

# Multiport Converter in Electrical Vehicles-A Review

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**Abstract**—In hybrid power sources or in electric vehicles, the promising concepts for these are multiport converters. They are much beneficial as conversion can be done in single stage while even interfaced with multiple input power sources. This paper presented the introduction and comparison of multiport converters with conventional converter. Here I present the application of multiport converters with reference to use of multi sources along with the advantages and disadvantages of both, the types of converters. Due to the flexibility of a multiport converter, it gives several advantages. It can be used for many applications as electric vehicle, renewable energy sources for Uninterruptible Power Supply without storage, or it can be used for storage of energy using hybrid sources.

**Index Terms**—multiport converter, electric vehicle, DC-DC converter.

## INTRODUCTION

With the expanded consideration towards energy proficiency and natural contamination, choices with a little carbon impression have discovered reestablished enthusiasm for late times.

The customary approach to enhance energy effectiveness is that we have to utilize our renewable sources in transportation instead of using the fuel which causes environmental problems.

Electric Vehicles are the representatives in charged transportation, and this innovation is presently developing quickly. While the carbon impression of an Electric Vehicle (EV) is effectively wrangled about it is seen as a promising distinct option for control fuel costs. EVs have an exceptional power profile that has both force usage and recovery at various moments of its operation.

DC-DC converters are equipment's, which are used to interface the power supply to the load. Based on the load requirements, the parameters of source are adjusted. The DC-DC converter experience as a receiver when a power source is available and also experiences as a power source sender for load.

As in last few years the power converters gain the attention toward itself. There are two ways for the integration of power side with load and storage side.

- 1) Common DC-DC bus
- 2) Multiport DC-DC bus

The common DC bus method is the conventional method. In conventional method, every source of energy is connected with its own DC-DC converter while in multiport DC-DC bus

method, there is a single controller for the multiple inputs and output ports.

## CONVENTIONAL CONVERTER VS MULTIPOINT CONVERTER

### A. Overview

As research is continued to overcome the needs in every field, power electronics is also progressing in the research field. To overcome the issues faced in conventional converters researchers have developed multi-port converters.

In conventional DC-DC power converter, there were some drawbacks as:

- 1) More conversion steps are included
- 2) more components were used
- 3) cost was high
- 4) Control was local for every controller.

In the multi-port DC-DC power converter, there will be fewer power components, which implies the expense of the power converter will be lower than that of the conventional converter.

Additionally, the transformation steps are minimized, bringing about higher productivity. Due to the vicinity of the transformer in some circuits, electric confinement is accessible, which is essential for safety. With the turn proportion of the transformer in certain topologies, it will be more effective to coordinate diverse renewable vitality wellsprings of distinctive voltage levels. At long last, there is a controller.

### B. Literature for multiport converter in electric vehicles

The bidirectional dc-dc converters alongside storage energy have turned into a promising choice for some power-related systems, including crossover vehicle, power module vehicle, a renewable-energy framework.

It diminishes the expense and enhances effectiveness, as well as enhances the execution of the system. In the electric vehicle applications, an assistant vitality storage battery retains the recovered vitality bolstered back by the electric machine.

Moreover, bidirectional dc-dc converter appeared in Figure 1 is, likewise, required to draw power from the helper battery to support the high-voltage transport amid vehicle beginning slope climbing and quicken.

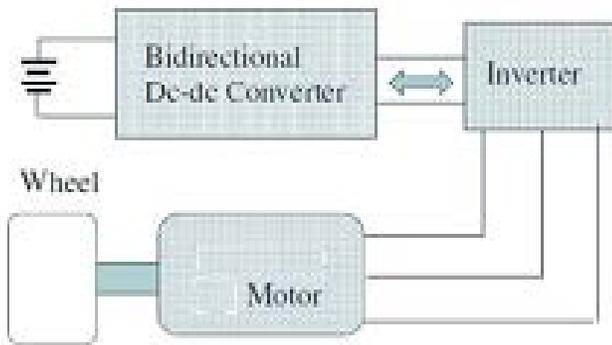


Figure 1: Bidirectional converter

Since a dc-dc converter can associate any two ports, it is characteristic of consider connecting ports up either by individual dc-dc transformation stages with a typical dc bus where energy from all ports is traded, or much less complex, by just change stages with the utilization of one port as the basic dc transport. These transformation stages are controlled freely, and a correspondence bus might be required for the end goal of overseeing power flow. Multi-port converter uses a solitary power transformation stage to interconnect all ports, rather than the individual dc-dc change stages, can be acquainted all together with make the entire system easier. In this manner, cost, size, and volume can be diminished because of fewer measures of devices and related circuits. The lessened change step results in efficient power.

In multiport DC-DC converter, the controller is centralized so there is no issue of complicated communication, only one converter controls the overall communication.

There are two different categories of integrated isolated multiport converters.

In first type of converter transformer is involved as shown in Figure 2.

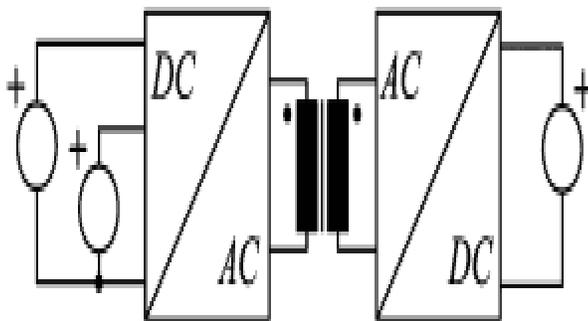


Figure 2: DC-DC converter with transformer

In [1] a converter is described that have low rating power rating of this converter is limited. Because to transfer energy only one port is allowed at a time via common magnetic components. The converter is based on working principle named as flux additivity in multi winding transformer, but this converter has an extra capability that is its reverse blocking diodes. by these diodes only power flow unidirectional and it will prevent the application from application where storage of energy system is deployed. With advancement a converter is designed in [2] named as boost dual half bridge topology.

The converter that exhibits the power flow in both direction, and it is bidirectional is presented. The presence of an inductor named as the boost inductor reduces the current ripple, but by reducing current ripple, we are increasing some parameters as cost, area and response from the system also changes the response of the circuit. In [3] converter topology is proposed, which is complex and difficult to implement is resonant converter topology. Multiport converter is proposed in [4] and [5] that are the derivation of the topology dual active bridge. A method has been proposed on the basis of time sharing in [6]. In second type, we can reduce the winding but only if common ground for ports allowed by the system [7], [8].

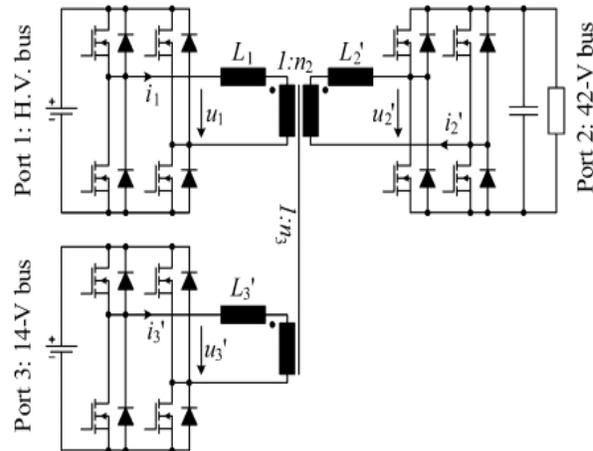


Figure 3: Proposed Converter in [9]

The transformer having high-frequency not just coordinates & trades of the power between all ports, additionally among all ports isolation is provided between all ports. Due to high current and switching losses, a bottleneck was, to generate high voltage the multiport converter doesn't properly. These issues are resolved in a converter which is proposed in research paper [7]. The strategy introduced in it was of changing the duty cycle constantly. The duty cycle is to be changed on the basis of voltage level of port. When power source or the storage component is added, it loses delicate exchanging promptly.

In [8] multiport converter is proposed, it is a three-port bidirectional converter along with high frequency isolated transformer. Multiport converter is made of using half bridge instead of a full bridge. Power source or capacity is interconnected following the same duty cycle is utilized as a part of all the half-connect cells and is the main variable that can make up for the variety of the voltage level.

In [9] an enhancement technique is presented for the topology in Figure 3 with the point of minimizing the general system misfortunes, where inside of the converter zero following influence is guaranteed, and the variety of an obligation cycle at every port decreases the exchanging misfortunes for port voltage varieties. This element permits capable power change, low weight and low volume development. Furthermore, the little flag model within the framework and the related control outline of the converter are created. Because of the job of the decoupling system, the multivariable control system can be deteriorated into a progression of autonomous single-circle subsystems, where the circle association can be dispensed with. Along these lines, high data transmissions for every control circle and quick element

reaction are achievable. A model of the multi-port converter has been manufactured and effectively tried. The exploratory results affirm the hypothetical investigation and demonstrate the decoupling and great element reaction. The proposed converter is a decent contender for the different voltage electrical framework in HEVs and FCVs, and has unmistakable points of interest of full disconnection, bidirectional force stream, high effectiveness and low weight.

Electric vehicle development is extraordinarily affected by electronics of power, innovation with the presentation of various designs [10], [11]. The Electric Vehicle, over the span of development, has included numerous locally available sources and capacity units [12]. To extinguish and catch the discontinuous prerequisites, high-energy ultra-capacitors are utilized as a part of expansion to an essential source [13].

In [14] storage system is accounted with battery and capacitor. This requires a multi-port power converter that oversees power from the greater part from the sources. To convey a managed voltage to the load multiport converter is used. The multi-port converters accessible in the writing can be comprehensively ordered into two important categorizations:

- 1) Isolated Converter
- 2) Non-Isolated Converters.

When voltage difference is high between load and source, the isolated converter is used. Separated converters demonstrate a typical pattern of imparted auxiliary twisting to individual essential windings for various sources [15]. In output voltage control isolated, converters are supported; multiport converters are complex in hardware implementation as compared to single port converter [16]. In [17], [18] multi-port converter was proposed, which are a few single data converters qualified for an expansion.

In non-isolated converters, there are some benefits as it has small structure and central control. Due to its versatility, it is being used for many applications. In [19],[20] converters were with time-multiplexed operation, and these converters are non-Isolated Multiple Input Converters (MIC). A non-separated buck-boost converter is presented in [20] that have a system which inspects a battery-ultra capacitor. Two groups of Multiple Input Converters (MIC) are introduced in [21] which are presented with the idea of PSC (Pulsating Source Cells). Further work is done in [21], to fundamental the non-detached converters with the idea of Pulsating Source Cells is presented. Other than topology induction, a few studies have been done on the control of MICs [22]-[23] and interleaved converters [24]-[25]. In [26] the work is done on DC-DC converters in its early era. Later in [27] this work is extended and new principles are proposed for recognize of essential topologies as topologies. As literature there is a vast variety of converters which are non-separated a non-separated. Various power sources are available and work is done with different sources. The situation in a renewable framework is that different irregular power sources are prepared to supply power at any given time moment. On the off chance that the thought of time-multiplexing of info sources is embraced, the promptly accessible vitality from renewable sources is squandered. Among the conceivable sources, the most promptly accessible one, helped by an auxiliary source in the event of crisis, is required. Some proposes a four port DC/DC converter suitable for Hybrid Hybrid-Electric (HEV) with a

renewable vitality source port, two storage ports and a load port. inventiveness of the work lies in the usage of an inductor as a support to exchange vitality from two sources to a heap. The blend of the proposed converter from the essential PSC, the switch acknowledgment, the little flag model and its outline are introduced in into work. In [28] paper proposes a four port DC/DC converter with an information port, two stockpiling ports and a heap port. The blend of the proposed converter, the switch acknowledgment, and the enduring state investigation of the majority of the critical working modes are displayed. Focused mode determination rationale with a PI controller for voltage regulation is proposed. The framework uses distinctive blends of sources and capacity units relying on the mode started. The outcomes demonstrate that the inductor can be utilized as a cushion to hybridize power sources. Rather than totally overlooking the source/stockpiling units and moving to an option source, the cross breed utilization of sources gives an alluring method for using low power sources in mix a mix high high-power. The plausibility of the converter is tried with various modes and it is suitable for car applications.

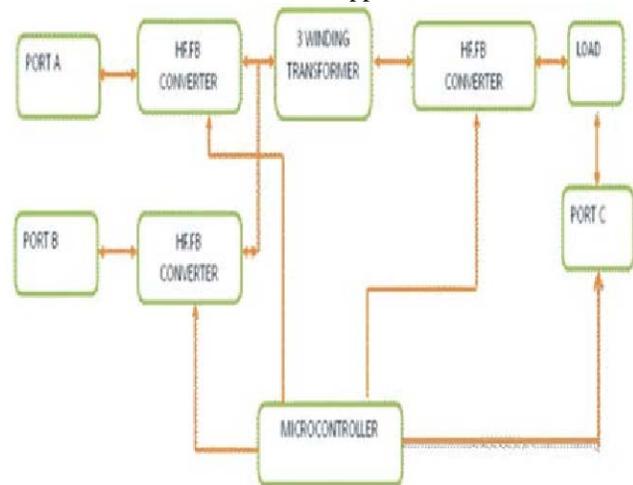


Figure 4: Multi-port converter's Block diagram

The Block diagram of the multi-port converter displayed in above Figure 4 consists of three ports high-frequency full bridge converter, three winding transformers and microcontrollers. High-frequency full bridge converters are operated at inversion and rectification mode. The three winding transformers are used in isolation purpose [29]. In research paper [30] an electric system for the propulsion is discussed. This system is composed of combined storage unit and generator. For the interfacing of different sources a Multiple-Input Power Electronic Converter (MIPEC) is designed and sized. The joined storage unit is made by an ultra-capacitors bank (UC), and a battery's bank called battery unit (BU). MIPEC is in charge of power flow control of on-board of the vehicle for every method of action. Details intended for Multiple-Input Power Electronic Converter planning to turn out from numerous observations concerning footing drive and driving cycle for referencing and on-board power supply source and capacity of unit characteristics. A converter is proposed in [31] which are three ports DC-DC converter, it has the capability to be bi-directional. Due to its structure as it is based on the cells (full bridge) so it allows the bidirectional flow in each port. By utilization of this configuration, it allows us to match the different voltage level of the whole system via the help

of a multi-winding transformer. The topology is designed while keeping in mind the incorporation of leakage inductance, to affect the phase shift control as required by the topology. Besides this, a dual PI strategy is proposed, which are three ports DC-DC converter. The strategy dual PI loop control is proposed to achieve management of power flow and voltage output should remain constant. For the improvement of the fuel cell stack slow transient response this topology is used. It is also verified through a hybrid fuel cell and super-capacitor system.

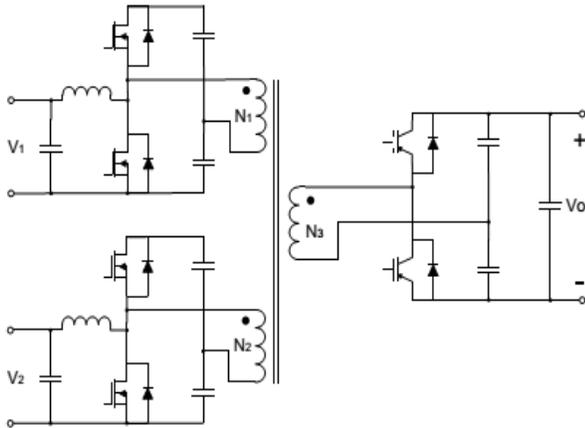


Figure 5: Bidirectional dc/dc converter triple half-bridge

The above-mentioned topologies adopt a multi-winding transformer to couple different power ports. Therefore, all ports are fully isolated with each other. However, some applications do not require all ports to be fully isolated, and the share of some grounds may allow fewer components and fewer transformer windings. A topology in [32] is intended for future hybrid and fuel-cell vehicles, which might have multiple voltage nets like: 14V, 42V and above 200V buses. An auto switched dc-dc converter, which uses 4 switches, suggested interconnecting these nets. Power flow control is built on a collective duty ratio, and phase shifts control, but auto-switching has a limited range. In [33], another sort of multi-port DC-DC power converter will be proposed with a specific end goal to coordinate energy sources and energy storage electively and financially. The proposed circuit is investigated, demonstrated, outlined, controlled, and recreated. Certain issues identified with functional application will be examined to confirm the value of the propose circuit. Because of the focal points like minimal effort and reduced structure, multiport converters are accounted for to be intended for different applications. for example, accomplishing three transport voltages of 14 V/42 V/H.V. (high voltage of around 500 V) in electric vehicles or cross breed electric vehicles, interfacing the PV board and a battery to a controlled 28-V transport in satellite stage power frameworks, PV vitality gathering with air conditioning mains or the battery reinforcement, mixture energy unit and battery frameworks, and half-and-half ultra-capacitor and battery. In perspective of device's topology, multi I/O converters grounded on buck, boost and buck-boost topologies. The bottle-neck in these configurations is the deficiency of bi-directional ports for the interfacing of storage devices. Proposed multi-port converters are also buildup of a multi-winding transformer on the basis of

both half and full bridge topologies. They can meet a disconnection prerequisite. Furthermore, have bidirectional abilities. Be that as it may, the real issue is that they utilize too numerous dynamic changes, notwithstanding the cumbersome transformer, which can't legitimize the one-of-a-kind elements of low part check and smaller structure for the coordinated multiport converter.

## CONCLUSION

In this research paper, an overview was presented regarding multiport converters.

In section 1 there is introduction. Introduction composed of little introduction about electric vehicles and along with the common and multiport DC-DC bus introduction.

Section 2 explains the overview regarding conventional converter and multiport converters. Differences and problem faced in conventional converters are mentioned. Different research papers regarding multiport converters with different techniques while interfacing with renewable-energy sources are analyzed and expressed in section 2.

Due to the flexibility of a multiport converter, it gives several advantages. It can be used in renewable-energy sources for Uninterruptible Power Supply without storage, or it can be used for storage of energy-using hybrid sources in electric vehicles.

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