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Three Level Neutral Point Clamped Inverter using Space Vector Modulation with Proportional Resonant Controller

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Abstract

Renewable energy is spreading in various format of supplying electricity such as in domestic purposes, grid integration, power generation and hybrid vehicle. Grid integration is one of the aspect is a necessary concern. This paper elaborates the control strategy installation necessary for grid integration. Most of the time, conventional inverters are used but in this paper the new multilevel inverter control strategy is taken for various purposes including cost, simple construction and less losses. This paper introduces a three level NPC inverter which uses space vector modulation for pulse generation. Three level NPC inverter contributes many benefits such as power quality improvement, reduction in harmonics, lower cost and improved efficiency. This document involves a novel control strategy with voltage oriented control using PR controller which helps the system to cope up the difficulties of the grid transmitting energy.

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Keywords: Three Level NPC inverter; PR controller; Space Vector Modulation; Power quality improvement; Grid integration.

1. Introduction

Technology now-a-days is changing as it is seen in few decades. Now the industries are reliable on long lasting clean energy sources. The most complicated phenomenon to be considered when using an economic, clean energy source is the efficiency and cost of the inverter [1]. As the conventional inverters have lot of problems compared to the upgraded inverters, so it is preferable to use multilevel inverters. In that case, the multi level inverters development is necessary. The policy that every industry believes is to make the technology compact and to increase the efficiency which will result in reduction of cost. To do so it is necessary to develop multilevel inverters. Now the industries are reliable on long lasting clean energy sources. The most complicated phenomenon to be considered when using an economic, clean energy source is the efficiency and cost of the inverter [1]. As the conventional inverters have lot of problems compared to the upgraded inverters, so it is preferable to use multilevel inverters. In that case, the multi level inverters development is necessary. The policy that every industry believes is to make the technology compact and to increase the efficiency which will result in reduction of cost. To do so it is necessary to develop multilevel inverters. Considering the fact that the multilevel inverters are more reliable than the conventional inverters, it is required to use insulated gate bipolar transistors (IGBTs) which are used for the purpose of switching. The probable development of IGBTs makes a difference in implementing the multilevel inverters [2, 4]. In recent years, the multilevel inverters gave the benefits of changing

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the voltage level and power ratings drastically. This makes the system compact which leads to the advantages of implementing such a topology. The advantages of such inverters cover the ride through capability problems, a substantial design development, dynamic performance improvement, large operating range of voltages and reduction in harmonics [1, 4]. The multilevel inverters have three different topologies dictated as neutral point clamped H-bridge and flying capacitors inverters [1]. Among these inverters, the NPC inverters have gain the attention and became the mostly implemented inverter for the clean energy sources.

This paper briefs about the implementation three level NPC inverters that are to be implemented on different control strategies. In this paper, the NPC inverter with respect to the space vector modulation technique is implemented.

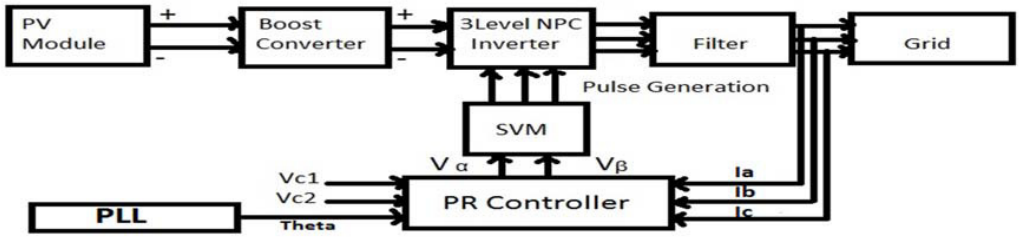

Fig 1. Proposed Model

This paper is focusing on increasing the efficiency as well as reduction in harmonics [4]. Most attention is paid towards implementing the SVM technique on three level NPC inverters.

1.1. Three Level NPC Inverter

The three level NPC topology consist of 12 switches including 6 diodes. It is necessary to connect two capacitors in series both charged with Vdc [1]. Each phase led contains 4 series switches with two diodes clamped in series. The main function of the diodes is to clamp the upper switches at higher potential to the zero dc-link point. A particular switching pattern will give the output of three level NPC inverter [4].

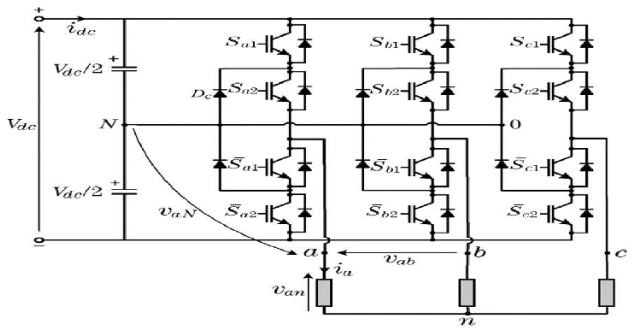

Fig 2. Three level NPC inverter

The circuit diagram shown above in fig 2 gives idea about the arrangement of the power circuit required for the three level NPC inverter. In this circuit, the diodes are arranged in such a way that it yields different stages of voltages with respect to neutral point N. The splitting of the voltage level is considered according capacitors C_1 and C_2 arranged in series with each other having neutral point N in between them. The division of voltages are obtained as Vdc/2, 0, -Vdc/2. So it is named as three level topology [1].

In this topology, the switches Sa_1 and Sa_2 are turned ON giving Vdc/2. For –Vdc/2, switches Sa1' and Sa_2' are switched ON and for 0, Sa_1' and Sa_2 are necessary to turned ON. This power circuit will then give the three level topology. The difference between the conventional inverter and the three level topology is that diodes used for the purpose of splitting the voltages. The dc bus voltages level gets half as the diode D_1 and D_1' are used. When switches Sa_1 and Sa_1' turn ON the voltage across a and 0 is Vdc. In this case, diode D_1' balance the voltage sharing between Sa_1' and Sa_2'. Sa_1' helps blocking the voltage across C_1 and Sa_2' helps blocking the voltage across C_2 [1]. It is observed that the voltage across Van is AC while Vao is DC. So while considering a and 0, when the output is removed, the circuit will act like a dc-dc converter.