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Comparison between Symmetrical and Asymmetrical Controlled Three-Phase High Frequency Isolated DC–DC Converter

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ABSTRACT: The increasing diversity of applications such as industrial, telecommunications, transports, aerospace, military, and the continuous demand for smaller, lighter, and more efficient high power supplies have forced to draw attention towards high frequency isolated, three-phase DC–DC converter. The proposed–DC converter can be used in applications which require very low voltage conversion ratio, isolation, good regulation against load and line disturbances, and fast dynamic response. In this paper review of modeling, control and design of high-frequency isolated three-phase DC–DC converter.

Key Terms—Line frequency isolated rectifiers, DC–DC converters, interleaved control techniques, pwm gate pulse & Symmetrical and asymmetrical control methods.

I. INTRODUCTION

There are many applications which demands high power from power supply, but cannot be applied high voltage due to the system requirements. These power supply employs in low, medium and high power applications such as: power supply for microprocessor, telecommunication equipments, chemical electrolysis, DC Arc furnace, Graphitizing Furnace, Copper refining, Plasma Torch, starting process of Aircraft, Large Hadron Collider (LHC) and nuclear fusion research of magnetic confinement approach [1-4].

Half-bridge topology maintains higher efficiency due to lower conduction losses. Soft switching permits higher switching frequency operation, reducing the size, weight and cost of the magnetic components. Interleaving of the two isolated converters is done using parallel input series output approach and phase-shifted modulation is adopted. It reduces the input current ripple at the fuel cell input, which is required in a fuel cell system and also reduces the output voltage. [2].

three-phase, power quality improvement converter configurations, control approaches, performance on supply and load sides in terms of input power factor, THD and well-regulated, reduced-rippled dc output, power rating, cost and selection for specific applications [6] in power semiconductor devices, integrated circuits, and packages for DC/DC converter applications. Special emphasis is placed on the latest discrete power MOSFET devices and packages. Features and trends in ICs for control of synchronous buck converters are highlighted as well [7].

Power losses of a bidirectional three-port DC–DC converter to be used in hybrid electric systems as a function of the voltage conversion ratios and the output power are evaluated in this work. An analysis and characterization of the current on the switches into the whole converter operating range a represented [8].

The cascade connection of a low-ripple voltage doublers pre-regulator and a classical boost converter regulator is proposed to improve the efficiency of the full system due to the reduction in average currents of all boost converters and the smaller duty cycle required for the conventional boost regulator.[9]

Power losses of a bidirectional three-port DC–DC converter to be used in hybrid electric systems as a function of the voltage conversion ratios and the output power are evaluated in this work. An analysis and characterization of the current on the switches into the whole converter operating range are presented 10].

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.

II. ISOLATED MULTI-PHASE DC–DC CONVERTER:

Fig. 1 shows the basic power circuit of an isolated multi-phase DC–DC converter. It consists of three stages: inverter stage, high frequency isolation and output rectifier stage. The power switches (S1 _ S2N) in inverter stage may be practically realized by, either IGBT or MOSFET with body diode and parallel connected RC snubber circuits. N units of single phase high frequency transformer with star-connected primary and mesh connected secondary are used to feed energy to load through multiphase output rectifiers.

Keeping in view of low voltage high current applications, different types of rectifiers such as forward type, center-tap, bridge, current doubler and tripler are considered. On the basis of secondary side load sharing, transformer design and thermal heat dissipation, multi-phase, full diode bridge is selected for low voltage high.

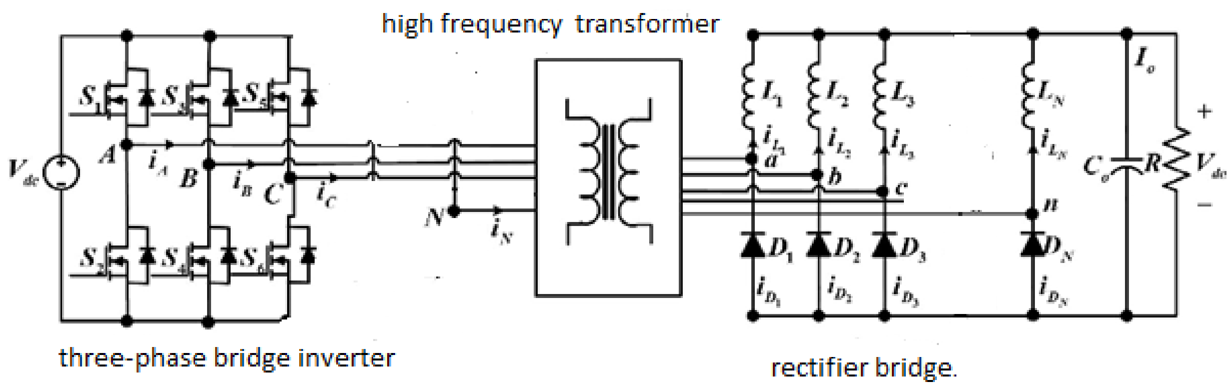
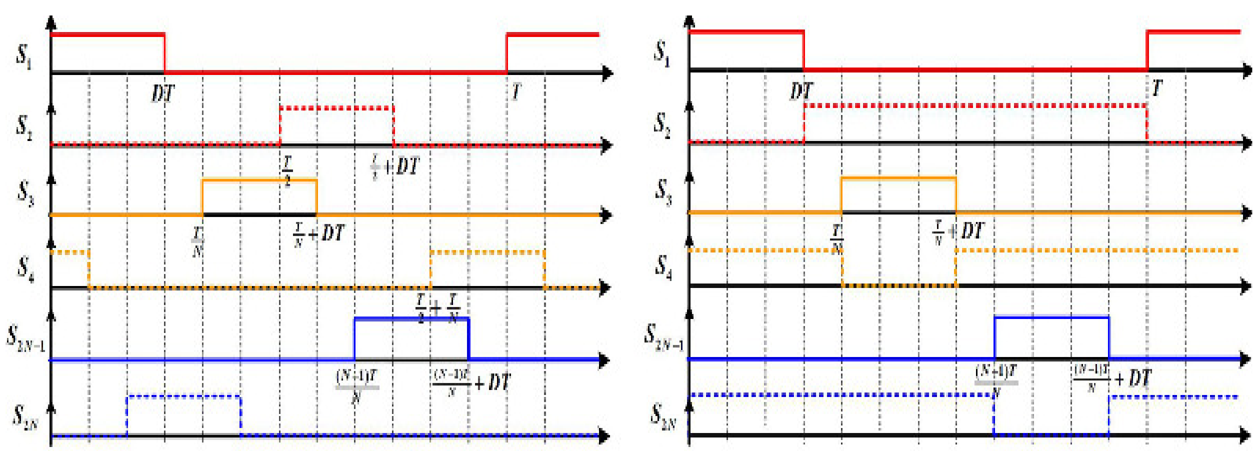


Fig. 1. Three-phase high frequency isolated DC–DC converter.

III. CONTROL TECHNIQUES

In this technique the output voltage with respect input source voltage and load variations, width of gate signals of power switches of 3 -□, full bridge inverter are varied. On the bases of duty cycle of switches, two control methods namely symmetric and asymmetric control are proposed as shown in Fig. 2. The duty ratio of the upper group power switches (S1, S3, S5) in inverter legs is same as that of lower group of power switches (S2, S4, S6,) in symmetrical control whereas in asymmetrical control duty ratio differs as shown in Fig. 2. It is observed that gate signals for power switches in different inverter legs are delayed by T/2 in symmetrical control and complementary in asymmetrical control. The gating signals for power switches in different inverter legs are advanced or delayed by T/N with respect to each leg to obtained three-phase balanced output voltages of Inverter Bridge.



(a) (b)

Fig. 2. Control methods: (a) symmetrical. (b) Asymmetrical.

Table 1. Comparison between Symmetric and Asymmetric Control Method.

Parameter	**Symmetric Control**	**Asymmetric Control**
Duty cycle control	$0<D<0.5$	$0 \le D \le 1$
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

IV. DESCRIPTION OF SIMULATION (SIMULATION MODEL)

The simulation model shown in Fig. 3 with the proposed control strategy has been simulated. For simulation purposes, software packages such as Matlab/Simulink and Advanced Continuous Simulation Language (ACSL) can be used. In this section, Simulink has been used to model the 3-φ high frequency dc-dc converter. The dc-dc converter has been simulated with the pwm gate pulse using the nominal parameters as given in. The dc link voltage in the simulation is equal to 230V rated value. A 750 W, prototype model of proposed DC–DC converter is built and tested at different operating conditions. Proposed simulation result under both control methods, performances of proposed converter have been investigated in view of low voltage high current applications. The Simulink model is shown in the figure below.

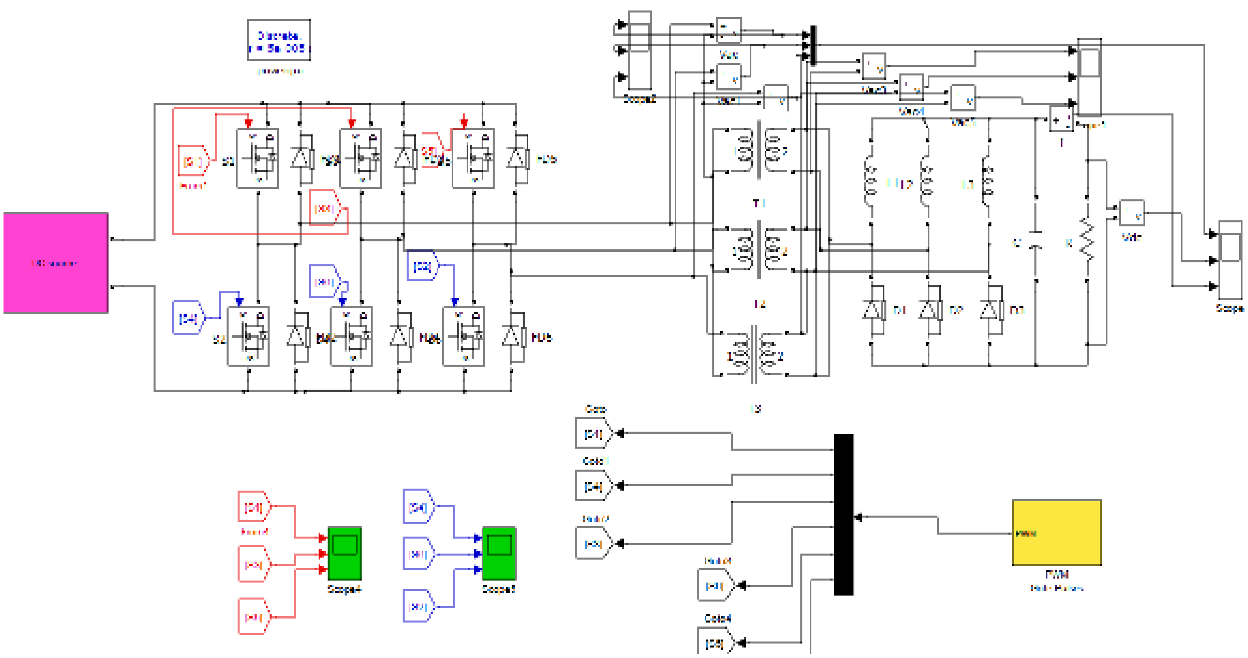


Fig. 3. Three-phase high frequency isolated DC–DC converter.

A. 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 Fig. 4.

B. 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 Fig. 5.

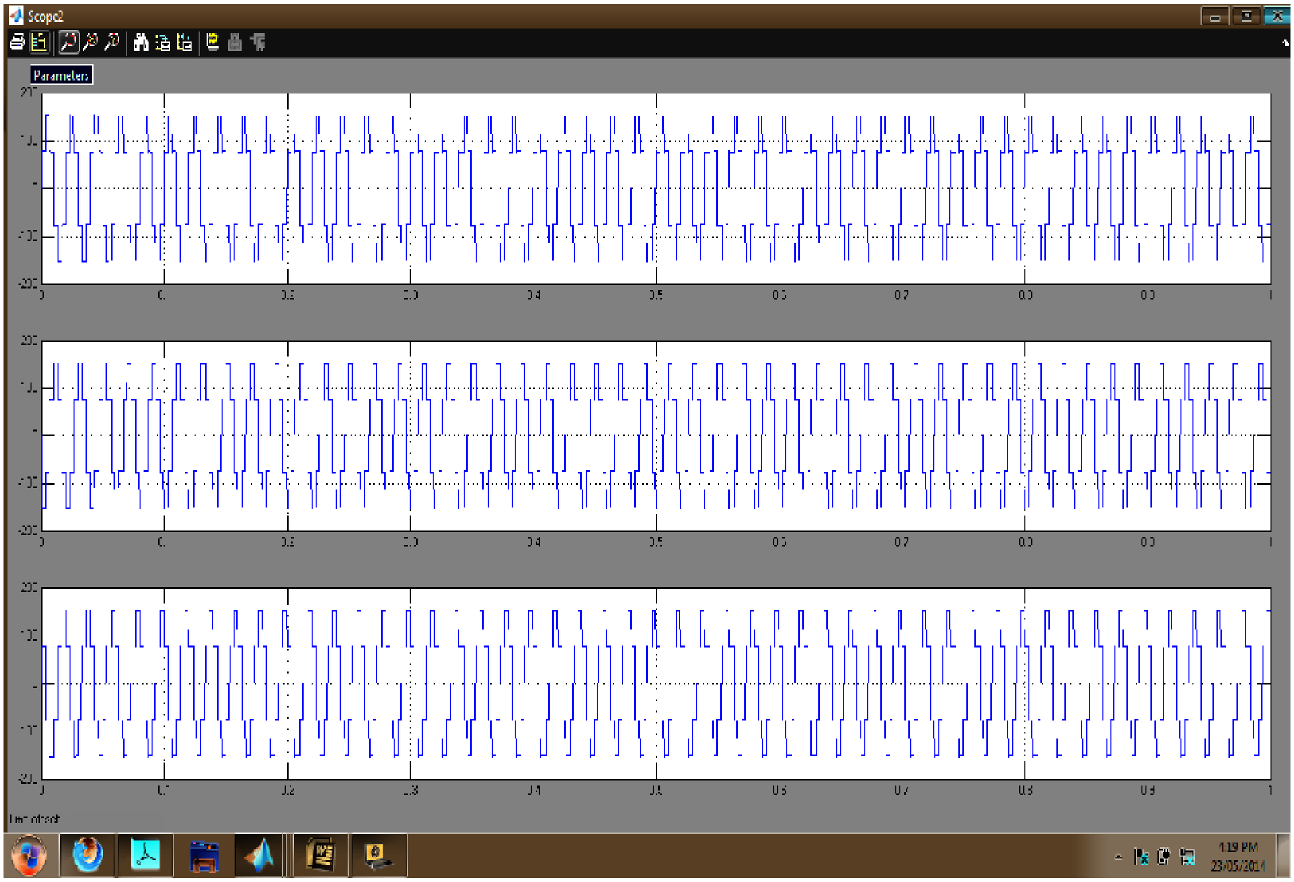


Fig. 4. Symmetrical control PWM.

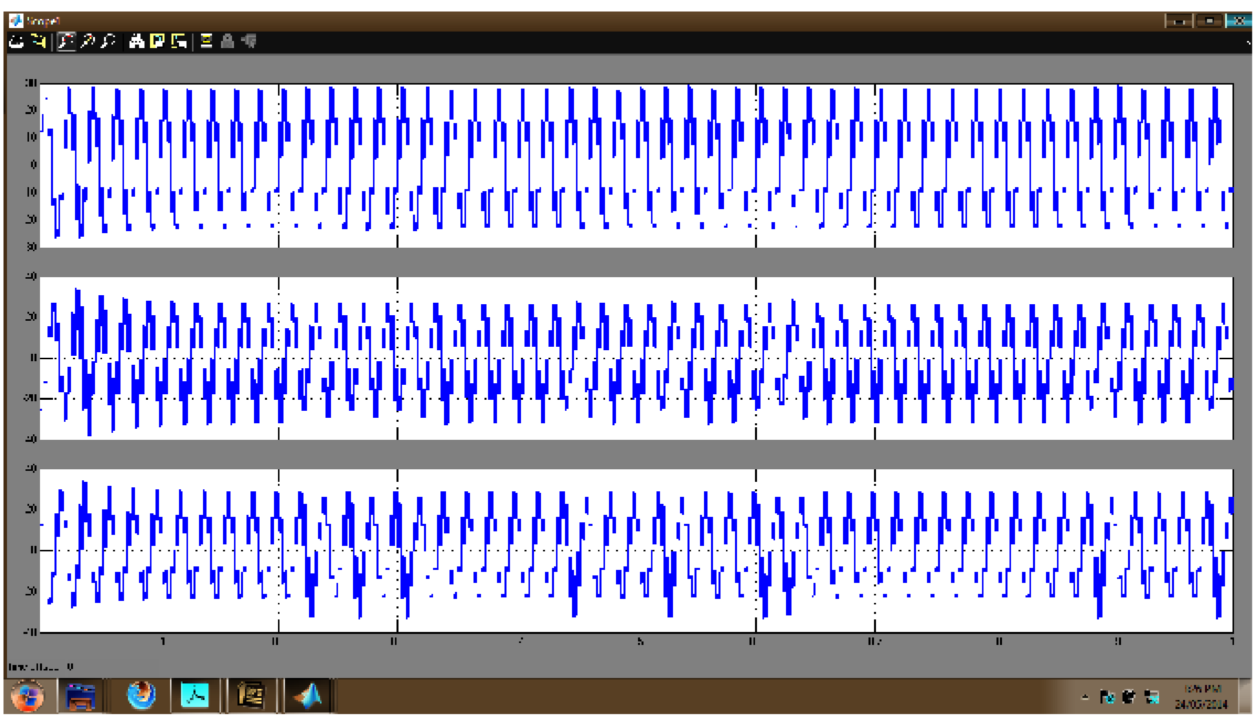


Fig. 5. Asymmetrical control PWM.

C. Design of output filter

in this method using pwm gate pulse with 3-□dc-dc converter In order to reduce output ripple, a three-phase interleave technique has been employed. In this scheme effective output ripple frequency is increased without increasing switching frequency of power switches. there output voltage and current will improve.

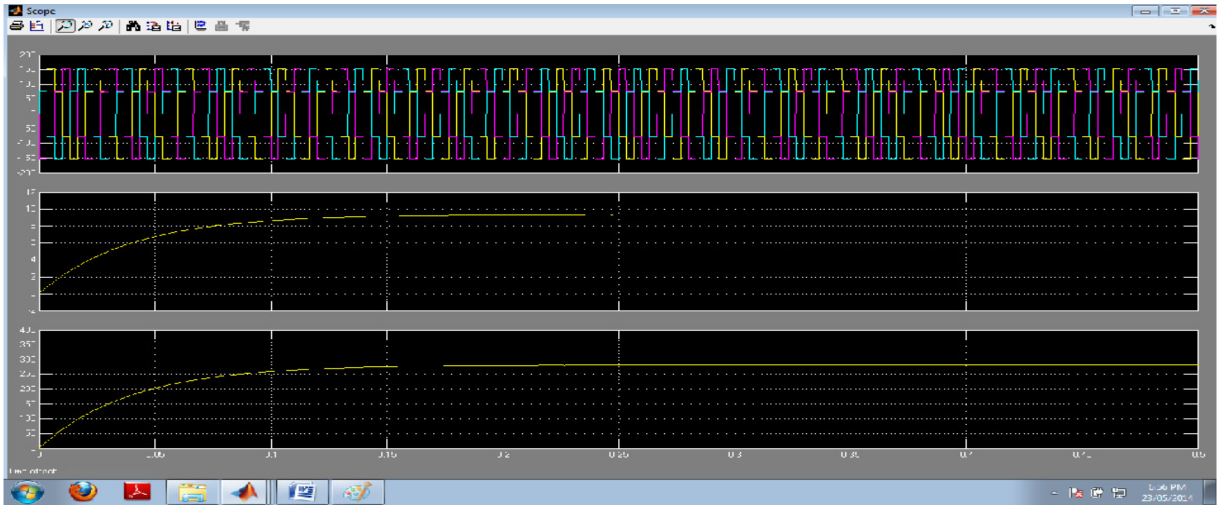


Fig. 6. Output voltage and current.

V. CONCLUSIONS

In view of major challenges associated with line frequency isolated converters for high power application at very low voltage, a high frequency isolated three-phase DC–DC converter is suggested to reduce size, weight and improved dynamic response. Proposed simulation results obtained under symmetrical and asymmetrical control methods, it is concluded that under symmetrical control method, all the power switches conduct uniformly unlike to asymmetrical control and hence uniform heat distribution is achieved with symmetrical control. On the other hand implementation of asymmetrical technique requires dead band circuits whereas in Symmetrical control, it is absent. And pwm gate pulse connected with dc-dc conveter gives the better output result of voltage and current.

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