current Dynamic Acceleration controller.

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II. CIRCUIT DESCRIPTIONS

The proposed flying-capacitor buck–boost converter with the pseudo current dynamic acceleration controller is shown in Fig. 1. The power stage contains five power MOS switches (MP1, MP2, MBP1, MBN1, and MN1*)*, two control MOS switches (MBP2 and MBN2*)*, one charge pump capacitor (*CF)* and a second order filter (*L* and *CL)*. The size of MP1, MP2, and MBP1 is 48 000 μm/0.5 μm, the size of MN1 and MBN1 is 22 000 μm/0.5 μm, the size of MBP2 is 800 μm/0.5 μm, and the size of MBN2 is 400 μm/0.5 μm. The proposed pseudo current dynamic acceleration controller is at the lower part of Fig. 1. The operating principles are described in detail below.

A.FLYING-CAPACITOR BUCK–BOOST CONVERTER

The reason why the proposed converter is named flying-capacitor buck–boost converter can be observed, as shown in Fig. 1. The flying capacitor *CF* should be large enough to maintain the voltage across itself. The inductance *L* and output capacitor *CL* constitute a second order filter. The five power switches are MP1, MP2, MBP1, MBN1, and MN1, and the control switches MBP2 and MBN2 perform voltage levels shift to turn MP1 ON or OFF.

There are no RHZs in the transfer function of the proposed converter. In contrast, a conventional buck–boost converter have RHZs in continuous-conduction-mode. This indicates that the dynamic behavior of the proposed converter is better than that of a conventional buck–boost converter.

B. PSEUDOCURRENT DYNAMIC ACCELERATION CONTROL SCHEME

It is composed of a non overlapping circuit and driving circuit, a digital circuit, a pulse width modulator (PWM), a PID compensator, and the pseudocurrent dynamic ramp circuit, which consists of a differentiator, a filter, and a ramp generator.

Non overlapping circuit: The circuit is generate a key builging block of switched capacitor circuits, the standard non overlapping circuit used simple inverter of realize delay for high to moderate frequencies.

Ramp Generator: A ramp generator is a function generator, that increases as a output voltage up to a specific value.

PID Controller: A Propotional Integral Derivative controller is a control loop feedback mechanism, that is continuously calculates an error values as the difference between a measured process variable and a desired set point.

Filter: The function of to remove unwanted frequency component from the signal to enhance wanted ones, or both.

Differentiator: It is a circuit that is designed such that the output of the circuit is approximately derectly propotional to the rate of change of the input.

Driving circuit: It is used for control the another circuits or components, such as a high power transistor.

Drawbacks of the existing process these are the problems faced such as Low transient response, Low efficiency, Presence of losses, Reduces the life time of the components.

C. TOPOLOGY OF THE BUCK–BOOST CONVERTER WITH THE RAIC TECHNIQUE

The conduction loss is four times that of a pure buck or a low-duty boost converter. The design of buck–boost converter not only needs to simultaneously reduce the conduction and switching losses but also needs to reduce the output ripple during the mode transition. The proposed buck–boost control scheme can effectively reduce the conduction loss through the use of the reduced average inductor current (RAIC) technique for improving efficiency.

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Furthermore, the feedforward compensation can effectively and rapidly reduce line disturbance on the converter's output to improve line transient response for the design of the voltage mode voltage mode switching converters. The implementation of the feedforward technique simply varies the peak and valley voltages of the sawtooth signal with the input voltage in buck and boost converters.

D. THE HYBRID BUCK–BOOST FEEDFORWARD

This paper presents the hybrid buck–boost feedforward (HBBFF) technique integrated in the buck–boost converter to regulate the output voltage with fast line transient response in fig.2.. Good line regulation is guaranteed to get little output voltage variation in case of the input voltage variation. That is, the HBBFF technique can improve the static and dynamic performance of the buck–boost converter without being affected by the large variation of the battery voltage.The proposed buck–boost converter with the RAIC technique, the HBBFF technique and the mode detector to demonstrate the performance of the buck–boost converter.

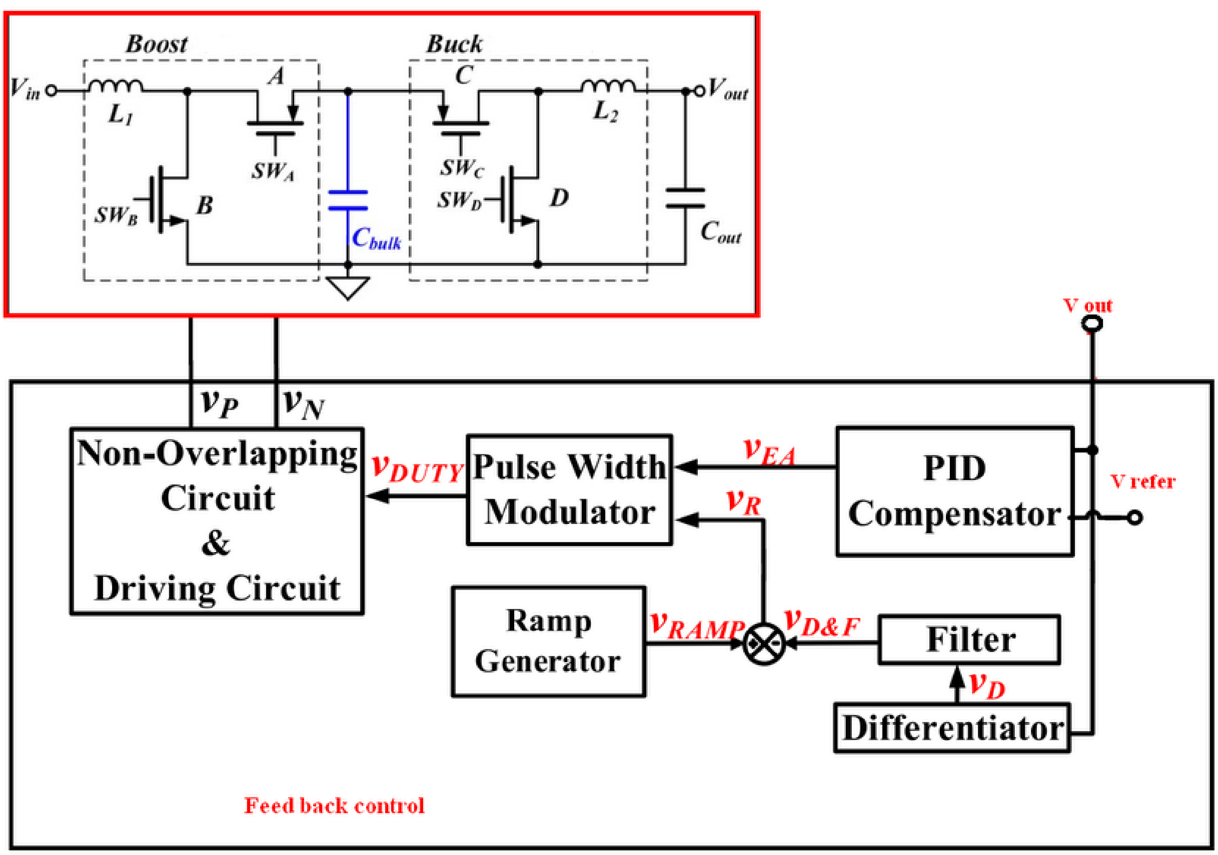

Fig.2. Proposed buck–boost converter with the RAIC and HBBFF techniques.

E. THE RAIC TECHNIQUE

The RAIC technique has lower average value without the undesired pulse skipping and large output voltage ripple. Besides, the power conversion efficiency can be improved in the proximate-linear buffer region since the RAIC technique reduces the switching possibility of the four switches during one switching period.

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RAIC technique uses two switching cycles composed of one buck and one boost cycles to constitute one regulation cycle when the supply voltage approaches to the output voltage. The switching loss can be reduced since only two switches are turned on/off in one switching cycle. Furthermore, the period of tAC that only delivers energy to the inductor is minimized and thus the average inductor current level, as shown in (2), can be close to the load current. In other words, the RAIC technique can reduce the conduction loss since the difference between the average inductor current and the output load current is reduced

$$I_{\mathrm{Load}} = I_{L,\mathrm{avg}} \frac{(t_{AD}+t_{BD})}{(t_{AD}+t_{BD}+t_{AC})}$$

-----(2)

III.PROPOSED WORK

The hybrid buck–boost feed forward (feedback technology) technique is integrated in this converter to achieve fast line response a new control topology minimizes the switching and conduction losses at the same time even when four switches are used. A wide input voltage range, the proposed buck–boost converter with minimum switching loss like the buck or boost converter. The buck or boost converter. Can reduce the conduction loss through the use of the reduced average inductor current (RAIC) technique and methodology used as Pseudo current dynamic acceleration (PDA) techniques It is composed of a non overlapping circuit and driving circuit, a digital circuit, a pulse width modulator (PWM), a PID compensator, and the pseudo current dynamic ramp circuit, which consists of a differentiator, a filter, and a ramp generator.

IV.CONCLUSION

In this paper, we analyze different technique for PDA,HBBFF,RAIC, and a highly stable flying-capacitor buck–boost converter applying a new pseudo current dynamic acceleration technique is described in the input voltage is 3.3 V, the output voltage range is 1.0–4.5 V, and the operation frequency is 1 MHz. The boost ratio of the positive output voltage is 2*D* and the power conversion efficiency reaches 90%,the duty cycle and the transient response time is only 2 μs, Several advantages include reduced switching losses through the use of only half the number of switches during each cycle and decreased conduction losses of power switches due to the RAIC technique. The efficiency is effectively improved and the HBBFF technique is integrated in this converter to minimize the voltage variation at the output of error amplifier. As a result, a fast line transient response can be achieved with small dropout voltage at the output.

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