



Review of Multi-Port DC/DC Converter with Control Techniques

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Abstract : DC-DC converters are widely used to efficiently produce a regulated voltage from a source that may or may not be well controlled to a load that may or may not be constant. Bidirectional multiport DC/DC converter is using in many of the applications. The control techniques are also very useful to control and manage the circuits. This paper presents review of multi-port DC/DC converter with control techniques.

IndexTerms – DC/DC, Control, Converter, Bidirectional.

I. INTRODUCTION

DC-to-DC converter is an electronic circuit or electromechanical device that converts a source of direct current (DC) from one voltage level to another. It is a type of electric power converter. Power levels range from very low (small batteries) to very high (high-voltage power transmission).

DC-to-DC converters are used in portable electronic devices such as cellular phones and laptop computers, which are supplied with power from batteries primarily. Such electronic devices often contain several sub-circuits, each with its own voltage level requirement different from that supplied by the battery or an external supply (sometimes higher or lower than the supply voltage). Additionally, the battery voltage declines as its stored energy is drained. Switched DC to DC converters offer a method to increase voltage from a partially lowered battery voltage thereby saving space instead of using multiple batteries to accomplish the same thing.

Most DC-to-DC converter circuits also regulate the output voltage. Some exceptions include high-efficiency LED power sources, which are a kind of DC to DC converter that regulates the current through the LEDs, and simple charge pumps which double or triple the output voltage. DC-to-DC converters which are designed to maximize the energy harvest for photovoltaic systems and for wind turbines are called power optimizers.

Transformers used for voltage conversion at mains frequencies of 50–60 Hz must be large and heavy for powers exceeding a few watts. This makes them expensive, and they are subject to energy losses in their windings and due to eddy currents in their cores. DC-to-DC techniques that use transformers or inductors work at much higher frequencies, requiring only much smaller, lighter, and cheaper wound components. Consequently these techniques are used even where a mains transformer could be used; for example, for domestic electronic appliances it is preferable to rectify mains voltage to DC, use switch-mode techniques to convert it to high-frequency AC at the desired voltage, then, usually, rectify to DC. The entire complex circuit is cheaper and more efficient than a simple mains transformer circuit of the same output. DC-to-DC converters are widely used for DC microgrid applications, in the context of different voltage levels.

An energy the executives procedure for a microgrid having sun based PV exhibits and a battery energy storage framework (BESS). The vast majority of the energy the board system utilized for business photovoltaic (PV) inverters and battery inverters don't think about the future burden conduct and can't guarantee the energy versatility for a PV and battery storage based microgrid. The entrance of microgrid with the circulation framework turns into a test for the dependable and safe activity of the current power framework. The irregular attributes of supportable energy sources alongside the arbitrary burden varieties incredibly influence the power quality and soundness of the framework. Consequently, it requires storage frameworks having both high energy and high-power taking care of ability to coincide in microgrids. A proficient energy the executives structure is planned in this work for a framework joined PV framework joined with half breed storage of supercapacitor and battery [2].

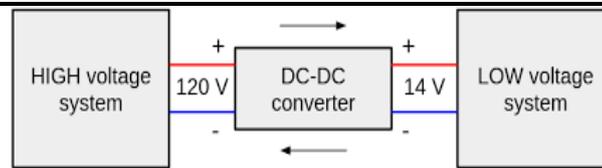


Figure 1: DC to DC Converter

A usable and flexible family energy the board framework is to create and carry out request reaction (DR) projects. These are under the half and half age of the energy storage framework (ESS), photovoltaic (PV), and electric vehicles (EVs) in the shrewd lattice (SG). Existing family energy the board frameworks can't offer its clients a decision to guarantee client solace (UC) and not give a reasonable arrangement as far as diminished fossil fuel byproduct. To handle these issues, this examination work proposes a heuristic-based programmable energy the executives regulator (HPEMC) to deal with the energy utilization in private structures to limit power bills, decrease fossil fuel byproducts, amplify UC and lessen the top to-average proportion (Standard).

II. LITERATURE SURVEY

A. M. Mahfuz et al.,[1] The proposed control technique of the energy the board framework (EMS) is approved involving the two reenactments in MATLAB/Simulink climate and via completing lab probes a created lab test stage. For the converters of the test stage, this article fosters an attractively connected seven-level staggered converter (going about as the sun based PV inverter) and a full-span inverter with a high level pulse width regulation strategy (going about as the BESS inverter). Business inverters generally require huge and massive power recurrence transformers for the matrix reconciliation of sustainable power sources. The high-recurrence attractive connection based power electronic converter can deliver different offset dc power sources with decreased size, guarantees lower power misfortunes during the energy change process and can likewise guarantee galvanic confinement. The outcomes from the reproduction and trial investigations of the EMS show that the created energy the board methodology guarantees both the minimization of the working expense of the framework and the expanded flexibility of the entire framework.

A. Bharatee et al.,[2] The consolidated battery and supercapacitor storage framework holds the normal and transient power changes, which gives a fast control to the DC connect voltage, i.e., it settles the framework and assists with accomplishing the PV power smoothing. The normal power dispersion between the power framework and battery is finished by actually taking a look at the state of charge (SOC) of a battery, and a successful and effective energy the executives conspire is proposed. Also, the utilization of a supercapacitor reduces the current weight on the battery framework during startling uniqueness in the created power and burden necessity. The exhibition and viability of the proposed energy the board approach are supported by reenactment studies.

S. Gangatharan et al.,[3] utilizes another control calculation that finds the strength of power accessible in the DC side prior to being moved. The change cycle is summoned provided that the power is sufficient, and assuming observed weak, then, at that point, the transformation interaction is removed and put away in an assistant battery. Transformation of weak power would bring about high misfortune across the converters and transformers. In this plan, the air conditioner loads are provided by the utility lattice, and the DC loads are taken care of by a sun based PV and a helper battery bank. The power transformation is done uniquely during unavoidable conditions. A model equipment arrangement has been created, and the target of the proposed research task has been approved. Further, the proposed plan would acquire significance in diminishing the expense of the power for a period of-utilization duty framework by improvement. A hereditary calculation is proposed to upgrade the energy the board of the microgrid framework.

V. N. Murty et al.,[4] Microgrids with mixture sustainable power sources are expanding and it is a promising answer for energize far off regions where conveyance network extension isn't attainable or not efficient. Independent microgrids with climate well disposed cross breed energy sources is a savvy arrangement that guarantees framework dependability and energy security. This work decides the ideal limit, energy dispatching and techno-monetary advantages of independent microgrid in far off region in Tamilnadu, India. Microgrids with crossover energy sources including photovoltaic (PV), wind turbine (WT), battery energy storage framework (BESS) and diesel generator (DG) are considered in this work. Different contextual investigations are executed with crossover energy sources and for each contextual investigation a near examination of techno-monetary advantages is illustrated. Eight distinct designs of mixture energy sources are displayed with sustainable parts of half, 60%, 65%, and 100 percent, individually.

A. Imran et al.,[5] utilized half breed hereditary molecule swarm advancement (HGPO) calculation and existing calculations like a hereditary calculation (GA), paired molecule swarm streamlining calculation (BPSO), insect settlement improvement (ACO), wind-driven enhancement calculation (WDO), bacterial searching calculation (BFA) to plan savvy machines ideally to achieve our ideal destinations. In the proposed model, shoppers utilize sunlight based chargers to deliver their energy from microgrids. We likewise perform MATLAB reproductions to approve our proposed HGPO-HPEMC (HHPEMC), and results affirm the proficiency and efficiency of our proposed HPEMC based procedure. The proposed calculation decreased the power cost by 25.55%, Standard by 36.98%, and fossil fuel byproduct by 24.02% when contrasted with the instance of without booking.

U. R. Nair et al.,[6] Model prescient control (MPC) works with online ideal asset planning for electrical organizations, warm frameworks, water organizations, process industry to give some examples. In electrical frameworks, the capacity of MPC can be utilized not exclusively to limit working expenses yet additionally to further develop environmentally friendly power use and energy storage framework debasement. This work evaluates the use of MPC for energy the board in an islanded microgrid with PV age and cross breed storage framework made out of battery, supercapacitor and regenerative power module. The goal is to

work on the use of inexhaustible age, the functional productivity of the microgrid and the decrease in pace of debasement of storage frameworks. The enhancements in energy booking, accomplished with MPC, are featured through examination with a heuristic based technique, as Fluffy surmising. Recreated conduct of an islanded microgrid with the MPC and fluffy based energy the executive's plans will be read up for something very similar. Aside from this, the concentrate additionally does an examination of the computational interest coming about because of the utilization of MPC in the energy the executive's stage. It is presumed that, contrasted with heuristic strategies, MPC guarantees further developed execution in an islanded microgrid.

A. M. A. Haidar et al.,[7] The recurrence shift keying (FSK) procedure has been embraced for sending the twofold sign over the power line correspondence (PLC). A piece of the calculation is used to manage the ideal booking control, while the other impels the dynamic-request reaction based photovoltaic power guaging. The exhibition of the proposed approach with the planned reinforcement infusion list has been approved utilizing information gathered from the viable organization of "Bario, Sarawak." The introduced outcomes recommend that the execution of the proposed methodology can work on the productivity of the general framework, causing less working expense and quick return. It was likewise observed that the paired sign can be moved with less mutilation through PLC networks when utilizing the FSK method contrasted with different strategies.

S. Alomari et al.,[8] A comprehensive mathematical modeling and control design for an isolated multi-port DC/DC converter for photovoltaic (PV) generation systems is discussed in this paper. The adopted converter is a modified flyback converter consisting of three ports, namely, a photovoltaic (PV) module input port, a bi-directional battery port, and an isolated output port. The output port is receiving its demanded power without any interruption, while the power extracted from the PV module is maximized adopting a maximum power point tracking (MPPT) controller.

K. Mahmud et al.,[9] proposes a planned multi-facet control technique for the energy the executives (EM) of lattice associated ac microgrids. The methodology predicts the client's heap interest and the photovoltaics (PV) power age for a day-ahead EM. It uses the PV power ages and the bidirectional energy exchanges from electric vehicles and battery storage to give a joined reaction to stack support. The framework likewise predicts any vulnerability in clients request and power ages and carries out day-ahead careful steps to handle that vulnerability. Two distinct forecast systems are utilized, autoregressive moving normal and counterfeit neural organizations, and their exhibitions for a day-ahead EM are explored.

J. Hong et al.,[10] Photovoltaic (PV)/battery crossover power units have drawn in huge examination interests lately. For the traditional appropriated power age frameworks with PV/battery mixture power units, two free power converters, including a unidirectional dc-dc converter and a bidirectional converter, are regularly required. This work proposes an energy the board and control technique for the PV/battery mixture conveyed power age frameworks with just one coordinated three-port power converter. As the coordinated bidirectional converter shares power switches with the full-span dc-dc converter, the power thickness and the unwavering quality of the framework is upgraded.

M. F. Zia et al.,[11] energy age sources basically give energy supply to far off regions these days. In any case, due to developing worries over ozone depleting substance outflows, the combination of sustainable power sources is compulsory to satisfy power needs and decrease climatic impacts. The headways in sustainable age sources and battery storage frameworks make ready for microgrids (MGs). Subsequently, MGs are turning into a reasonable answer for power supply lack issues in remote-region applications, like maritime islands. In this work, an islanded MG, which comprises of PV framework, flowing turbine (TT), diesel generator (DG), and Li-particle battery, is considered for Ouessant Island in Brittany locale in France.

S. Kumar et al.,[12] presents a private photovoltaic (PV) battery energy storage (BES) based three-stage network synchronized microgrid. The goal of the proposed microgrid is to foster a completely independent power the executives conspire in utility-coordinated and islanded modes. To control the PV-BES microgrid in network tied mode, oneself standardized assessor (SNE) control is utilized for power the executives. Moreover, having consistent exchange capacity, the proposed microgrid mitigates power quality aggravations brought about by nonlinear burdens tied at reason behind normal coupling (PCC).

III. CONTROL TECHNIQUES

Voltage mode control of DC-DC converters

It is a type of single loop controller connected to a reference voltage, so at first output voltage is measured and compared to a reference voltage (figure-2). This VMC method is used in research as well as in industry due its easy implementation^{6,7}. It uses measured output and reference voltage to generate the control voltage. After this the control voltage is used to determine the switching duty ratio by comparison with a constant frequency waveform. This duty ratio is used to maintain the average voltage across the inductor. This will eventually bring the output voltage to its reference value and which help in the delivery of constant voltage without any variation.

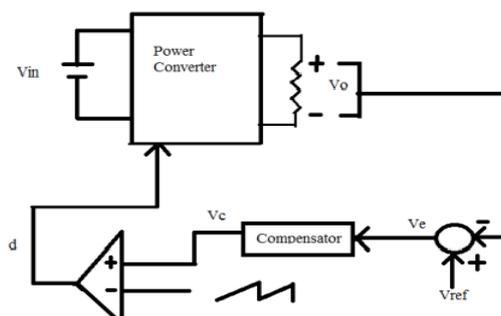


Figure 2: Voltage mode control of power converter

Current mode control of DC-DC converters

It is more complex than VMC as it contains dual loop including voltage and current control loops (Figure- 3). There are various applications of CMC for different applications [8-10]. After sensing the inductor current it is used to control the duty cycle. An error signal is produced after comparing the output voltage V_o with fixed reference voltage V_{ref} and this error signal is used to generate control signal i_c . The next step is to sense inductor current and compare it with control signal i_c to generate the duty cycle of particular frequency and drive the switch of the converter.

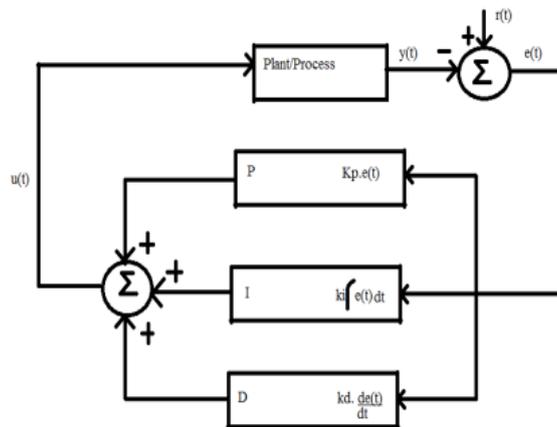


Figure 3: Current mode control of DC-DC converters

PID Controller

PID control is one of the oldest and classical control techniques used for DC-DC converters [11, 12]. It uses one of its families of controllers including P, PD, PI and PID controllers (figure-3). These different combinations will give us various ways to regulate dc power supply in these converters. But here we will discuss only PID in details. Due to the various advantages of PID it is widely used for industrial applications in the area of power electronics. One of the main causes for the use of this classical technique still in industrial applications is easy implementation of tuning method like Ziegler-Nichols tuning procedure by which we can easily optimize proportional, integral and derivative term of this control method needed to achieve a desired closed-loop performance.

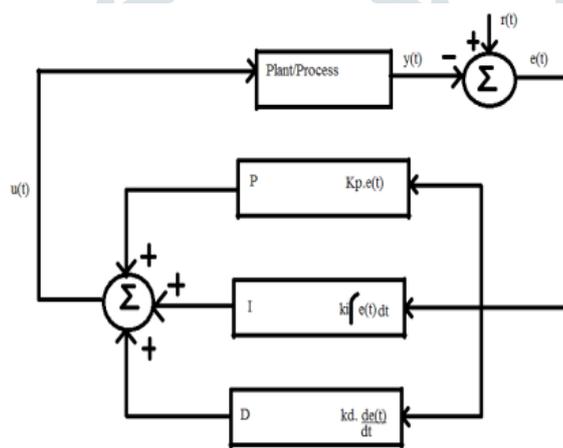


Figure 4: Block diagram of PID controller

Commonly used as controllers for boost converters in PV. Some important advantages of PID control technique are:

- i. It is easy and simple to implement.
- ii. Easy to understand.
- iii. Reliable for linear systems.

IV. CONCLUSION

DC-DC converters are one of the important electronic circuits, which are widely used in power electronics [1-3]. The main problem with operation of DC-DC converter is unregulated power supply, which leads to improper function of DC-DC converters. There are various analogue and digital control methods used for dc-dc converters and some have been adopted by industry including voltage- and current-mode control techniques. A multi-port DC/DC converter is discussed with its control techniques. The battery stores the extra power when the power generated from the PV exceeds the load demand and supports the PV when the power generated from PV is insufficient.

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