Analysis of Zero Voltage Switching, Power Factor Correction for four switches Three Phase Three Level Boost Rectifier

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Abstract: Analysis of zero voltage switching PFC (power factor correction) for four switch Three Phase Three Level Boost Rectifier introduced for achieving less input current and less respective total harmonic distortion (THD). By using four switches, phenomenon also achieved two low output nd one common output for the three different application at the same time using 340 volt Vl-L input voltage and also achieved unity power factor.

Keywords: power factor correction, boost rectifier, ZVS, ZCS, EMI.

1. Introduction

Actually the analysis of the three phase boost rectification is typical, but after the analyzing of this simulation model technique it is easily done. Previously Zero voltage switching power factor correction for three phase three level boost rectifier introduced which gives the path to design this SIMULINK model.

For high voltage application, this model helps to easily analyze the changes in input current at full load and different switching states.

This model achieve less input current over high output voltage and also less correspondence THD ie. < 3% at over the 10 to 12% output voltage.

The balancing output achieved by using the balancing capacitive load, connects two capacitors in series at load for balancing the output voltage. This gives two lower output and single common high voltage. Here also use the clamping diodes performance which clamp the output and help for the input power factor correction. Because of the clamping phenomenon the clamping noise occur which effect the input current, so eliminating this type noise EMI (Electromagnetic interference) filter use hare.

EMI filter is usually a capacitor inductor topology for handling this type of disturbances in input current.

Transformer of EMI actually uses for the dot convention performances so the same winding resistance and should be the same winding voltage of each winding use here

2. Proposed Block Diagram

The figure shows the three phase three level model of ZVS PFC BOOST rectifier proposed modal. In the circuit see the 3 phase input given to the EMI filter for avoiding the clamped noise. And then the input given to the Rectifier which is control by the four switches. Switches can be performed by the PWM method. Than the output of the rectifier is connected with the clamped capacitors’ that connected in series. Connect the load across these capacitors and measure the output voltage.

3. Simulink Model and Analysis

The zvs pfc for three phase three level boost rectifier SIMULINK model present in figure 3 . C1, C2 and C3 are the three capacitors connected in Y (star connection) In this model and this connection create a neutral point. The neutral point once connected with middle of pairs of switches and middle of output capacitors also. Which helps the balancing the output voltage.

Cₜ (Clamping capacitor) connected across the switches. take two winding linear transformer having same winding voltage and same resistance of the winding For clamped inductor. Cᵣ is the reset capacitor that use for reset the
inductor current connected with pair of switches serially. $C_{o1}$ and $C_{o2}$ the output capacitors.

By figure 4(a) saw when the switch $S_1$ and $S_2$ on inductor current $i_{L1}$ flows from inductor $L_1$, $S_1$ and $S_2$ the $i_{o1}$ flows through $V_{o1}$ and switches capacitor $V_{cc}$ will charged. After some time switch $S_2$ will turned off then than the $V_{cc}$ going to discharged and current flows from $S_2$, $S_3$. the measured current peak of $i_{L1}$ is equal to $V_{AN}/L_1$.

When the diode $D_{c1}$ is forward biased than the current $i_{L1}$ decreases linearly then the current calculated by equation,

$$i_{L1} = V_{AN} - (1 - 2D)V_{o1} \frac{T_S}{2L_1}$$

After some time the switch $S_1$ also off. After some delay the switch $S_3$ and $S_4$ are on fig 4(b). This phenomenon actually for the negative half cycle for the rectifier. At this time current $i_{L2}$ and $i_{L3}$ flows through to the inductor $L_2$ and $L_3$ and also the current going to the $V_{o2}$ side.

When the diodes $D_{c2}$ and $D_{c3}$ are forward biased than the current $i_{L2}$ and $i_{L3}$ are simultaneously increases linearly.

$$i_{L2} = -V_{AN} + (1 - 2D)V_{o2} \frac{T_S}{2L_2}$$

4. Switching Operation MOSFET

In the modal take the PWM method for switching performance. The figure-4 shows the switching phenomenon of the MOSFET When the $S_1$ is ON then the $S_2$ also ON for some instantaneous of time, then it will OFF.

![Figure 2: Switching pulses for the MOSFET switches](image)

![Figure 3(a)](image)

![Figure 3(b)](image)
Fig 3- analysis of the modal fig-3(a) and 3(b) for the switch operation of S1, S2, S3 and S4. figure 4 shows the simulation switching model for the MOSFET switches.

5. Simulink Results

The results of the matlab simulink model was evaluated on 340V_{LL} voltage where the C1,C2 and C3 are 2.2\mu F, L1, L2 and L3 are 89\mu H. D1-D6 taking the simple ratings and the diodes D7 and D8 having high snubber value.
Figure 5 shows the input current I₁, I₂, and I₃ waveforms of simulink result in scope at full power at 340V_L-L voltage.

Figure 6: Measured DC output at 340V_L-L input voltage.

Figure 6 shows the output power at full load in voltage 340V_L-L having 96% of efficiency. Figure shows the measured three level input voltage change by corresponding output voltage.

Figure 7 the three phase input current (Iₐ, I₋, and I₃) THD of the input current achieved less then 3% total harmonics reduction level by the SIMULINK modal shows by figure.

6. Conclusion

In this paper presented Analysis of Zero Voltage Switching, Power Factor Correction for four switches Three Phase Three Level Boost Rectifier using four switch (PWM) operation simulink modal. Voltage across the each switch measured one half of its value was clamped with output voltage. By SIMULINK results achieved less than 5% input current total harmonic distortion over the given input and achieved above 10-30% load. The total performance and assumption done by MATLAB new version at 340 line to line voltage. Achieved 94% efficiency with full load.

References


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