Design and Implementation of Three Level Isolated Single Stage Power Factor Corrected Converter

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Abstract:

For low-cost isolated ac or dc power converters adopting high-voltage dc-link, research efforts focus on single-stage multilevel topologies. This paper proposes Single Stage Power Factor Corrected Three Level Converter for high dc-link voltage low-power applications, achieved through an effective integration of ac or dc and dc or dc stages, where all of the switches are shared between two operations. With the proposed converter and switching scheme, input current shaping and output voltage regulation can be achieved simultaneously without introducing additional switches or switching actions. In addition, the middle two switches are turned on under zero current in discontinuous conduction mode operation, and the upper and bottom switches are turned on under zero voltage. Due to the flexible dc-link voltage structure, high power factor can be achieved at high line voltage.

Keywords: Mat lab simulink, converters.

1 INTRODUCTION

For improvement of grid quality and full capacity utilization in transmission lines, an Ac or Dc power converter is used. These converters operate with high power factor (PF) and low Total Harmonic Distortion (THD). By achieving high PF with high efficiency, inductive and capacitive filters followed by a diode bridge are used in Passive PF correction (PFC) circuits. In a circuit, low line frequency filters are needed but they are heavy. In high frequency operation the circuit size must be reduced. two Stage high frequency PFC converter proposed [1]-[4]. With Si semiconductor devices, switching frequency operates from 10 to several 100 kHz, in front end of Ac or dc PFC converter. With wide-band gap devices, switching frequency operates from several 100 kHz to 10 MHz’s. Next stage is Dc/Dc converter; this gives output voltage regulation as well as galvanic isolation. In two stages controllers are independent. In a light load condition, by reducing efficiency of the converter, constant switching losses are occurs there are parasitic capacitance losses. In this method more number of costly and big size of components are used. For minimum cost, number of switches is reduced in Single Stage Ac or Dc converters [5]-[10]. Initially by dividing control scheme and few switches in a circuit, Dc/Dc stage and front end of PFC stages were integrating and operations are performed in Single Stage. An inductor or capacitor, unit of energy storage are present in center of two stages, acts as a power buffer and gives good time. This circuit exactly operates in Discontinuous Conduction Mode (DCM) for simple PF control. For input current shaping and output voltage regulation, Switches are suffered from more current or voltage stresses and its power level is not more than 200W. In many researches, more focus on average to maximum power applications, in Single Stage Full Bridge converter (SSFB). To reach high power factor, current shaping inductor is spread out by current fed SSFB converters and it is connected to input of Diode Bridge. Dc bus voltage is beyond mark because in Transformer, Dc bus capacitors are present in the primary side. Due to the high amplitude in output voltage, the frequency is doubled and its operation also within the limit. In a Dc bus, high value capacitor is present on primary side.

light Load situation Dc bus voltage is high, output regulation and input current shaping are done in a single controller. In Discontinuous Conduction Mode, above mentioned converter’s output current ripple is very high and operation becomes transient. Switches are unprotected due to high voltage pressures, in double Level SSFB converters. But in multilevel converters, the voltage pressures across the Switches are highly reduced. Range of the Dc link voltage is in between 400V to 800V. In a Discontinuous Conduction Mode, input current is adjusted with constant duty cycle because to decouple the dc bus voltage and output voltage controllers. Bottom Switches are simultaneously transfers energy from Dc bus to output and shapes the input current. In the center of separate Dc bus capacitor two Diodes are connected because to protect input current.

II LITERATURE SURVEY

“A new regulation methodology for a buck-support info AC/DC converter”

A novel regulation methodology for a force element revised (PFC), disengaged AC/DC converter got from the reconciliation of a non isolated, two switch buck-support AC/DC converter with a segregated double dynamic scaffold DC/DC converter (2SSBDAB). This methodology, termed spasmodic driving/trailing edge (DLTE) tweak, serves to augment the obligation cycle of the information switch while keeping the current in the buck-support inductor broken. Thus, the peak components of the streams in the exchanging gadgets are minimized, the info switch is turned on at zero current and the zero-voltage exchanging scopes of the scaffold switches are unaffected by the coordination. A traditional detached, PFC AC/DC converter ordinarily comprises of a help converter fell with a forward converter. The evaluations required of the force exchanging gadgets of the 2SSBDAB utilizing the DLTE tweak methodology are like those required of the traditional outline for wide line voltage operation. In any case, the 2SSBDAB converter has higher line voltage surge resistance than that of the routine configuration and,
dissimilar to the customary outline, it has characteristic inrush current constraining.

“A Single-Switch AC/DC Fly-back Converter Using a CCM/DCM Quasi-Active Power Factor Correction Front-End”

The significant issues that exist in the single-stage air conditioning/dc converters with force element remedy (PFC) and present a novel converter in view of a semi dynamic PFC plan. Two extra windings twisted in the transformer of a traditional dc/dc flyback converter are utilized to drive and accomplish ceaseless current mode operation of an info inductor. Furthermore, coordinate vitality exchange ways are given through the extra windings to enhance the change proficiency and to lessen the dc transport capacitor voltage underneath 450 V for widespread line applications. The proposed converter can be effectively intended to consent to IEC 61000-3-2 Class D necessity and to accomplish quick yield voltage direction. By legitimately tuning the converter parameters, a great tradeoff between effectiveness, dc transport capacitor voltage anxiety, and symphonious substance can be accomplished.

III BLOCK DIAGRAM AND OPERATION

The proposed converter is essentially an integrated version of a boost PFC circuit and three-level isolated dc–dc converter. Basically, a diode bridge and an inductor are added to the three level isolated dc–dc converter topology. The proposed converter exhibits high PF with less number of switches/diodes. With the proposed converter and switching scheme, input current shaping and output voltage regulation can be achieved simultaneously without introducing additional switches or switching actions.

A. BLOCK DIAGRAM

![Fig.3.1 three level isolated single stage PFC converter.](image)

B. MODES OF OPERATION

**Mode I**

This mode is valid for t0 to t1. Switch S1 and Switch S2 are ON and diode D8 conducts at the auxiliary side of Transformer. Applying $-\frac{V_{dc}}{2}$ to primary side of the Transformer, the capacitor $C_{dc1}$ discharges to the load and $V_{L0}=\frac{V_{dc}}{2N}\cdot V_{0}$.

**Mode II**

This mode is valid for t1 to t2. Switch S1 is OFF and Switch S2 is remains ON and diode D5 conducts. Across the Primary side of Transformer zero voltage is applied and current freewheels. Output voltage of inductor is equivalent to $-V_{0}$ and output current of inductor is reduces straightly.

**Mode III**

This mode valid for t2 to t3, Switch S2 and Switch S3 both are ON, that time primary side of current is continuous to freewheel and zero voltage is on primary side. Under output voltage, output current of inductor is continuously decreases. That time $V_{in}$ connected crosswise over $L_b$ and energy is stored in the inductor.

**Mode IV**

This mode valid for t3 to t4, Switch S3 is OFF and Switch S4 conducts. Across the Primary side of Transformer zero voltage is applied and current freewheels. Output voltage of inductor is equivalent to $-V_{0}$ and output current of inductor is reduces straightly.

![Fig.3.2. Switching operation](image)
This mode valid for t3 to t5, Switch S2 is OFF and Switch S4 and S3 are ON. Stored energy in the inductor, transfers the energy to the Dc link capacitor. In between Vin - Vdc inductor current decreases straightly, that time Vdc/2 is applied to the primary side of the Transformer. In leakage inductance, current is transferred to Cdc2 in this situation output current flows from D8 to D7. At t=t5 stored energy in Lb is transferred to the dc link and at t=t6 current flows from D8 to D7 is finished.

Mode V

This mode valid for t5 to t6. Switch S3 and Switch S4 are ON and diode D7 conducts. That time Cdc2 is discharges and Vdc/2 is used in primary side of the Transformer. In output inductor voltage is VL0=Vdc/2N-V0. In a discontinuous conduction mode input current always at zero.

Mode VI

This mode is valid for t6 to t7. Switch S4 is OFF and Switch S3 is ON. Both diode D6 and D7 are conducts and D6 allows leakage current to freewheel. Under \(-V0\) output current is decreases.

Mode VII

This mode is valid for t7 to t8. Switch S2 and Switch S3 are ON. Input side of energy is stored in inductor and its operation is same as mode 3. Excluding that in mode 3 primary side current is opposite.

Mode VIII

This mode valid for t8 to t10. Switch S3 is OFF; both Switch S1 and Switch S2 are ON. Its operation is same as mode 4. In inductor energy is stored and that energy transferred to Dc bus capacitor. In this situation output current of inductor flows in between D7 and D8.
The proposed converter is utilized for the straightforward circuit structure development for the powerful thickness application. The proposed idea is further can be utilized as the consistent dc voltage is required, whether it can be a lattice, dissemination or transmission framework. Since the extent of the converter got lessened the proposed converter goes about as the all the more proficiently and less warmth misfortunes where space of the execution required less.

VI CONCLUSION

In low power applications we can use this three level Single Stage PFC converter. In this paper shows in a constant duty ratio how high Power Factor will be achieved by using minimum number of Diodes or Switches. The switching operation is modified and consistent with Single Stage operation by adding Diode Bridge and inductor to Three Level Dc to Dc converter. By using lower PFC inductor, ripple frequency of input current is double of the Switching frequency. The design and control of the circuit is solved by regulating output voltage and shaping input current. By changing the De link voltage from 400V–800V, line voltage will be within 265V and Power Factor will increase from 0.88 to 0.99.

VII REFERENCES


