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A Single Stage Multilevel Integrated Ac-Dc Converter

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Abstract:
Here a Single stage multilevel integrated ac–dc converter is presented. This converter improving or boosting power factor correction. And also this converter topology is advanced than previous ac-dc converters mainly the converter is operating with two independent controllers. An input controller is used to power factor correction and it regulates the dc bus, and the output controller is used to control the output voltage of this converter. The input controller prevents the dc-bus voltage from becoming excessive. The paper explains the operation of an improved version of new converter and its procedure for proper design. Experimental results are obtained using mat lab.

Index Terms: **AC–DC power conversion, single-stage power factor correction (SSPFC), three-level converters.**

I. INTRODUCTION

Normally high power ac–dc converters are required to have some power factor correction (PFC) capability to. PFC methods are generally divided into the following three categories:

1) Passive PFC converters: These converters are using passive elements such as inductors and capacitors .these filters are used to get the sinusoidal input current. . Although these converters are inexpensive, heavy and bulky in size and these used for limited number of applications.

2) Two-stage converters: They consist of an ac–dc boost pre-regulator converter and an isolated dc–dc full-bridge converter .These Two-stage converters are require two separate switch-mode converters and this can be increase the cost of the converter .Mainly these converters are having poor efficiency when operating under light-load conditions.

3) Single-stage converters: These converters can perform PFC/ac–dc conversion and dc–dc conversion with just a single full-bridge converter. Previously proposed single-stage ac–dc full-bridge converters have the following drawbacks.

a) Some are current-fed converters are having boost inductor connected to the input of the full-bridge. Any way these converters can achieve a near-unity input power factor, these converters are lack an energy-storage capacitor across the converter input side of dc bus, which can result in the appearance of high voltage over shoots we can observer across the dc bus.

b) Most are voltage-fed, single-stage, pulse width modulation (PWM) converters with a large energy-storage capacitor connected across their primary-side dc bus. These converter are operating with fixed switching frequency, and the bus capacitor prevents voltage overshoots and ringing from appearing across the dc bus. However, have the following drawbacks:

i) The primary-side dc-bus voltage of the converter may become excessive under high-input-line and low-output-load conditions.
ii) The input power factor of a single-stage voltage-fed converter is not as high as that of current- fed converters.
iii) The converter is operating with an output inductor current that is discontinuous for all operation conditions.

But some problems are also available in single-stage converters. This is excessive dc-bus voltages due to the

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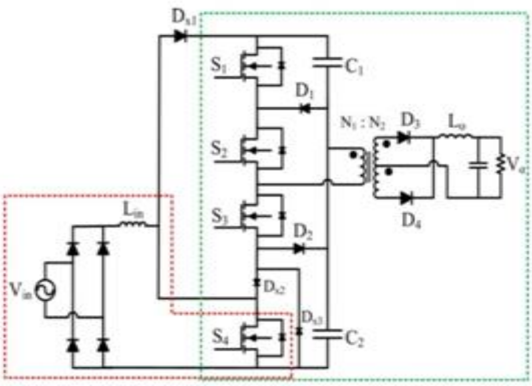
lack of a dedicated controller to regulate these voltages, large output ripple, distorted input currents, and reduced efficiency.

In the paper, a new single-stage ac–dc converter that does not have the drawbacks of previously proposed single-stage and two-stage converters is proposed.

II. OPERATION OF THE PROPOSED CONVERTER

Normally the proposed converter operation is simple. It integrates an ac–dc boost PFC converter into a three-level ac–dc converter. Here the operation of this converter is in three levels, in first level we are constructing a diode bridge with boost inductor L_{in} , boost diode $D_{x\ 1}$,. In second level we are using four switches along with two capacitors, named as C_1 and C_2 is used .In third level we are using center tapped transformer With half wave diode bridge and inductor L_o is used for dc generation.

In first level we are converting input ac into dc by using the full bridge diode bridge operation in and second level we are converting this dc into ac, In this level we are using Mosfets to convert dc into ac. Because Mosfets are having high switching frequency. When S_4 is off, it means that no more energy can be captured by the boost inductor. In this case, diode $D_{x\ 2}$ prevents input current from flowing to the midpoint of capacitors C_1 and C_2 .In this case we are using high switching frequency for

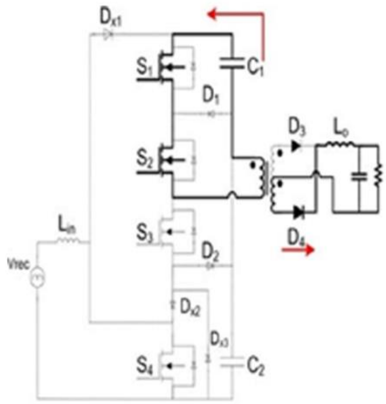


Proposed single stage three level ac to dc converter

Mosfets i.e 50Khz.Although there is only a single converter, it is operated with two independent controllers. One controller is used to perform PFC and egulate the voltage across the primary-side dc-bus capacitors by sending appropriate gating signals to S_4. The other controller is used to regulate the output voltage by sending appropriate gating signals to S_1 to S_4..It should be noted that the control of the input section is decoupled from the control of the ac–dc section and thus can be designed separately.

Typical converter waveforms are shown in Fig.3, and equivalent circuit diagrams that show the converter's modes of operation are shown in Fig.4 . It is assumed that the supply voltage is constant within a switching cycle. It is also assumed that the input current is discontinuous, although there is no reason why the input current cannot be made to be continuous if this is what is desired. The converter has the following modes of operation:

Mode1: During this mode, switches S_1 and S_2 are ON and energy from dc-bus capacitor C_1 is transferred to the output load. In the output section, a negative voltage at the output. On the output rectifier side diode D4 will act and this voltage can be rectified to DC.



Mode-1

Mode 2: During this mode, switch S_2 is ON. No energy transformation can be done to the output load. In this mode the output voltage will be '0'.

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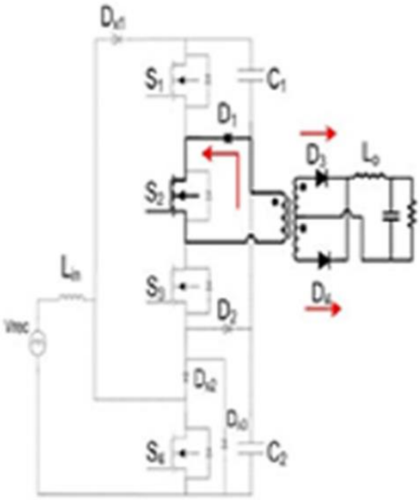
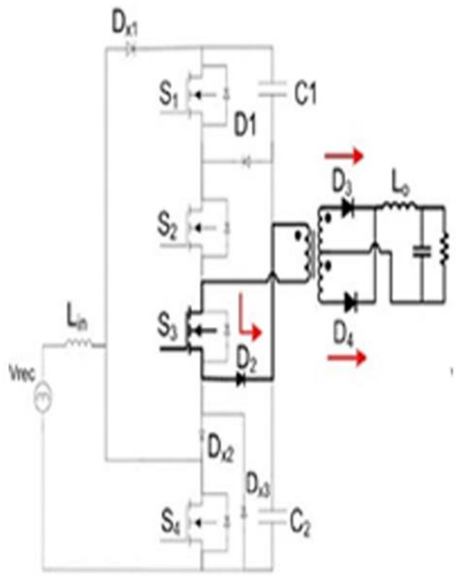


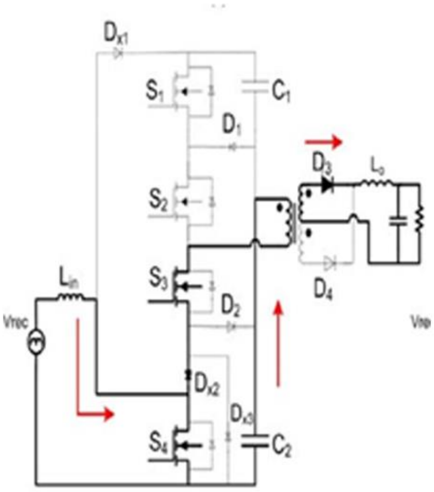
Mode-2

Mode 3: During this mode, switch S_3 is ON. No energy transformation can be done to the output load. In this mode the output voltage will be '0'.



Mode-3

Mode 4: During this mode, switches S_3 and S_4 are ON and energy from dc-bus capacitor C_2 is transferred to the output load. In the output section, a negative voltage at the output. On the output rectifier side diode D3 will act and this voltage can be rectified to DC.



Mode-4

III. CONVERTER FEATURS

The proposed converter has the following features:

Reduced cost compared to two-stage converters: The proposed converter may be expensive. Normally previously proposed converters like two stage converters are more expensive, when it is compared with this three level integrated ac-dc converter. This converter using less number of switching diodes and less number of mosfets for circuit.

Better performance than a single-stage converter: This proposed converter is having better performance than the single stage converter. It is having better input power factor for line applications. The proposed converter is having dedicated controller at input section and it can perform power factor correction and regulating the dc bus voltage. And controller is regulating the output dc voltage at o/p section.

Improved light-load efficiency: Here in this case we are operating this converter on dc bus voltage of 400 V. So to maintain this high voltage we are using MOSFETS which is having max voltage of 200V across it. This voltage is reducing the 75% of turn on losses. This converter is improving the light load

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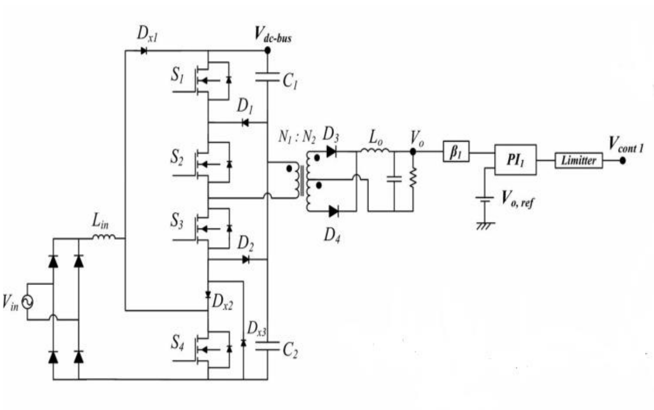
efficiency. Here switch output capacitances are having insufficient amount of current is available to discharge before switches to turn on.

Increased design flexibility: This proposed converter is operating with high dc bus voltage of 400V, it can be operate more than this voltage. This converter having more advantages when it is compared with the other converter. Here in this case the design flexibility is more important, this converter is easy to design and mainly it reduces the size of the single stage converter when it is compared with the conventional two stage converter. Mainly it reduces the cost of the converter. Although this proposed converter is more flexible in design and less cost due single converter is operating with two independent controllers. And also it is improving the light load efficiency.



Circuit of Three level integrated ac to dc converter

IV. CONVERTER DESIGN

Now we have to design the converter which is discussed in this section. For example we are design the converter with following parameters.

1) input voltage V_{in} = 230 V_{rms}
2) output voltage V_o = 48 V
3) maximum output power P_o = 230 W
4) switching frequency f_{sw} =1/T_{SW} = 50 kHz
5) input current harmonics: IEC1000-3-2 for Class D electrical equipment

Step 1: Determine Value for Output Inductor L_o

First of all we have to design the output inductor for output current continuous mode. The inductor value should not be less than the min value of maximum load. The output inductor L_o will makes the output current to continuous when converter is operating with max input voltage. The min value of output inductor can be find using these formulas

$$\mathrm{Lo,max} \geq \frac{Vo^2}{0.5\,Po,max}\,\frac{1-\mathrm{Dm}}{2} * \frac{\mathrm{Tsw}}{2}$$

Now substitute the value of Lo,max =230W

Output voltage Vo = 48V

Tsw = 20µs

Dm=0.45

And finally it gives the output inductor value Lo,min=9.36µH ,so we have to consider the output value should be 10µH for easy calculations. Here the low inductor value should be used because of the DC bus can be exceed while doing the operation.

Step 2: Determine Value for Turns Ratio of Main Transformer N

Now we have to find the value of N, by using V_{bus} ,D, V_o

$$Vo = \frac{\mathrm{Vbus}}{2\mathrm{N}}\mathrm{D}$$

Now by using the duty cycle D_{max} and with dc bus voltage

$$N \geq \frac{\mathrm{Vbus,min}}{2\mathrm{Vo}}\mathrm{Dmax}$$

Here in the above case Dmax value is 0.75,Vo is 48,Vbus is 650V .By substituting all the above values in this equation we are getting the turns ratio of the transformer will be around 5.

Step 3: Determine Value for Inductor L_{in}

Now we have to find the value of inductor value L_{in} ,in this the value should be more than the output inductor. In this case input current will be in discontinuous mode for all operating conditions. And here high peak current will affect the converter so to protect the system from this high inductance is required for the converter.

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$$Lin, max < \frac{[(Vbus, min)]^2 * Dmax * [(1 - Dmax)]^2}{2Po, max\ fsw} D$$

Here Dmax value is 0.75,Vbus is 650V, Po,max is 1.35KW and fsw is 50KHz by substituting all these values in above equation we are getting the value of inductor value L_{in} =80µH.

It should be noted this converter is made to operate with two independent controllers which they cannot interact with each other.

V.SIMULATION RESULTS

Here we are doing the operation for getting the output dc of 48V.With input of 230V AC ,for1 this we giving high switching frequency of 50KHz for mosfets and also The input inductance is L_{in} = 80 μH, L_o = 10 μH, and C_1 and C_2 = 2200 μF. The main transformer ratio was 5:1.The switching wave forms of voltages and primary voltage of center tapped transformer and also output DC voltage at load section are shown in above all figs. And input voltage & input current also we can observe in this converter. With the help of this converter we can rectify all drawbacks of single stage converter with nearly unity power factor.

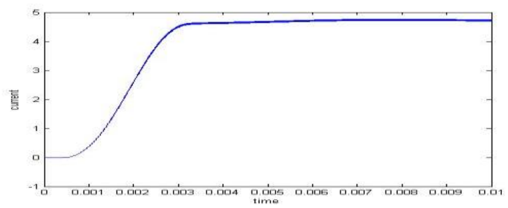

Fig 1: output current

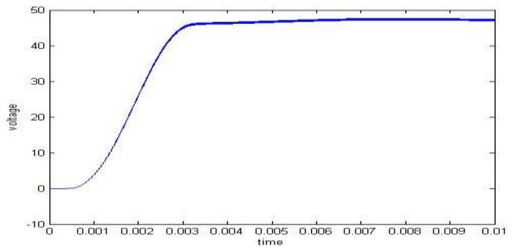

Fig 2: output voltage

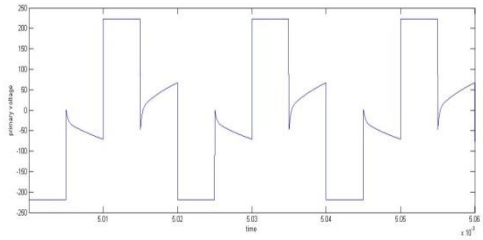

Fig 3: output voltage of primary side

VI. CONCLUSION

Here a new Single stage multilevel integrated ac-dc converter is proposed. Normally this converter is operating with two independent controllers. And one controller is used to regulate the dc bus voltage and for PFC another controller is used to regulate the output voltage. The proposed converter has the advantages over the conventional two-stage converter and also this converter reduces the size when it compared to previous converter. The outstanding feature of this converter is that it combines the performance of two-stage converters with single converter and reduce the cost of single-stage converters. Experimental results that confirm the performance of the converter are also presented in the paper.

REFFERENCES:

[1] J.-Y. Lee, "Single-stage AC/DC converter with input-current dead-zone control for wide input voltage ranges," IEEE Trans. Ind. Electron., vol. 54, no. 2, pp. 724–732, Apr. 2007.

[2] D. D.-C. Lu, H. H.-C. Iu, and V. Pjevalica, "A single-stage AC/DC converter with high power factor, regulated bus voltage, and output voltage," IEEE Trans. Power Electron., vol. 23, no. 1, pp. 218–228, Jan. 2008.

[3] H. Ma, Y. Ji, and Y. Xu, "Design and analysis of single-stage power factor correction converter with a feedback winding," IEEE Trans. Power Electron., vol. 25, no. 6, pp. 1460–1470, Jun. 2010.

[4] H. S. Athab and D. D.-C. Lu, "A high-efficiency

ac/dc converter with quasi-active power factor correction," IEEE Trans. Power Electron., vol. 25, no. 5, p. 1103-1109, May 2010.

[5] H. L. Cheng, Y. C. Hsieh, and C. S. Lin, "A novel single-stage highpowerfactor ac/dc converter featuring high circuit efficiency," IEEE Trans. Ind. Electron., vol. 58, no. 2, pp. 524–532, Feb. 2011.

[6] P. Barbosa, F. Canales, J. Burdio, and F. Lee, "A three level converter and its application to power factor correction," IEEE Trans. Power Electron., vol. 20, no. 6, pp. 1319–1327, Nov. 2005.