DC-DC Booster for various Applications

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Abstract— **In this review paper, a low voltage and low power techniques have been applied to implement in analog circuits basically in amplifiers. These circuits are suitable for low power devices such as those required in many Internet of Things (IoT) scenarios and in energy harvesting systems. The structure of the review paper is as follows: introduction and some basics of DC booster followed by different techniques for DC-DC Booster and finally the conclusion is there which represents the best method of DC converter and the usage of DC booster in various applications and further future scopes. At circuit level, different power efficient amplifiers are compared in this work. They are obtained by combining various different low voltage techniques. These techniques can be applied to single-ended or to fully differential amplifiers, leading to different topologies. The various circuits are compared with other relevant publications, showing a very competitive performance.**

Keywords— **Circuit level, IOT, Low power.**

I. INTRODUCTION

A boost converter (step-up converter) could also be a DC-to-DC power converter that steps up voltage (while stepping down current) from its input (supply) to its output (load). it is a category of switched-mode power supply (SMPS) containing a minimum of two semiconductors (a diode and a transistor) and a minimum of 1 energy storage element: a capacitor, inductor, or the two together. To reduce voltage ripple, filters made up of capacitors (sometimes alongside inductors) are normally added to such a converter's output (load-side filter) and input (supply-side filter). For high efficiency, the switched-mode power supply (SMPS) switch must activate and off quickly and have low losses. the arrival of a billboard semiconductor switches within the 1950s represented a serious milestone that made SMPSs like the boost converter possible. the main DC to DC converters were developed within the early 1960s when semiconductor switches had become available The aerospace industry's need for small, lightweight, and efficient power converters led to the converter's rapid development. Switched systems like SMPS are a challenge to style since their models depend on whether a switch is opened or closed. R. D. Middlebrooks from Caltech in 1977 published the models for DC to DC converters used today. Middlebrooks averaged the circuit configurations for every switch state during a technique called state-space averaging [1]. This simplification reduced two systems into one. The new model led to insightful design equations which helped the expansion of SMPS. Battery power systems often stack cells serial to realize higher voltage. However, sufficient stacking of cells isn't possible in many high voltage applications thanks to lack of space. Boost converters can increase the voltage and reduce the amount of cells. Two battery-powered applications that use boost converters are utilized in hybrid electric vehicles (HEV) and lighting systems. The NHW20 model Toyota Prius HEV uses a 500 V motor. Without a lift converter, the Prius would wish nearly 417 cells to power the motor. However, a Prius actually uses only 168 cells [citation needed] and boosts the battery voltage from 202 V to 500 V. Boost converters can also use as power devices at smaller scale applications, like portable lighting systems [8]. A white LED typically requires 3.3 V to emit light moreover a lift converter can intensify the voltage from one 1.5 V alkaline cell to power the lamp. An unregulated boost converter is used because the voltage increase mechanism within the circuit mentioned because of the 'Joule thief'. This circuit topology is employed with low power battery applications, and is aimed toward the power of a lift converter to 'steal' the remaining energy during a battery. This energy would rather be wasted since the low voltage of an almost depleted battery makes it unusable for a traditional load. This energy would otherwise remain untapped because many applications don't allow enough current to flow through a load when voltage decreases. This voltage decrease occurs as batteries become depleted, and may be a characteristic of the ever present alkaline battery.

II. BASICS OF DC-DC BOOSTER

It is s a simple converter which is used to convert the DC voltage from lower level to higher level. Boost converters is also called a DC to DC converter. There are three types of categories: Buck Converters, Boost Converters and Buck Boost Converters. There are various applications in which DC-DC Booster is been used like: Automotive applications, Power amplifier applications, Adaptive control applications, Battery power systems, Consumer Electronics, Communication Applications. Moreover, there are diverse advantages too like it gives the high output voltage, low operating duty cycles, lower voltage on MOSFET. The main working principle is: Most of the electric power circuit designers will choose the boost mode converter because the output voltage is usually high in comparison to source voltage. The signal acquires by the sensor is processed by an analog front-end and converted to the digital domain by an Analog to Digital Converter (ADC). Afterwards, the signal is processed, stored in memory and sent by the transceiver unit. The power unit is responsible for extracting power from the power source and conditioning it adequately to power all the modules of the system. [3]

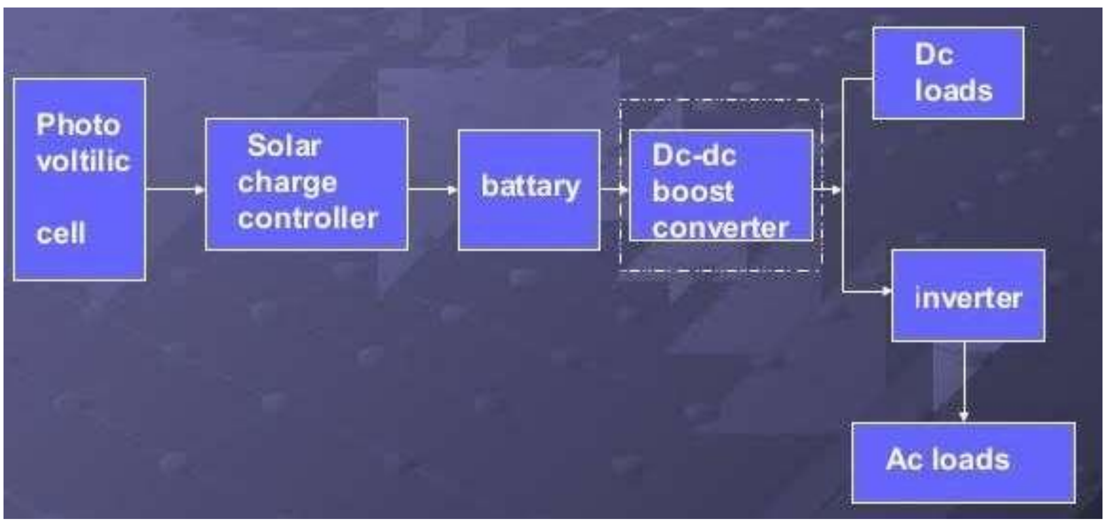

Fig. 1. Block Diagram of DC Booster [3]

As an Example, an energy harvesting transducer captures the ambient energy, obtaining a DC or AC voltage, depending on the type of source. This energy is stored after being transformed by the DC/DC or AC/DC converter respectively. As mentioned, the storage element can be a super capacitor or a secondary battery. At the end, a DC/DC converter regulates the voltage, in order to provide a stable voltage to the target circuit.

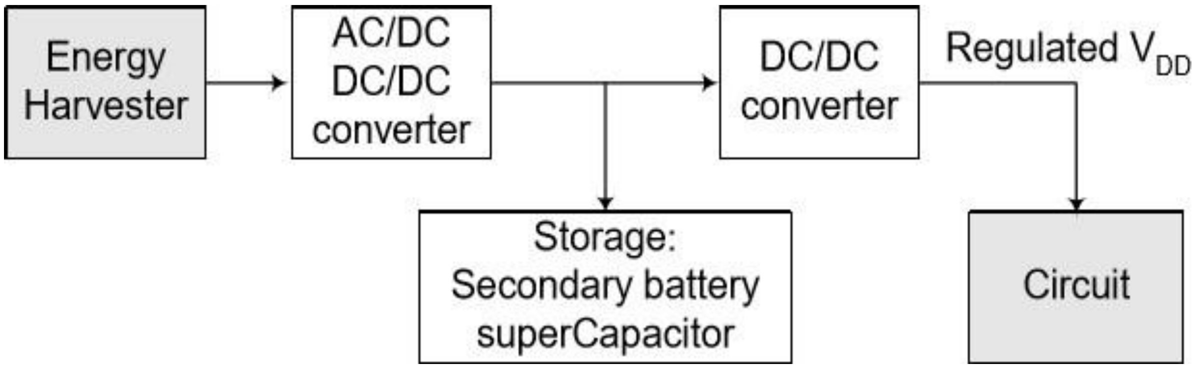

Fig. 2. Energy harvesting microsystem [3]

III. TECHINIQUE OF DC-DC BOOSTER

1) Buck Converter [2]

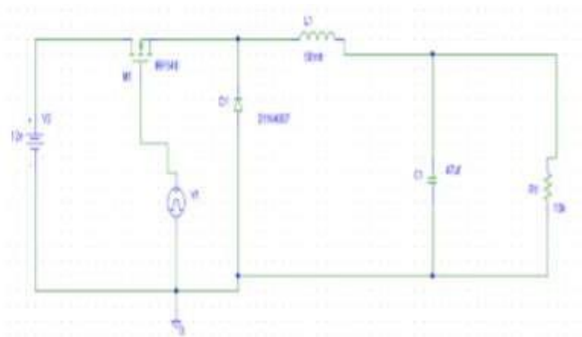

Fig 3. Simulated circuit of buck converter

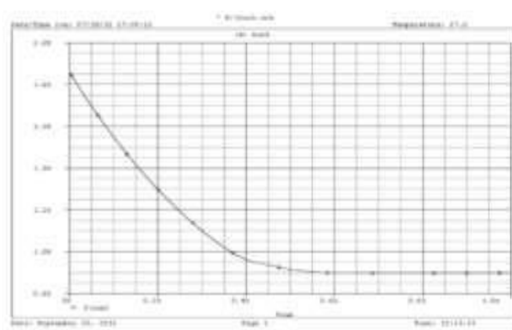

Fig. 4. Output Voltage of Buck Converter

From the simulation results it's found that just in case of the buck, boost and buck-boost converters, the specified output voltages are often obtained by selecting proper values of inductor, capacitor and switching frequency. All of those individual theories were difficult for anyone to understand primarily and putting them collectively within the simulator which was extremely puzzling. But it's been done best to formulate an impressive scheme dissertation with affluent in its contest. At each stage, targets were set to accumulate the required skills to satisfy the standards of the research and style the circuits for implementation into the software simulation. This research gives the chance to review new skills and lift valuable knowledge in circuit designing and problem solving skills which has greatly enriched knowledge and understanding through the erudition route which can help one certain the further progression.

2) Bi-directional dc-dc converter with coupled inductor[4]

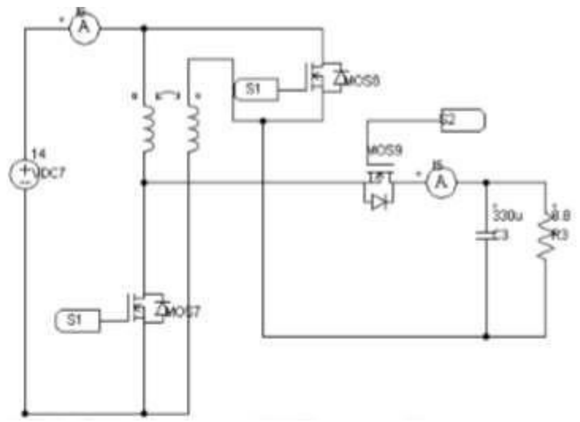

Fig. 5. Bidirectional DC-DC converter with coupled inductor

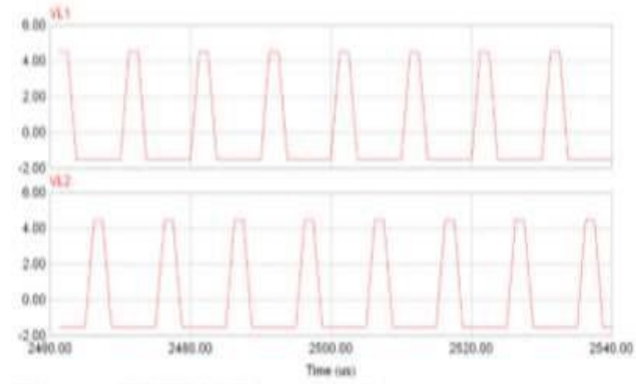

Fig. 6. Output Waveform of Bidirectional DC-DC booster with coupled inductor

The role of controller is vital while it's using for a specific application. Various filter selection helps to scale back the harmonics within the converter. Different simulations are used for various analysis. Various converters are designed supported the essential converters by modifying the circuit parameters. Steady state and transient analysis is important for the converter during disturbances. a number of those converters are simulated and presented during this paper. it's not so difficult to research a converter and apply control method to those converters. Various areas are often elaborated with one converter. This paper helps as a suggestion to review the dc-dc converters. The converters are often analyzed by using state space analysis which isn't mentioned during this paper. The converter also because the controller is often converted into digital domain.

3) Bidirectional resonant DC-DC Converter [5]

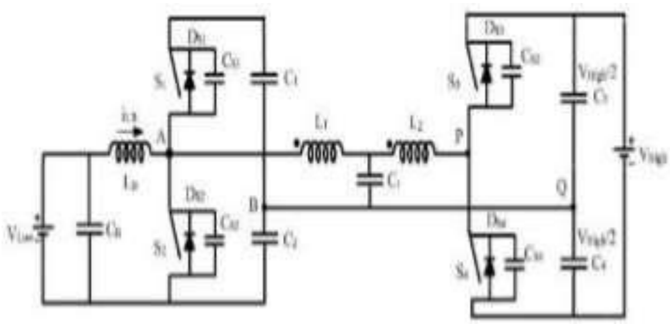

Fig. 7. Circuit diagram for the DC-DC converter

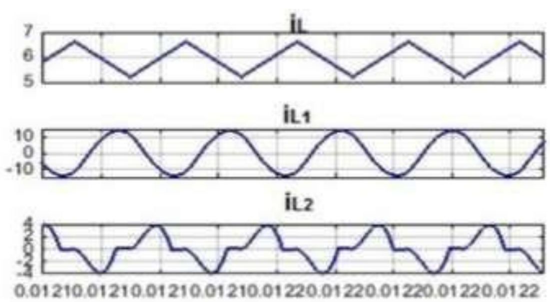

Fig. 8. Output Waveform for the conventional circuit

A bidirectional dc-dc converter with a transformer-less LCL resonant is usually recommended. Elevated step-up or step-down ratio and one can say ZVS turn-on for all switches, and ZCS turn-on and turn-off for all diodes, both in buck and boost mode, are all the features of the converter. The proposed converter can attain ZVS for switching for a special load spectrum. with none internal snubbed circuit, the device voltage is retained. The findings of the simulation are verified to verify the proposed evaluation, layout and soft-switching also as validate the converter efficiency. The converter retains high effectiveness, particularly during the two-way energy flow.

IV. COMPARISON OF DIFFERENT METHODS

Converter	G_{g0}	G_{d0}	ω_0	Q	ω_z
Buck	D	$\frac{V}{D}$	$\frac{1}{\sqrt{LC}}$	$R\sqrt{\frac{C}{L}}$	∞
Boost	$\frac{1}{(1-D)}$	$\frac{V}{(1-D)}$	$\frac{(1-D)}{\sqrt{LC}}$	$(1-D)R\sqrt{\frac{C}{L}}$	$\frac{(1-D)^2R}{L}$
Buck-Boost	$-\frac{D}{(1-D)}$	$\frac{V}{D(1-D)^2}$	$\frac{(1-D)}{\sqrt{LC}}$	$(1-D)R\sqrt{\frac{C}{L}}$	$\frac{(1-D)^2R}{DL}$

The two main control strategies, namely, the Current mode control and the Voltage mode control are implemented in the dc-dc buck converter. The simulation results are presented along with the Simulink model for the effective understandings of the control strategies [7]. The schematic waveforms of each control strategies are also given such that the simulation result waveforms can be compared with the schematic waveform and thus it can be concluded that the voltage mode control and the current mode control are implemented in the buck converter.

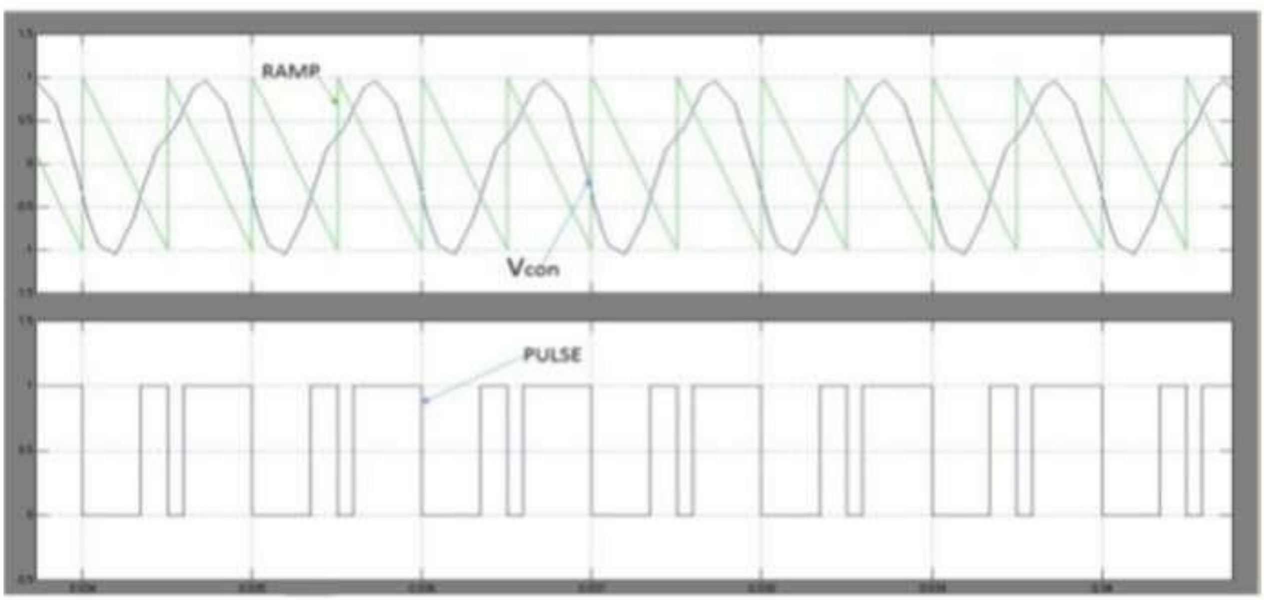

Fig 9: Waveform of Vcon and Vramp and the corresponding switching action

Following are the Areas of Future Study which can be Considered for Further Research Work [9]:
1) Implementation of control strategies on different converters using different techniques.
2) Transient analysis can be done.
3) Slope Compensation.

CONCLUSION

A DC to DC converter (booster) takes the voltage from a DC source and converts that particular voltage of supply into another DC voltage level, they're wont to increase or decrease the voltage level. This is often commonly used automobiles, portable chargers and portable DVD players. The converter takes the facility from the battery which will cut down the voltage level and similarly a converter step-up the voltage level. for instance, it'd be necessary to step down the facility of an outsized battery of 24V to 12V to run a radio. DC to DC converters in electronic circuits is done using switching technology. Switched mode DC-DC converter converts the DC voltage level by storing the input energy temporarily then releases that energy at different voltage output. The storage is completed either in magnetic flux components like an inductor, transformers or field components like capacitors. This conversion method may increase or decrease the voltage level. Switching conversion is more power-efficient compare to the linear voltage regulation, which dissipates unwanted power as heat. The high efficiency of a switched-mode converter reduces the heat sinking which is needed and increases the battery efficiency of portable equipment. Efficiency has increased thanks to the utilization of power FETs, which are ready to switch more efficiently with lower switching losses at higher frequencies than power bipolar transistors and use less complex drive circuitry. Another improvement in DC-DC converters is completed by replacing the flywheel diode with synchronous rectification employing an influence FET, whose 'on resistance' is way lower, which reduces switching losses. The efficiency of the converter has increased because of the use of power FETs, which are able to switch more efficiently with lower switching losses at higher frequencies than power bipolar transistors and can use less complex drive circuitry.

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