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Original Research Article

MULTIPHASE DC-DC CONVERTER FOR USING LOW VOLTAGE POWER APPLICATIONS

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Abstract: The growing diversity of applications together with commercial, telecommunications, transports, aerospace, navy, and the non-stop demand for smaller, lighter, and extra high power supplies have forced to draw attention towards high frequency isolated, three-phase DC–DC converter. Power applications are found mostly with low output voltage around 9V to 10V .and power level found to be 750W.A power conditioning system for such applications generally consists of a dc-dc converter and a dc-ac inverter, and the dc-dc converter for low-voltage, high-power must deal with a high voltage step-up conversion ratio and high input currents. Although many dc-dc converters have been proposed, most deal with high input voltage systems that focus on step-down applications, and such dc-dc converters are not suitable for low-voltage, high-power applications. Multiphase isolated dc-dc converters offer several advantages that are very desirable in low-voltage, high-power applications. First, a multiphase is constructed with paralleled phases, which increase power rating and current handling capability for high input current. Second, an interleaving control scheme produces a high operating frequency with a low switching frequency, and the high operating frequency reduces size of passive components. Thirdly, use of a transformer provides electrical isolation and a high conversion ratio. Lastly, several multiphase converters are capable of soft-switching operation, which increases converter efficiency.

Keywords: Three phase inverter rectifier high frequency transformer isolated dc-dc converter Pulse with modulation and symmetrical and asymmetrical technique.

1.0 Introduction

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There are numerous packages which needs high electricity from strength deliver, but cannot be applied high voltage due to the gadget necessities. These strength deliver employs in low, medium and excessive strength applications together with: strength supply for microprocessor, telecommunication equipments, chemical electrolysis. [3-4] good sized development inside the fields of circuit topologies, semiconductor electricity gadgets, manage idea, advances in incorporated electronics have substantially decreased the scale of many digital structures. a good way to utilize the benefits of compact denser electronics, strength densities (output strength in line with unit quantity) which are a good deal higher than what's feasible with gift DC-DC power converters are demanded Based on the system requirements there are various types of DC to DC converter topologies.

DC to DC Converter can be classified as isolated and non-isolated its depends upon the electrical isolation.

1. Step down convert or buck converter
2. Step up converter or Boost converter

The objective of this paper is to evaluate the performances of high frequency isolated three-phase full bridge converter under symmetric and asymmetric control techniques with PWM gate pulse and further, to investigate its suitability for applications require high power at relatively low voltage.

2.0 High Frequency Transformer

In addition to the electrical isolation, transformers offer other advantages, such as noise decoupling and multiple outputs with multiple secondary windings. Typical disadvantages are that a) design and costs of transformers are non-trivial, b) unbalanced input can cause transformer saturation, c) difficulty in cross regulation between multiple outputs and d) a transformer introduces additional losses. Nevertheless, transformers are required to provide the electrical isolation, and the high-frequency transformers offers several additional advantages over the line frequency transformers.[15] Advantages of the high-frequency transformers can be evaluated from a systematic point of view. First, a transformer's size and weight vary inversely with frequency, thus the line frequency transformers, which operate at 50 Hz, are large in size and weight. However, dc-dc converters operate in frequency range of tens or hundreds of kilohertz, therefore a improvement in size, weight, and cost can be made by incorporating a high-frequency transformer into a dc-dc converter stage. Secondly, incorporating a line frequency transformer at the end of power conversion system tends to cause lower efficiency. Transformers are utilized to boost low-voltage to high-voltage, thus all the stages before transformer must operate in a low-voltage condition. When a line frequency transformer is used, the entire power conditioning system operates in low-voltage. Assuming the same power rating, a lower voltage translates to a higher current and the high current results a higher conduction losses and a lower overall efficiency.

Advantages of the high-frequency transformer can be also evaluated from a dc-dc converter point of view. First, a transformer in the dc-dc converter stage enables a better device optimization and lowers voltage and/or current stresses on switching devices. Second, lower voltage and/or current rated devices cost less. Third, the better device utilization and optimization enable use of better devices with a lower on-resistance, which leads to less conduction losses and a higher efficiency.

2.1 High conversion ratio and current handling capability

When a 240dc voltage is a connected with a inverter .then its convert dc to ac voltage and ac supply is fed with high frequency transformer which raring of transformer 750W 150/25V.therfore which ac voltage is a converted in to step down voltage .this ac voltage is measure across by charging capacitor C .When execess current is produce then its current is passes through resistance R which are connected with parallel circuit C. Its combination is called Snubber circuit. The dc-dc converter output is then connected to the dc-ac inverter to obtain a 120/240 VAC RMS output.

3.0 Multiphase Dc-Dc Converter

Figure 1 illustrates how a general three-phase dc-dc converter is constructed, which is used as an example to explain multiphase converter architectures. Input can be either a voltage or a current source. In the when a dc voltage source and converters deal with dc voltage to dc voltage conversion. A input filter is often required to reduce to noise and disturbance from converters. Many renewable energy sources, such as batteries, photo-voltaics, and especially fuel cells, are sensitive and vulnerable to disturbances, such as negative currents and current ripples, and the input filter lessens such disturbances.

After the input filter, a power stage chops and inverts the dc input into high-frequency three-phase interleaved ac signals. Interleaving phase control schemes allow higher effective frequency operations and offer several benefits. The ac signals then excite a high-frequency multiphase transformer, and the transformer either steps-up or steps-down the ac signals to an appropriate level. One advantage of three-phase transformers is its flexibility of transformer configuration.

Once the transformer outputs attain an appropriate output level, the output is rectified with a suitable three-phase rectifier, such as a three-phase full-bridge rectifier, a current Tripler, or a hybridge rectifier. The rectified signal is filtered and supplied to output sinks.

3.1 Operating modes

A three-phase interleaved asymmetrical PWM duty cycle controls the V3. The individual phase of V3 can be viewed as a half-bridge, and typically a symmetrical duty cycle is utilized in a single-phase half-bridge topology. In the single-phase half-bridge topology, such as shown in section 2.1.2, an asymmetrical duty cycle causes volt-second to unbalance, which causes transformer magnetizing current to saturate. Additionally, the saturating current causes unbalanced voltage in split dc capacitors as well. However, the asymmetrical duty cycle does not cause the volt-second to unbalance in the transformers in V3.

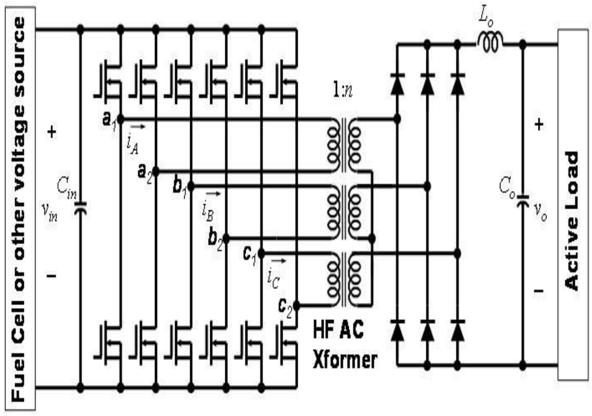
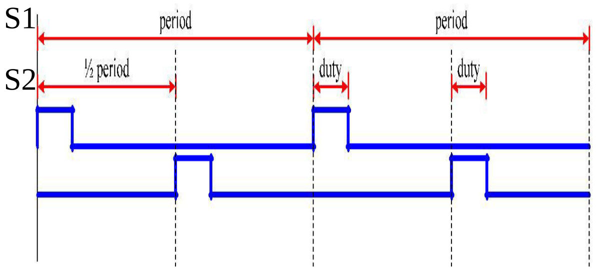


Fig.1 Multiphase high frequency isolated DC–DC converter

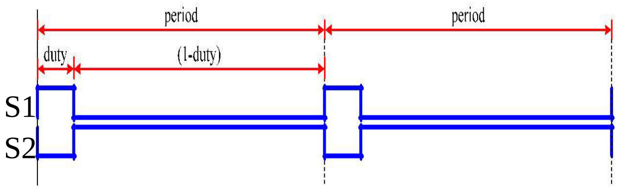
The symmetrical duty cycle and the asymmetrical duty cycle are briefly compared in Figure In symmetrical duty cycle, one of two switches in a phase-leg is in on-state for the duration of duty cycle. At the end of duty cycle, the switch turns off, and both switches in the phase-leg is in off-state. At the half of the period, the opposite side device turns on and operate the same manner as previously.

In the asymmetrical duty cycle, when the upper switch in a phase-leg is in on-state, the lower switch is in off-state, and vice versa. Therefore, one and only one switch is in on-state at any time.

The asymmetrical PWM control allows duty cycle control from 0 to 1, unlike the symmetrical PWM control, which only allows duty cycle control from 0 to 1/2. When duty cycle exceeds 1/2 with the symmetrical PWM control, a shoot-through condition, where both upper and lower switching devices in a phase-leg turn on at the same time, occurs. However, the asymmetrical duty cycle does not shoot-through regardless of duty cycle, since opposite side device in a phase-leg always complements the other.



(a) Symmetrical duty cycle



(b) Asymmetrical duty cycle

Figure 2 – Comparison between symmetrical and asymmetrical duty cycle

As the asymmetrical duty cycle of V3 changes from 0 to 1, three operating regions can be identified based on the duty cycle: 0<D<1/3, 1/3<D<2/3, and 2/3<D<1. In the first operating region, 0<D<1/3, output voltage increases linearly from 0 V to $n \cdot V_{IN}$ as the duty cycle increases from 0 to 1/3, where n is transformer turns ratio and V_{IN} is input voltage. In the second operating region, 1/3<D<2/3, the output voltage remains at $n \cdot V_{IN}$ regardless of the duty cycle. In the third operating region, 2/3<D<1, the output voltage decreases linearly from $n \cdot V_{IN}$ to 0 as the duty cycle increases from 2/3 to 1. The first region and the third region, where the output voltage can be regulated with the duty cycle control can be called "regulated converter mode." The second region, where the output Voltage remains the same regardless of the duty cycle can be called "dc transformer mode."The operating principal of the regulated converter mode is the same in both first region and third region. Operating in the third region, where the output voltage decreases as the duty cycle increases, makes control design different from convention. Therefore, the duty cycle is typically limited to 0.5, and the converter is prevented from entering the third region. Figure 3 illustrates conversion ratio and operating modes of V3.

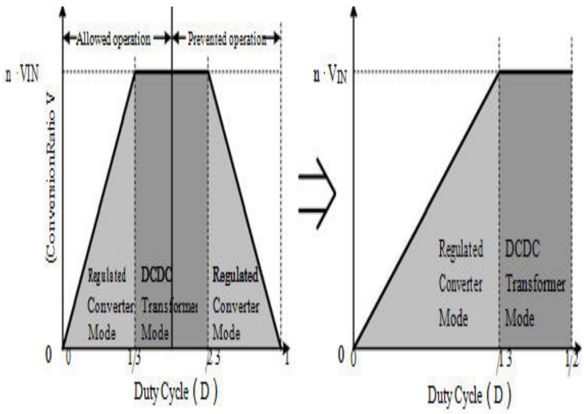


Figure 3 – Conversion ratio operating modes

3.2 Comparison between Symmetric and Asymmetric Control Method:

Parameter	Symmetric Control	Asymmetric Control
Duty cycle control	0<D<0.5	0≤D≤1
Operating range	Small	Wide
Thermal stress	Better	Poor
Diode voltage stress	Vdc/2n	Vdc/3n
Inductor current	Io/3	Io/3
Implement device losses	Small	More
Size and weight	Small	Small

4.0 Description of Simulation (Simulation Model)

This section summarizes the results of the research work done on the existing and proposed algorithms. The work demonstrates the three-phase high frequency isolated DC–DC converter with using pulse with modulation technique and the proposed design is tested by MATLAB/simulink. Computer modeling and simulation is widely used to study the behavior of various complex systems. With proper simulation techniques, a significant amount of experimental cost could be saved in the prototype development. Among several simulation software packages, SIMULINK is one of the most powerful techniques for simulating dynamic systems due to its graphical interface and hierarchical structure and in addition SIMULINK uses MATLAB as a Tool for mathematical purposes which further enhance the modeling process. This software permits the design of special user blocks, which can be added to the main library. Here the simulation and its results for scalar Technique is presented.

4.1 Specification of component

Parameter	specification
Input voltage	230V, DC
Output power	9.5 V ,280 A
Switching frequency	20KHz
High frequency transformer (3 unit)	1-ϕ,250VA,150/25V Ns//Np=0.1677
Filter inductor (3 unit)	5Mh
Output capacitor	440µF

4. 2 Symmetrical control PWM method:

In this method using symmetrical control PWM give the better output result of dc-dc converter. in case of operating range are very small as compare to asymmetrical control technique. The output result shown in the figure below.

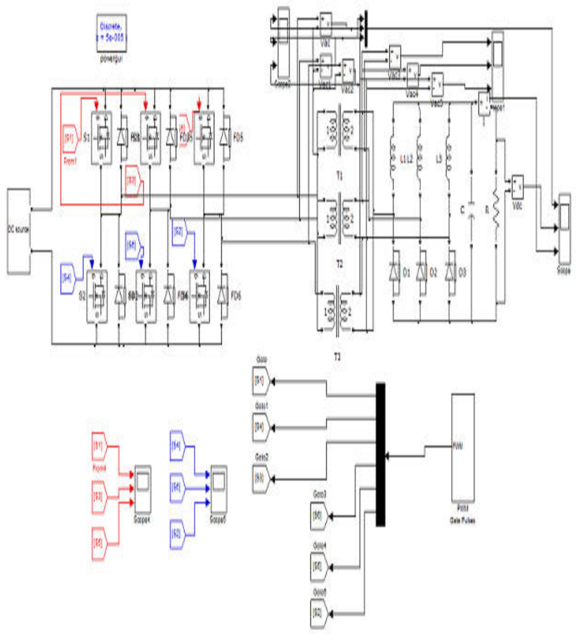


Fig.4.Three-phase high frequency isolated DC–DC converter

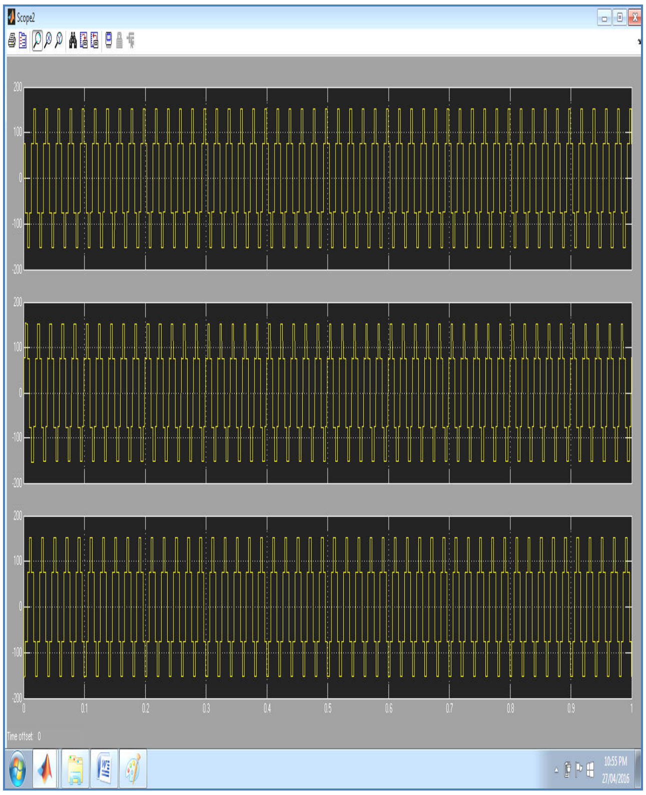


Fig.5. Symmetrical control PWM

4.3 Asymmetrical control PWM method:

In this method using Asymmetrical control pwm give the poor output result of dc-dc converter. in case of operating range are very wide as compare to symmetrical control technique. the output result shown in the figure below.

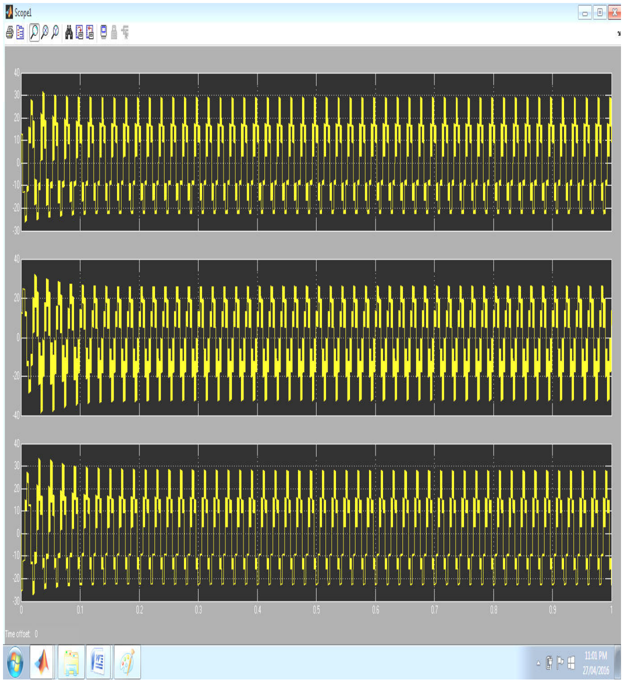


Fig. 6 Asymmetrical control PWM

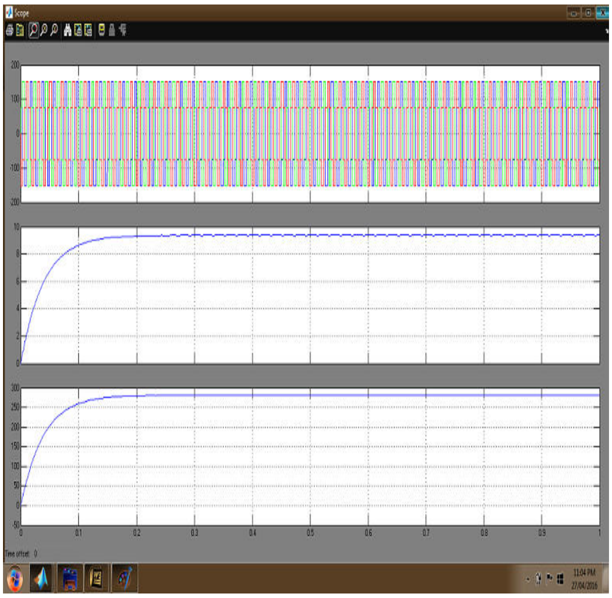


Fig.7 Output voltage and current

5.0 Conclusions and Future Scope

The work presented in this dissertation is a comparative study of three-phase high frequency isolated DC–DC converter with using pulse with modulation based on their simulation results. MATLAB has been chosen in this work due to its versatility. Simulation results are presented for different operating conditions. All the conclusions drawn are obtained by analyzing the simulations done in MATLAB. Following conclusions have been drawn from the work accomplished.

1. The line frequency isolated converters for high power application at very low voltage, a high frequency isolated three-phase DC–DC converter is used to reduce size weight and dynamic response.

2. One main advantage when we are analysis the symmetrical and asymmetrical control methods, In case of symmetrical control method all the power switches conduct uniformly as compare to asymmetrical control methods.

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