HIGH BOOST DC-DC CONVERTERS FOR RENEWABLE ENERGY APPLICATIONS – A REVIEW

A.Gopi Research Scholar
R.Saravana Kumar Professor
Kavitha .V Research Scholar
K.subramanian Associtae Professor
School of Electrical Engineering, VIT University, Vellore
rsaravanakumar@vit.ac.in

Abstract: *The target of this manuscript is to make a review about high boost DC-DC converters for renewable energy applications. Various type of sources and hybrid sources of those systems and power converters are consider for review. The review articles which referred are detailed information of the each source of energy. The right power converter which is high boost DC-DC converter low voltage source renewable energy. Sample converter analyzed as a model for all highlighted power converters these converters can be efficient, power interface, compact and modular with reduced environment impact.*

Key words: *High boost, DC-DC converters, Renewable energy*

1. Introduction.

More interconnections among countries and synchronous areas are foreseen in order to fulfil the EU 2050 target on the renewable generation share. One proposal to accomplish this challenging objective is the development of the so-called European Super Grid. Multi-terminal HVDC networks are emerging as the most promising technologies to develop such a concept [1]. The use of wind energy as a promising renewable energy in actual world conjuncture and its use on distributed generation is summarized [2]. The integration of solar photovoltaic (PV) into the electric vehicle (EV) charging system has been on the rise due to several factors, namely continuous reduction in the price of PV modules, rapid growth in EV and concerns over the effects of greenhouse gases [3]. Power electronics is an integral part of modern energy systems. Moreover, its use adds costs to capital investments in energy systems, along with some reliability issues. Therefore, innovative solutions in power networks require [4]. The off-grid Photovoltaic Diesel Hybrid Systems (Off-grid Mini Grids) where only AC loads are connected. It will take into consideration the different types (performed through of the DC coupled, AC coupled or hybrid DC-AC coupled configurations), solutions (PV/Diesel and PV/Diesel/Energy Storage) related with the diesel hybridization of those systems and their main elements (power converters) [5]. This review article exhibits the importance of choosing the right power converter architecture and the related technology. In this context it is highlighted that the output power interface can be efficient, compact and modular [6]. Microgrids are envisioned as one of the most suitable alternatives for the integration of distributed generation units in the utility grid, as they efficiently combine generation, energy storage and loads in the same distribution network [7]. Renewable energy sources are considered as the alternative energy sources because of rising environmental concerns and depleting conventional energy resources. Solar energy has a significant role for meeting the increased requirement of electricity with the reduced environmental impact. The power generation from a Photovoltaic (PV) system gets affected as the optimum operating point changes due to the variation in the environmental factors such as temperature, solar insolation, etc. In spite of the fluctuations, to achieve maximum power from solar energy system, maximum power point tracking (MPPT) technique is essential [8]. The high efficient DC-DC converter main classification are shown in Fig.1.

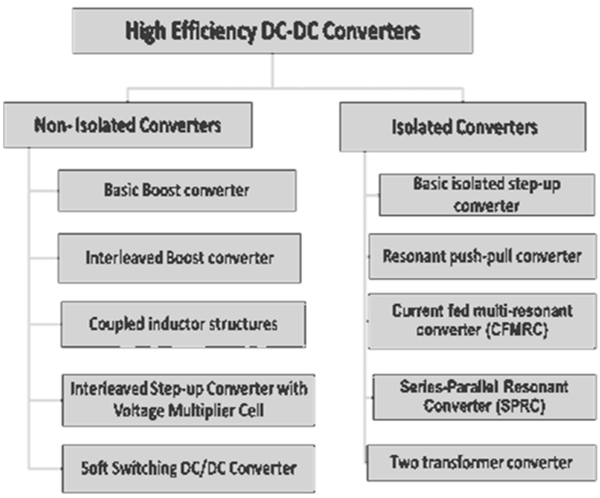

Fig.1. Efficient DC-DC Converters

Impedance-source networks cover the entire spectrum of electric power conversion applications (dc-dc, dc-ac, ac-dc, ac-ac) controlled and modulated by different modulation strategies to generate the desired dc or ac voltage and current at the output. A comprehensive review of various impedance-source-network-based power converters given[9].

The development of power converter topologies, with an increased number of components seems to be an interesting option in modern applications, especially in terms of reliability, efficiency, and current or voltage distortions improvement [10].

Impedance networks cover the entire of electric power conversion from dc (converter, rectifier), ac (inverter), to phase and frequency conversion (ac-ac) in a wide range of applications [13]. Some DC/DC converters are investigated aiming for the optimized utilization due to simultaneous utilization of many distributed generation units in a system and the importance of utilizing multi-input converters [14].

Review of the common techniques used for high step-down dc-dc voltage conversion is presented. First, the limitations of conventional buck & synchronous rectifier buck converters used for high step down dc-dc voltage conversion which include narrow duty cycle, high voltage stress, large ripple and low efficiency are briefly discussed [15].

The major consideration in dc-dc conversion is often associated with high efficiency, reduced stresses involving semiconductors, low cost, simplicity and robustness of the involved topologies [16]. Renewable energy sources (RESs) have experienced a rapid growth in the last decade due to technological improvements, which have progressively reduced their costs and increased their efficiency at the same time [17]. A boost converter is used to clamp the voltage stresses of all the switches in the interleaved converters, caused by the leakage inductances present in the practical coupled inductors, to a low voltage level. Overall performance of the renewable energy system is then affected by the efficiency of step-up DC/DC converters with closed loop control action, which are the key parts in the system power chain. The new era of transformation toward dc, providing significant solution to its insufficient current carrying capacity, increasing fault currents, poor power quality, difficulty in flexible integration of large-scale renewable energy sources, etc. [18].

Fuel cells are becoming the most interesting and promising alternative resources for both automotive industry and stationary power plants. As the fuel cell output voltage is low, achievement of high step-up, low cost and high efficiency DC-DC conversion is the major consideration. This paper reviews and analyses the various DC-DC converters suitable for fuel cell system applications [19].

Over the last years, the two-level three-phase voltage source converters (VSCs) have received an increasing attention as an alternative to conventional thyristor converters [20].
Impedance networks cover the entire realm of electric power conversion in a wide range of applications. Many converter topologies are presented in the literature in order to overcome the limitations of the traditional voltage source, current source, classical buck-boost, unidirectional and bidirectional converter topologies [21].

Microgrids are a suitable, reliable and clean solution to integrate distributed generation into the mains grid. Microgrids can present both AC and DC distribution lines [22]. Parallel to growing grid-integrated applications, the power converters have been an important research field for the power conversion and power quality [23]. Conventional energy sources such as thermal, diesel appliances, and nuclear are difficult to generate the electricity for the presence of greenhouse emission, maintenance problem. To overcome such problems, solar energy is one of the fastest growing renewable energy sources across the globe. In recent trends, solar power generation has tremendous growth. Solar energy offers various advantages such as contamination free, quiet in operation, long life, zero input energy cost, low maintenance [24].

Impedance-source switched mode converters are an emerging technology in electric energy conversion. They overcome limitations of conventional solutions by the utilization of specific impedance-source networks [25]. Power electronics and fuel cell technologies play an important role in the field of renewable energy [26]. Multi-input converters, used to integrate different renewable energy sources, accommodate a range of sources and pools to their advantage such that the energy source is diversified to enhance utilization and reliability of the renewable source. The literature reports the development of several front-end DC-DC converters that could interface the sources. The topologies were classified based on the energy conversion stages, namely, DC-DC boost converter and voltage source inverter, and the kinds of controllers that control the circuit to ensure stabilization of load and input voltage, maintain component tolerance and system ageing [27]. At present the proportion of DC load in end-use electricity consumption becomes increasingly higher, so adopting DC power distribution could reduce the total number of power converters and improve the power consuming efficiency [28]. High boost isolated DC-DC converter with controller action explained [29].

The paper analyses possible protection coordination strategies of protection devices to ensure safety of any components in the DC microgrid. These summarized coordination strategies can be suitable for any DC microgrid configurations. In the next content, an effective protection coordination system of a real community-sized DC microgrid is developed, which use fast-acting fuses to replace no-fuse circuit breakers already installed at some certain locations in the DC microgrid [30]. The second part of the paper presents the MPPT systems for extracting maximum power from a photovoltaic installation. The maximum transfer between generator and receiver is obtained by interconnecting a DC-DC converter which performs continuous adaptation of load to a PV generator [31]. During the last few years, the partial resonant ac-link converters have gained a significant consideration due to their outstanding advantages. Compared to other types of power converters, these ac-link converters are compact in size, reliable, efficient, and they guaranty longer life time and bidirectional power flow [32].

This maximum power point tracking (MPPT) for photovoltaic arrays with only one current sensor. Initially, a review of MPPT methods with only a current sensor is performed with extension for a variety of dc/dc converters. Furthermore, the same topology is developed to achieve better performance in the presence of sensor offset and environmental noise[33-36].

An isolated high step-up single switch DC-DC converter for renewable energy sources is proposed. In the proposed converter high step-up voltage is obtained by single power switching technique that operates low duty cycle with isolated transformer inductors and switched capacitors and power diodes [37].

The proposed method is robust, cost effective, and behaves well dynamically and in the steady state all these converter are explained [38-46]. After a theoretical analysis of presented approach, its validity and effectiveness are verified by simulation and experimental results. For example here two types of recent DC-DC converter model and simulation with key operating wave forms are analyzed.

2. High Boost DC-DC full bridge converter operation.

The operating wave forms of the proposed converter are shown in Fig. 2. The proposed converter operating modes can be divided into four operating modes.

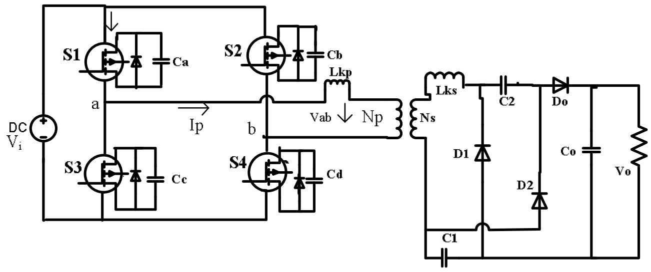

Fig. 2. DC-DC full bridge Converter

Switches S1 and S4 active switches are ON. Diodes D1 and D2 are reverse biased. Do is forward biased. The operating circuit in this mode is shown in Fig. 3. L_m stores energy from the input voltage V_i. L_m and leakage inductance L_k in series with V_i. Leakage i_{lk} continuous and circulates. When primary voltage zero hence input currents also be equal to zero. Secondary current is decreases; the secondary leakage L_{ks} limits the flow, to the output. The secondary winding voltage V_s and boosting voltages V_{C1} & V_{C2} are linked series to release energy to the output capacitor C_o and the load R. When it drops to zero boosting capacitors C1 and C2 begin to charge. This mode ends at t= t1. The input power is transferred to the secondary side through S_1 and S_4. The voltage $V_0/2n$ is put on L_r, that is L_r determines the slope of the primary current $i_p(t)$, given by:

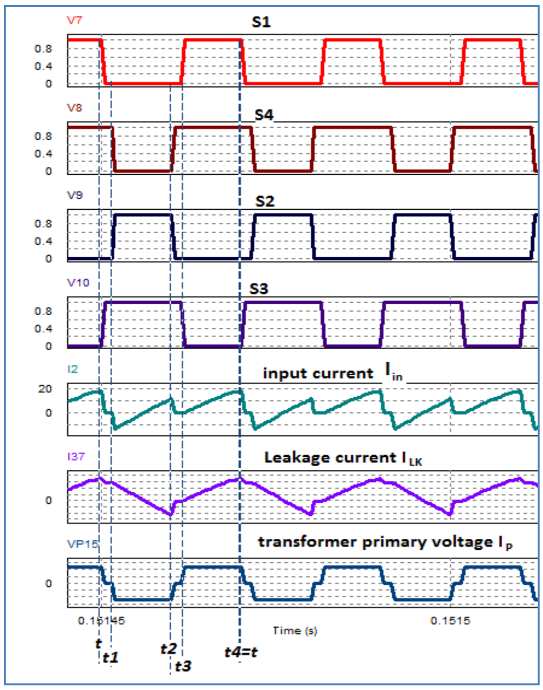

Fig.3 . Operating waveforms

3. DC-DC Converter with voltage doubler.

Fig. 4 shows the isolated full bridge converter comprises of four primary side power switches labeled S1, S2, S3 and S4. Power transferred to the transformer secondary whenever any two diagonal switches, S1 and S2 or S3 and S4 are ON simultaneously. Conversely, whenever the two upper or lower switches, S1 and S3 or S2 and S4 are ON simultaneously, this is known as the freewheel state. During the freewheel state it is important to note that the transformer is shorted, resulting in zero voltage across both the primary and secondary windings. Also, there is a finite delay between the turn OFF and turn ON of S1, S2 and S3, S4 when the resonant period occurs. The key operating waveforms are as shown in Fig.5.

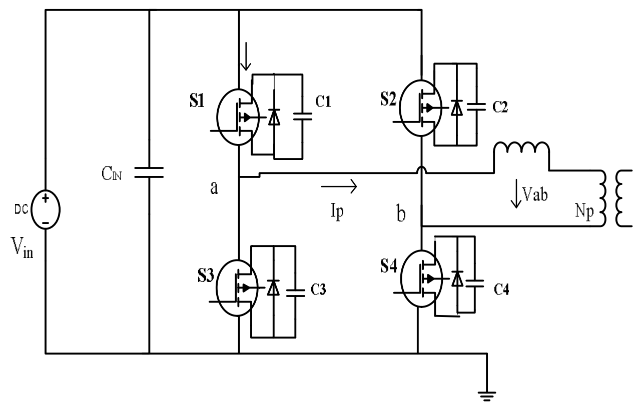

Fig 4. DC-DC Converter bridge circuit

The push-pull, half-bridge topologies common properties are which makes the full-wave rectification necessary, is that they utilize bipolar voltage across the secondary side of the transformer. A rectification method which offers simpler structure and better utilization of the isolation transformers in push-pull, half bridge and bridge power stages where usually full wave rectification is required on the secondary side of the transformers. This circuit operates in such a way as to produce an output voltage that is twice the transformer secondary voltage. It is known as a voltage doubler. It is a full-wave voltage doubler, because it uses both half-cycles of the incoming ac wave. Each capacitor is charged individually form its rectifier. But they appear in series to the output. If double the output voltage cu the current in half to maintain the same power level. Each capacitor is recharged while the other is discharging so there is some cancellation of the ripple voltages. The other major DC-DC converters and their modern design specification are shown in Table.1

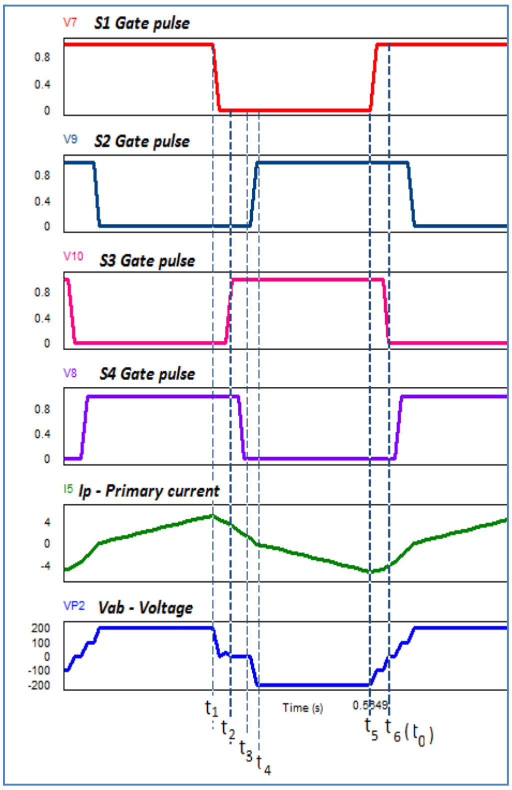

Fig 5. Key waveforms

4. DC-DC Converter single switch isolated converter.

In this paper single controlled switch as shown Fig.6 used in the flyback system with isolation for better circuit protection and the operations analyzed. The boost converter and fly back converter outputs are integrated and improve the high voltage gain and improve the efficiency of high boost converters, these boost converters are applicable in renewable energy sources. The integrated boost flyback converter uses coupled inductor techniques to achieve high boost voltage with low duty, and thus slope compensation circuit is disregarded. DC-DC converters with coupled inductors can provide high voltage gain, but their efficiency is degraded by the losses associated with leakage inductors. These degradations improved in the proposed circuit provided with isolation transformer. The conventional topologies to get high output voltage use flyback converters, they have the leakage components that cause stress and loss of energy that results in low efficiency. These disadvantages overcome by using active clamp and the transformer turns ratio provides the high boost and isolation.

Table 1.
Major DC-DC converter classclassification.

Topology	%η	Pmax (kW)	Gain (V/V)	*fs* (kHz)	Vin (VDC)	VBUS (VDC)	V. Gain Formula	No.of Switches	No.of Diodes
Basic isolated	94.0	0.10	11.6	20	30 to 60	350	n/1-D	2	2
Resonant Push Pull	95.5	1.5	10	70	35 to 60	350	2n/1-D	4	2
CFMRC	96.0	0.15	15.2	255	23	350	-	2	2
SPRC	97.0	0.19	35.0	215	20 to 35	700	-	4	2
Two tr. converter	97.0	0.26	-	-	36	-	2n/1-D	2	4

The new circuit is not a used the operation integration and switched passive components. There is possibility of this proposed circuit to use protection for high voltage application.

High boost DC-DC converters operating at high voltage regulation are widely proposed in many industrial applications. High boost dc-dc converters are play a important role in renewable energy sources such as fuel energy systems, DC-back up energy system for UPS, High intensity discharge lamp and automobile applications. The converters require increasing low dc voltage to high dc voltage. The conventional boost converters are able to get high voltage gain with high voltage duty ratio the problem is Electro Magnetic Interference and complexity increases. In this proposed method high boost topology proposed with closed loop control. Output voltage controlled with better voltage regulation for various change in the load conditions.

When switch is turned ON the magnetizing energy induced on secondary side of transformer V_s is connected with V_{in}, V_{c1} charge V_{c2} and simultaneously V_s charge V_{c3}. Both lift capacitors are charged and discharged equally via coupling inductor. When switch is turned off the stored magnetizing energy is released and opposite polarity is induced on secondary side of transformer(N_s) made with V_{in},V_{c2} and V_{c3} is connected in cascade and charge the capacitor C_0 and resistor. The using series connection of boost converter and flyback converter, we achieve the high output voltage gain. The proposed dc-dc converter worked in six operating modes, the six operating modes are discussed below, the mode is operated in six modes, given brief explanation about current flowing in six different modes. The output operating waveforms are shown in Fig.7.

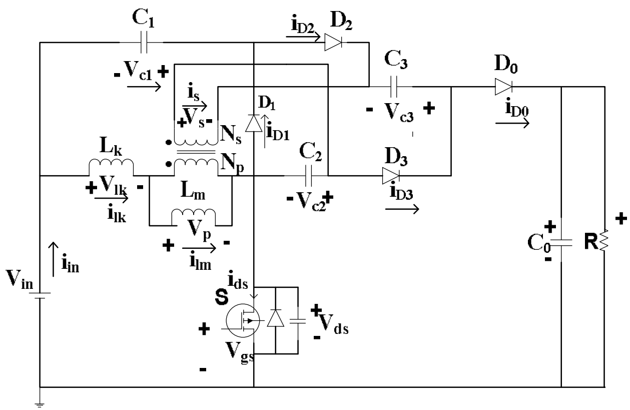

Fig.6 High boost single switch DC-DC Converter

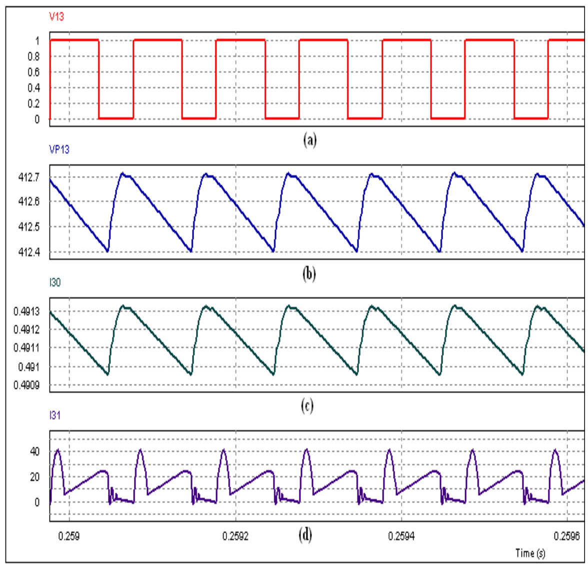

Fig 7 Waveforms of the single switch converter
(a) output voltage Vo (b) output current Io
(c) gate pulse (d) MOSFT switch voltage

5. Conclusion

In this paper, a comparison of different topologies of high boost DC-DC converters are illustrated. The proposed converter have been reviewed briefly by the reference of differ research groups. The review suggests that the research of DC-DC converters as gained increasing attention from researchers in the area of integrating renewable energy and storage systems. The helps the appropriate selection of converters for utilization in practical applications in integrating renewable resources and future research needs to be carried out to increase the voltage gain of the converters and to design novel DC-DC converters.

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