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Deduction in Leakage Current in Resonant Bi-directional DC-DC Converter

Pratibha Shukla | Abhay shukla

Department of Electrical & Electronics Engineering GEC Raipur, Chhattisgarh, India

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ABSTRACT

This Paper Presents A Whole New resonant twin active bridge (DAB) topology, that uses a tuned inductor-capacitor-inductor (LCL) network. As compared to ancient DAB topologies, the planned topologies significantly reduced the bridge current, lowering every physical phenomenon and alter losses and conjointly VA rating associated with the bridges. The performance of the DAB is investigated using a mathematical model at a lower place varied operational conditions. Experiment results of a model is reduced the outflow current of the circuit. are presented with discussion to demonstrate the improved performance of the LCL DAB topology. Result clearly that the planned DAB Topology provide higher efficiency over an oversized vary of every input voltage and as compared to ancient DAB topology

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KEYWORDS: DC-DC Converter, Resonant Converter, Artificial Neural Network, PID controller, Breaker.

1. INTRODUCTION

IN Newly years, international issues relating to future fuel shortages is cut back the depends to come up with electrical power transfer [1]. Power is more and more developed from star, airflow, & recurrent event sources of energy. These things area unit nonconventional in by default, but highly variable, resulting in likelihood of serious motion mismatches through power provide and required intensity [2-3]. However, it has been seen that the level of mismatching will be overcome by addition the batteries of electrical driven machine, that aren't employed at specific time, into power circuit. This may offer method for running grid stabilization, but needs a bifacial power for energy transferring to one source to another. All the numerous varieties of bifacial constant source converters working to the Vehicle to Grid system [8], the D.A.B device could be most popular theme, because it includes a tiny element for operation of power transmission. additionally, it has state that a large vary of potential rating level, because it is straight work in voltage up & voltage down mode. However, a previous D.A.B technology device victimization single control attracts an oversized reactive level of current element at reducing in operation wattage indication [5-6], that will increase the device resistivity level or decreasing the conductivity. This current element conjointly required the employment large D.C. bus electrical device. Therefore, numerous processes wont reduced the level of reactive or useless current rating. Modulation (P.W.M) upper potential level is utilization by shifting power to increase the Z.V.S vary to account the device low power load potency [12] , through a reducing in the no use. Ramp signal and quadrangle are observed Endeavour cut back the electricity, hence, the conductivity

reduction. & resulted in a deduction within change losses by achieving no level of current change a number of the conductivity semiconductor device.[14-18] within the reactive wattage was decreases by victimization leveled P.W.M every circuit, and part shift across the converter circuit. Similar management of the conductivity of power there to employ in except that the modulation process is directly algorithmic program. Circuit conductivity level was decreased within the actual level, where voltage switching is operated a full level. However, circuit efficiencies in different kind of cases were still restricted for big variations in the voltage level increment & decrements magnitude relation, significantly beneath reduction level of the power rating of the circuit. instead of reduction in switching losses in the circuit,[11] the aim is to step-down of different current parameter to improved the efficiency of D.A.B technology. By this proposed methodology, twin angle rotation management signal P.W.M of every circuit utilization, yet bidirectional process of switching circuit. whereas every process is using for the rising the two way converter performance if we compare another converter or D.A.B. technology, the ensuing potency was but ninetieth at maximum demand or less demand power requirement. when Endeavour cut back the root mean square current and voltage switching, freelance modulation management of every circuit, yet as a part changes between the circuit, is utilized in a P.W.M theme was indicated in [17], then the management algorithmic operated from twin modulation techniques, at pulse width modulation process that changes smooth a most for a angle shift of half of the angle of full load power. This provided important enhancements in decreased power efficiency while not decreasing the conductivity within the rated power capability. For a direct current modulation relation of 2:1, [9] the potency changes to seventy seven at a another load to around ninetieth at rated consumption. Hence the circuit needed a lot of complicated system then shifting techniques. So that, variety of twin kind D.A.B device converter, using another type of series network, is projected. The system an increases the switching power vary and decreases the level of circulating current of the circuit within the voltage level changer machine windings, because of increases the current signals [19]–[22].So that, despite the management and resonant phenomena is utilized, all another D.A.B. technology which have consumed more power and decrease the efficiency of the circuit.

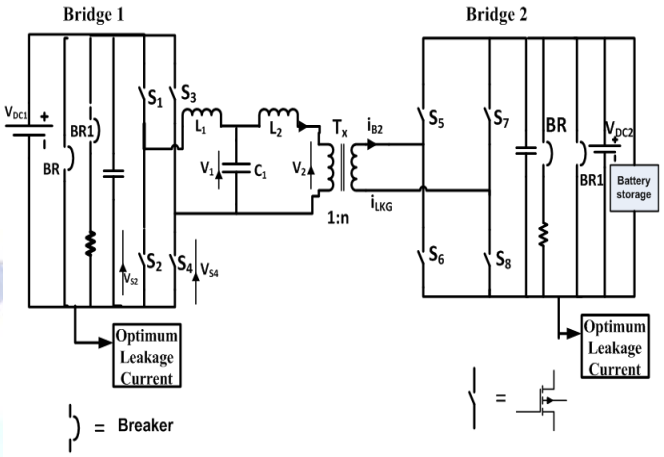

Figure 1 New Resonant Bidirectional DC-DC Converter

This technique illustrate a unique D.A.B technology, which are using the resonant phenomena to reduction the level of reactive power and overcome the demand of reactive power to the circuit. The converter is utilized the inductive capacitive inductive filter for resonant phenomena, which has the outpouring winding ration of electrical voltage level riser circuit device, considerably cut back the level of electrical current , therefore, the conduction losses which are generally generated by the current in semiconductor switch and the windings[22-23]. Natural management theme is used, wherever every bridge is circuit is driven by the modulation technique whereas repairing the part shift between the bridges fastened at $\pi/2$ or $-\pi/2$, to direction control of the power management. By the analysis of theory yet as simulink output area unit given compared practical level of 2500watts model, illustrated the flexibility of the bidirectional converter bifacial wattage is high potency high level power and provide high magnitude DC voltage level[19].

2. Proposed Method

Proposed planned resonating Dual active bridge technology device are, during which S1 − S8 defined a conducting device. In the load terminal side facet is illustrate by the constant potential supply system, VDC2. In observe, this constant magnitude signal source, that is in load terminal side is in connected, for storage of the power we are used a battery circuit or a ultra capacitor as per requirement. Moreover, in a very sensible thing, L2 is also incorporated with the leak inductance of the electrical device rather than using a distinct electrical

device. the first facet four switch conduction system, of the planned dual active bridge technology is conducting invery fast process and very fast frequency, Fs ,and transforming the constant source voltage level VDC1 into the ac signal.

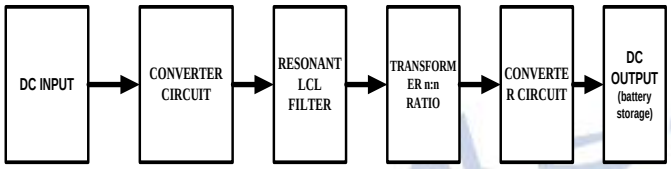

Figure 2 block diagram forward mode conduction

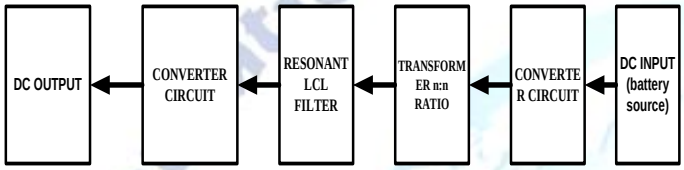

Figure 3 block diagram Reverse mode Conduction

which is produced by the modulation process supply v1 and circuit a pair of is operated at an equivalent frequency because the primary bridge is dc offer potential level VDC2 to a P.W.M AC signal supply vB2.[17-19] These 2 time varying signal are joined to along to associate degree seclusion electrical device associate degree an L1C1L2 network, that is tuned to Fs . Previous converters which are using the concept of D.A.B technology use linear element network for e.g. inductor & capacitive network to scale back conduction reduction by raising the conductivity level of semiconductor device vary. New proposed topology is used for the resonance phenomena and operated in different cycles and using the different modulation for the provided pulses of switches square measure utilized to manage the switches so as to attain soft switching However, as a results of the tuned (resonant) L1C1L2 network utilized, the planned system will not exhibit multiple operative modes as each the resonant and switching frequencies square measure identical and may be controlled victimization a simple PWM theme. Within the planned system, the direction and magnitude of power flow is regulated by dominant the pulse breadth of voltages v1 and vB2 [24], whereas keeping the section shift between them constant. This is often achieved by operative switches S1 and S2 of Bridge one in anti phase at the switch frequency Fs with a requirement cycle of fifty to come up with voltage vS2, as indicated in Fig. 2. Switches S3 and S4 square measure operated within the same way, except that vS4 lags vS2 by a displacement of $\alpha 1$ degrees. The ensuing voltage v1, driving the network, is equal to the distinction between vS2 and vS4. Thus, $\alpha 1$ modulates the pulse breadth (i.e., duty cycle) of the ac voltage v1 within a vary of 0–50% as $\alpha 1$ changes from 0◦ to 180◦. Bridge a pair of is controlled in a similar approach, employing asection displacement of $\alpha 2$, to produce a pulse-width-modulated ac voltage vB2 that is offset from v1 by a section shift ϕ.[13] The tuned (resonant) L1C1L2 network presents a high electrical resistance to harmonics generated by the converters, and thus, the currents i1 and iB2 square measure close to sinusoidal as shown by dotted lines in. beneath tuned conditions, the magnitudes of the bridge currents i1 and iB2 square measure proportional to vB2 and v1 , severally. Additionally, i1 will be leading vB2 by 90◦, whereas iB2 are insulation v1 by 90◦, thus causing the bridge currents to align with the voltages once ϕ is±90◦. As such, the ability flow of the planned resonant DAB can be regulated by dominant $\alpha 1$ and $\alpha 2$, whereas maintaining ϕ fixed at ±90◦ to reduce the VA rating of the bridges.

3. RESULTS

Dual active bridge technique is 2500watts resonant concept is used engineered is obtained by the circuit are bestowed the above simulated value of different kind of parameter which are using in the resonant dual active bridge can verified in the theoretical approaches. Therefore efficiency and parameter of the model can be illustrate the below sections. The system time configurationally value in operation beneath final value were obtained using a MATLAB perform gauge are summing the total response of the primary techniques which is obtained by the Fourier series expression and denotes the value of different voltage is symbolic representation v1 and v2 . Parameter section of the circuit can be associate potency of ninety six at full load condition,. Circuit is disciplined by associate controller circuit, exploitation modulation value of the different firing angle of the circuit is that $\alpha 1$ & $\alpha 2$ and large Φ of $+\pi/2$ or $-\pi/2$. Defining the power of the given D.A.B to power can be transmitted by the forward mode of direction; the input voltage of the circuit 2 of dual active

bridge technology is referred by the voltage vB2 that's insolent π/2.

TABLE I
CIRCUIT PARAMETER OF SYSTEM

Parameter	Theoretical value	Experimental value
Rated power	2.5 kW	
V_{DC1}	380 V	
V_{DC2}	50 V	
Turns ratio n	7.54	
Magnetics	Ferro cube E65/32/27	
f_s	50KHz	
L_1	145 μH	144 μH
L_2	145 μH	146 μH
C_1	69.8 nF	66 nF
HV Switches	FDP054N10 MOSFET	
LV SIDE	FDP054N10 MOSFET	

Conduction of the both bridges angle of the modulations is 165◦ and beneath these conditions, more or less 2500wats provides to theoretical Vdc2 to Vdc1. Leakage current of the D.A.B. circuit were more or harmonic containing signal and and high voltage circuit, so indicating close to zero reactive wattage circulation between the bridge and therefore the inductive capacitive inductive passive network. What is more, the experimental model illustrate in smart agreement with the theoretical result, so confirming the model level accurate value bestowed in different conditions. Fig. nine defined the model result in both of the approaches in theoretical and experimental result also of the advanced two way DC-DC, hence in the reverse condition modes the bridges can be transfer the power in reverse direction and approximate 2000watts of power can be transferred in reverse directional mode. Bridges can be operated with the angle of firing is 120◦ conduction when the inversion process is done, in the model vB2 hardly leading v1 by π/2◦ so transfer of power seventieth of rated power from Vdc2 to Vdc1. Since the bridges ar operated at a phase modulation of 120◦, as compared to other D.A. technology here the improvement of result is very high and hence higher efficiency are achieved because of level of voltage is increased in both of the modes of conduction either forward or reverse mode, so that other parameters then its improved many of the parameter of the circuit. In mathematical calculation of the model bestowed are often used to analysis during a resonant D.A.B beneath various in different kind of operation and accounting for variations in component values.

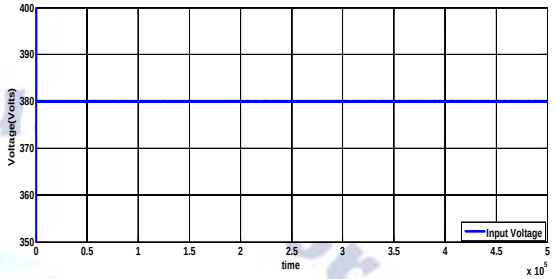

Figure 4 Input Voltage of Forward Mode

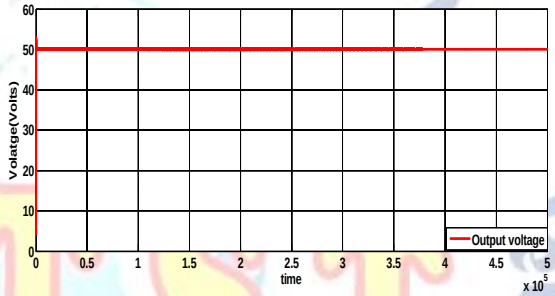

Figure 5 Output voltage of forward mode PID Controller

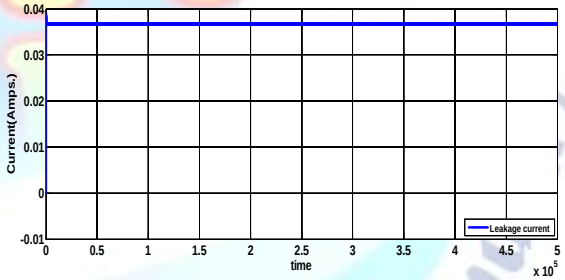

Figure 6 Leakage Current PID Controller forward mode

When reverse direction is required then or say that if the using the resonant phenomena of the DC-DC converter topology then we should provide if the 50 volts as a input in the load side then figure show that the boost process is getting proceed and the developed simulation result is

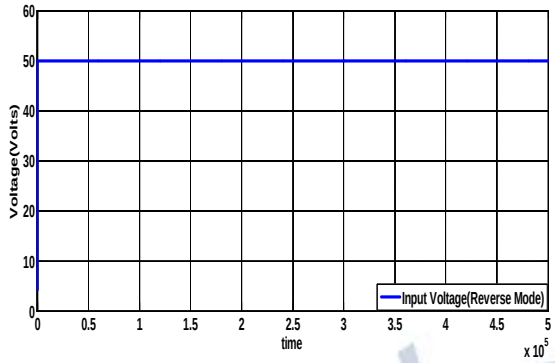

Figure 7 Input Voltage Reverse Mode PID Controller

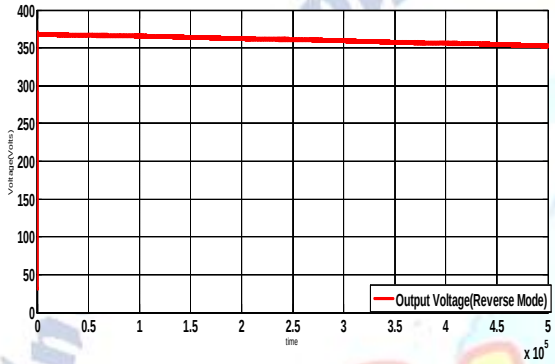

Figure 8 Output voltage Reverse Mode PID Controller

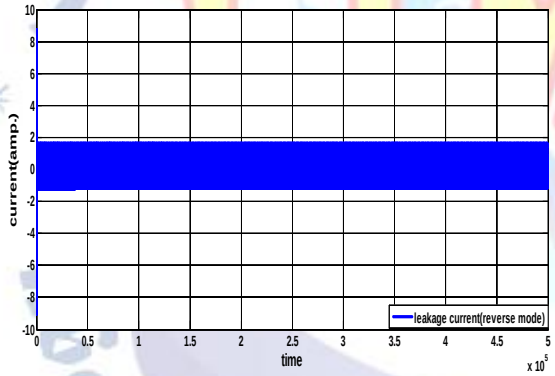

Figure 9 Leakage current Leakage Mode PID controller

The input voltage is presented in figure 7, output voltage of the system is represented on the figure 8. in these case for reduction of leakage current using the control the action of controller PID and neural network both type of controller is used so that the controller Leakage current system when using in ANN controller the output waveform can be represented by the figure 9.

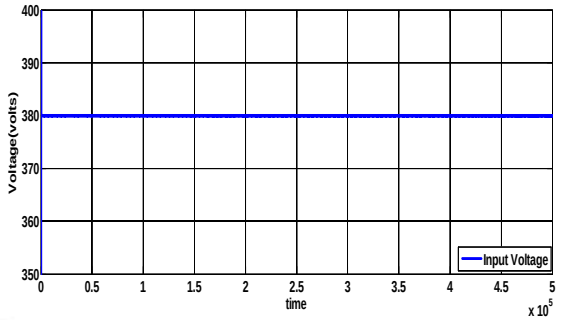

Figure 10 Input Voltage Forward mode ANN Controller

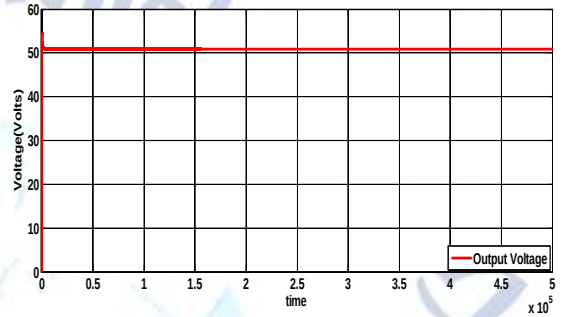

Figure 11 Output voltage Forward Mode ANN Controller

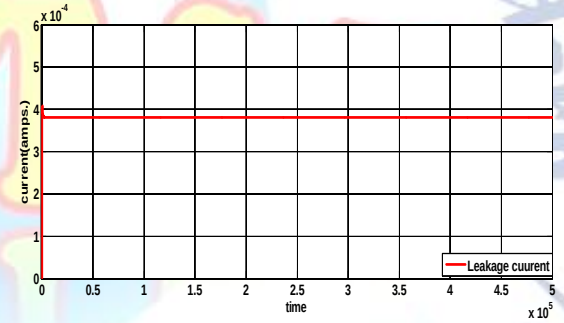

Figure 12 Leakage Current Forward Mode ANN Controller

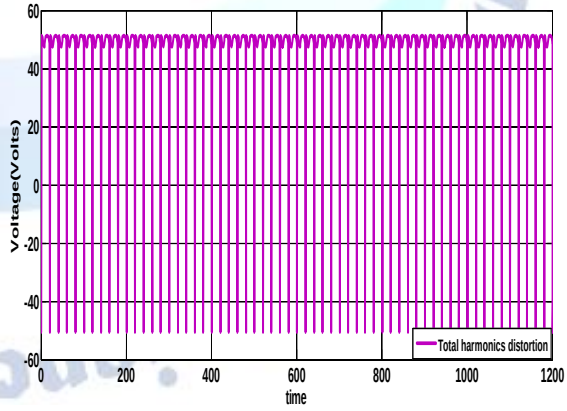

Figure 13 Total Harmonics Distortion in Forward mode

When the reverse mode is operated then the level of output voltage and the lekage current is changed in these case so that we applied same situation for the neural network as compare to the neural network topology

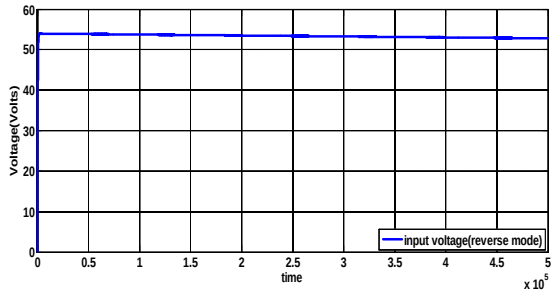

Figure 14 Reverse mode Input voltage ANN Controller

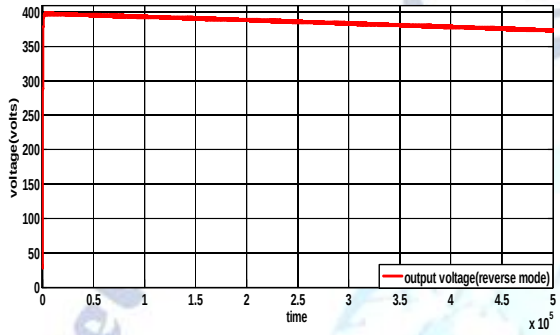

Figure 15 Output voltage Reverse mode ANN Controller

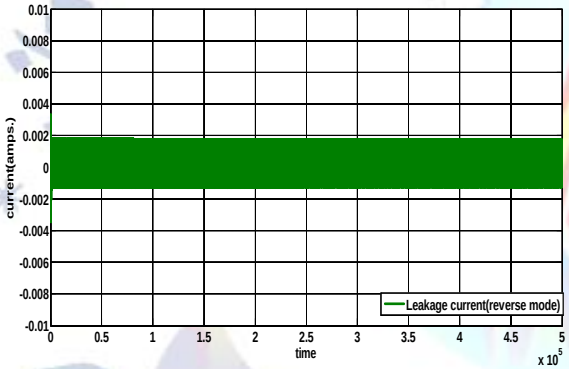

Figure 16 Leakage Current Reverse mode ANN Controller

The experimental and theoretical potency values, every of which has the facility losses within the magnetic parts similarly as those from the shift devices, square measure shown in Fig. 19. Though the model DAB given during this paper has not been optimized for potency, the results recommend a big improvement within the performance as compared to standard DAB converters with SPS management. Additionally, even higher efficiencies square measure possible to be obtained if the Bridge a pair of voltage is raised, avoiding the comparatively massive conductivity losses within the secondary a part of the circuit. As evident from Fig. 18, each the theoretical and experimental efficiencies are in smart agreement. As such, the mathematical analysis given may be accustomed accurately characterize the losses in an exceedingly resonant DAB below varied operative conditions and accounting for variations in element values.

4. Comparative Analysis

So in below the comparative analysis is provided, which may clearly indicated that the level of output voltage and the leakage current of the circuit is what, when we using different kind of controller to the circuit for controlling the pulses of the switches, below two figure indicates that the level of the deviation of the values when we are used a different kind of controller.

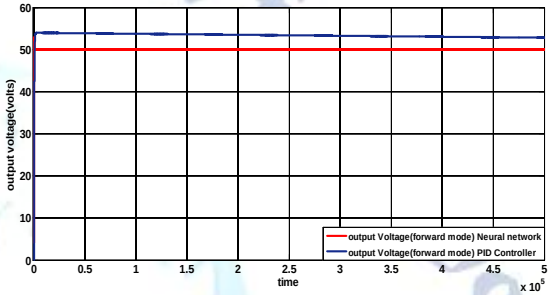

Figure 17 Output Voltage Result Comparison Forward mode

the level of voltage can be boosted then the level of leakage current can be decrease which can be seen in the figure

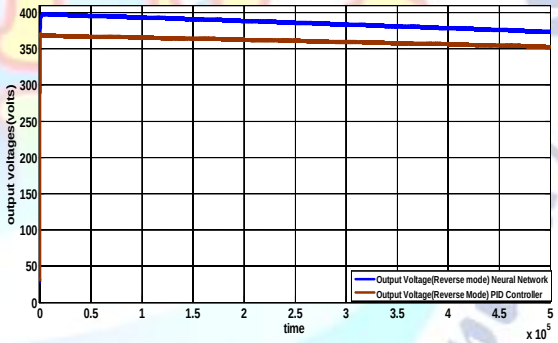

Figure 18 Output Voltage Result Comparison Reverse Mode

The level of leakage current can be decreases when the neural network is applied to controlling the pulses of the switches.

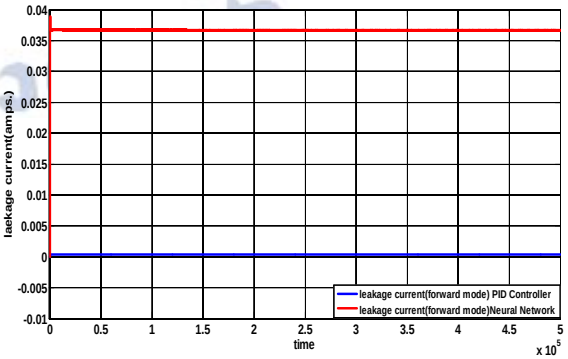

fig. 19. Leakage current comparison result

5. CONCLUSION

New bidirectional resonant converter is proposed here with the using of the inductive capacitive inductive filter so that the both of the conduction is possible with using the resonance phenomena. A model of the D.A.B. technology is described by the above and mathematical result is shown as the above. In different condition we observed that a 2500watts can be generated if we consider this D.A.B. technology, and also described the performance of the constant current converter performance. Output of the two way DC-DC converter can be shows that its offers low conducting current. So if the level of current is getting reduced so that switches loss can be reduced so it's also improved the efficiency, and provides high level voltage in the output side in any of the side if we used as buck mode or boost mode as our requirement. So this proposed method is reduced leakage current and improved voltage level.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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