EE-312L Power Electronics

Project Multilevel Inverter Inverters

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Chapter 1

Abstract

Multilevel Inverters has developed as a significant substitute in the field of high and medium power industrial applications. The multilevel inverters exhibits several intrinsic advantages over traditional two level inverters such as reduced voltage stress, reduced rating of devices, and good quality of output Power. Even though Classical topologies of multilevel inverter are still utilized in most of the key areas, the cascaded multilevel inverter is considered to be the most important power converter as it is able to produce medium power output voltages with low voltage configuration of components. The cascaded multilevel inverter with reduced number of overall switch counts is an essential objective in the emerging topologies nowadays. In this paper, a comprehensive analysis of latest cascaded multilevel inverters with reduced number of switches has been reviewed and analysed. This paper will exemplify the introduction, and the qualitative parameters of these topologies. In this project a detailed exploration of various topologies of 5 level, 7 level 9 level cascaded multilevel inverter.

Chapter 2

Introduction

The cascaded H-bride multilevel inverter is to use capacitors and switches and requires less number of components in each level. This topology consists of a series of power conversion cells and power can be easily scaled. The combination of capacitors and switches pair is called an H-bridge and gives the separate input DC voltage for each H-bridge. It consists of H-bridge cells and each cell can provide the three different voltages like zero, positive DC, and negative DC voltages. One of the advantages of this type of multilevel inverter is that it needs less number of components compared with diode clamped and flying capacitor inverters. The price and weight of the inverter are less than those of the two inverters. Soft-switching is possible by some of the new switching methods. Multilevel cascade inverters are used to eliminate the bulky transformer required in case of conventional multiphase inverters, clamping diodes required in case of diode clamped inverters and flying capacitors required in case of flying capacitor inverters. But these require a large number of isolated voltages to supply each cell.
At the beginning of the project the problem was arose regarding components soldering on the circuit board.We had to be extra careful while soldering because the components of the circuit are placed adjacent to each other with minimum spacing.It took us few hours to correctly place every component.

1 Motivation

There are number of research on cascaded H-bridge inverters. 5-level, 7-level and 9-level inverters are the first first step to make a proper purely sinewave giving inverter. When we see more and more levels, the more the output becomes more AC. Which means that we are getting good results of our inverter. We have used tlp250 octocoupler which plays an important role in this project.Several problems with the H-bridge inverters have been identified.
The main aim in this project was to learn working of cascaded H-bridge inverters. We had to get the output of LSMCPWM and PSMCPWM 5-level, 7-level and 9-level.

2 Problem Statement

Consider a single phase cascaded H-bridge multilevel inverter.The inverter is being fed by two independent DC voltage sources V1 and V2. The output of first stage is vH1 whereas the output of second stage is vH2.The total voltage between terminal A and N is vH1 + vH2. The PWM for each MOSFET (Switch) is decided by tracking the path of voltage sources to the output terminals for desired voltage level. A two stage cascaded H-bridge multilevel inverter can have 5-level, 7-level or 9-level output voltage depending on the magnitude of both voltage sources.

Chapter 3

Literature Review

In recent years, multilevel inverters have gained popularity with medium and high power ratings. Renewable energy sources such as photovoltaic, wind, and fuel cells can be interfaced to a multilevel converter system. Many multilevel converter topologies have been proposed during the last two decades. Research has engaged novel converter topologies and unique modulation schemes. The three types of multilevel converter structures reported in the literature are: cascaded H-bridge converter with separate dc sources, diode clamped (neutralclamped), and flying capacitors (capacitor clamped). Modulation techniques and control paradigms have been developed for multilevel converters such as sinusoidal pulse width modulation (SPWM), selective harmonic elimination (SHE-PWM), space vector modulation (SVM), and others. Many, multilevel converter applications include industrial medium-voltage motor drives, renewable energy systems with utility interface, flexible AC transmission system (FACTS), and traction drive systems. The common multilevel converter topologies are the neutral-point-clamped converter (NPC), flying capacitor converter (FC) and Cascade H-Bridge (CHB) have developed from last two decades. Multilevel inverters are best for medium and high power applications.
Cascaded H-bridge multilevel inverter can be implemented using only a single dc power source and capacitors.

Chapter 4

Software Implementation

The circuits were simulated in MATLAB Simulink. The screenshots of circuit and output are as follows:

1 Phase Shifted Carrier Based PWM (PSCPWM)

1.1 5 level

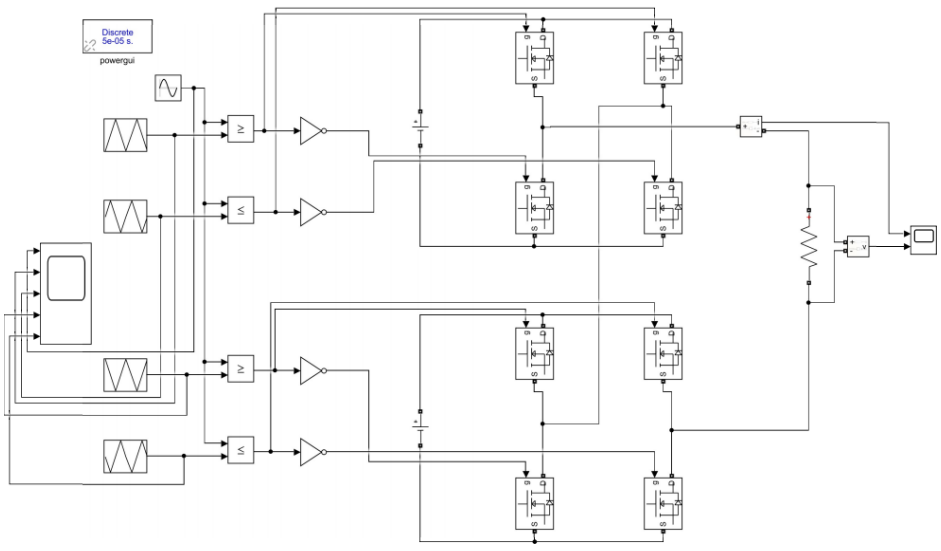

Figure 4.1: Circuit Diagram in Simulink for PSCPWM 5 level

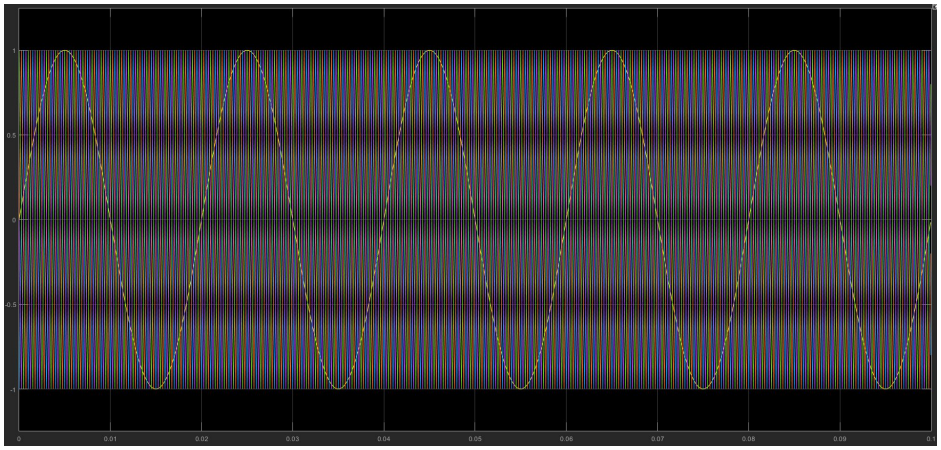

Figure 4.2: Input for PSCPWM 5 level

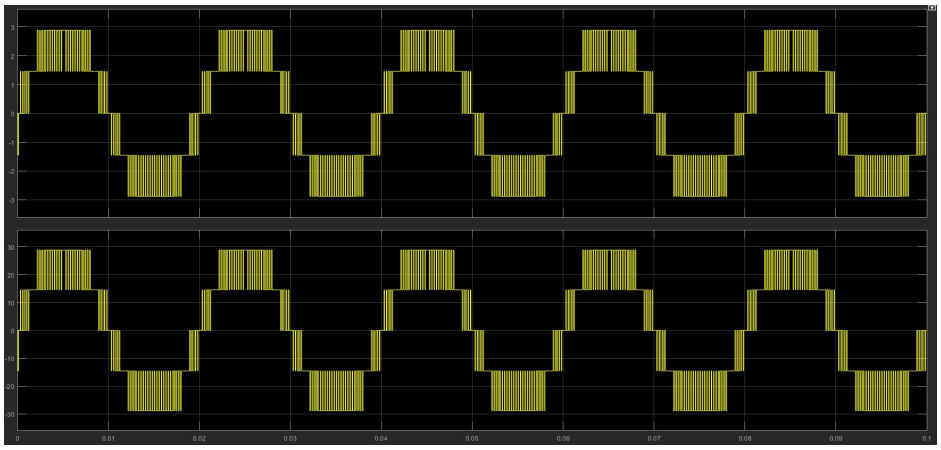

Figure 4.3: Output for PSCPWM 5 level

1.2 7 level

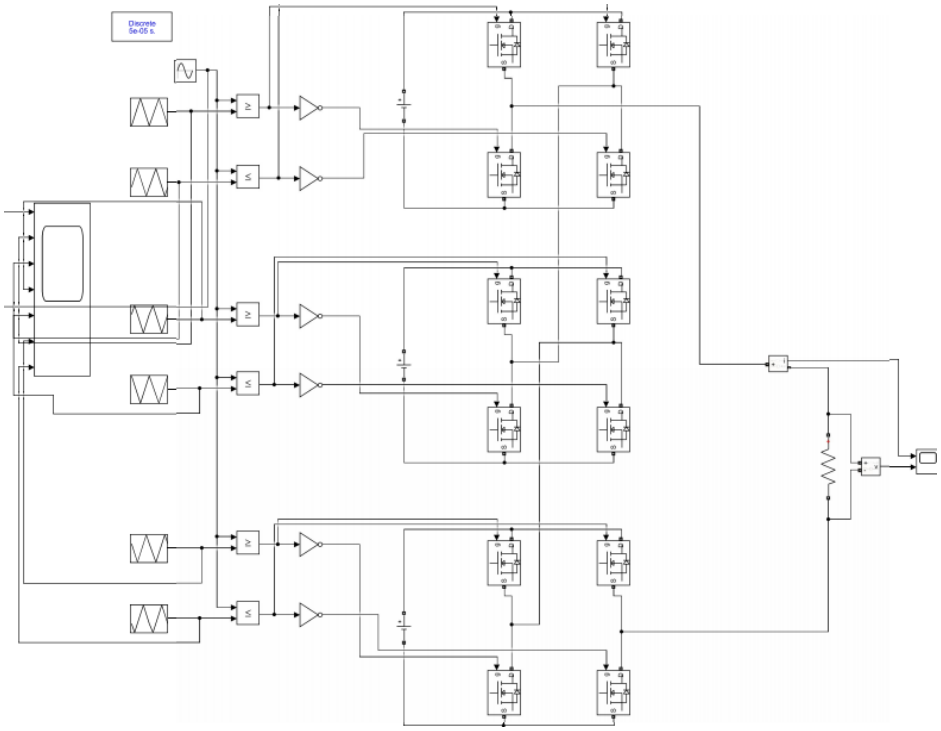

Figure 4.4: Circuit Diagram in Simulink for PSCPWM 7 level

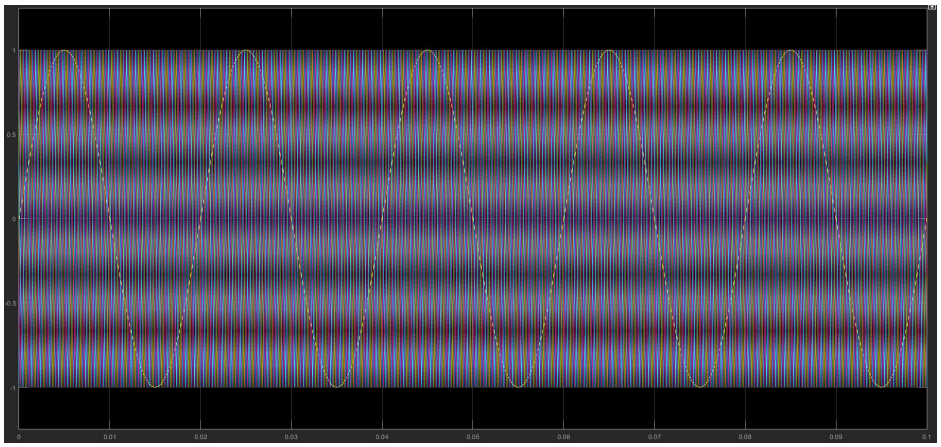

Figure 4.5: Input for PSCPWM 7 level

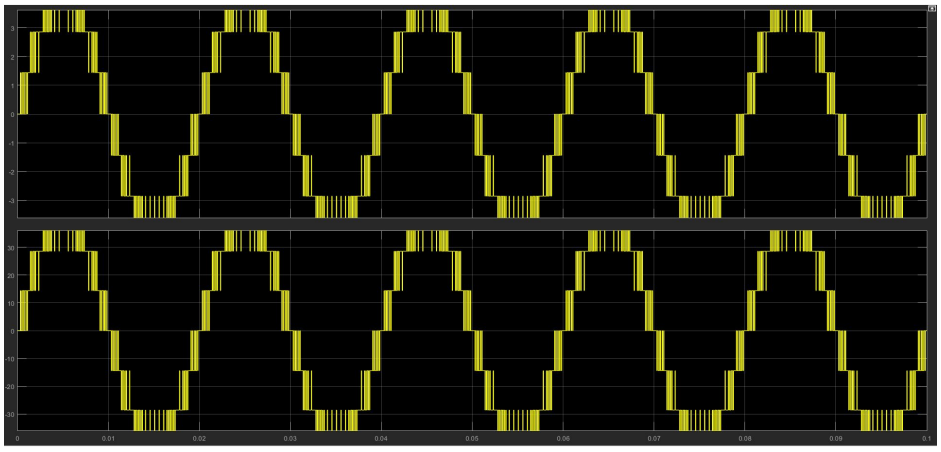

Figure 4.6: Output for PSCPWM 7 level

1.3 9 level

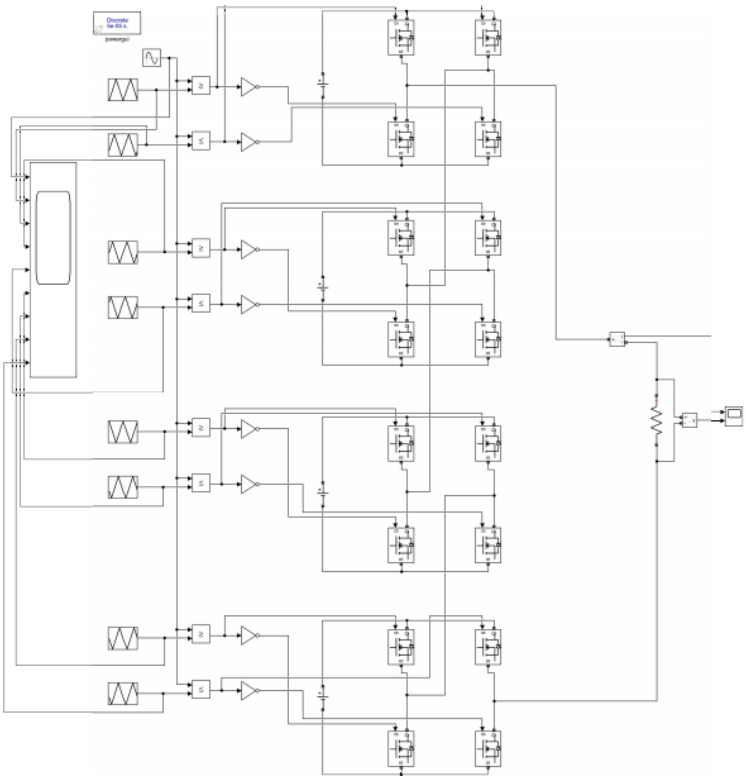

Figure 4.7: Circuit Diagram in Simulink for PSCPWM 9 level

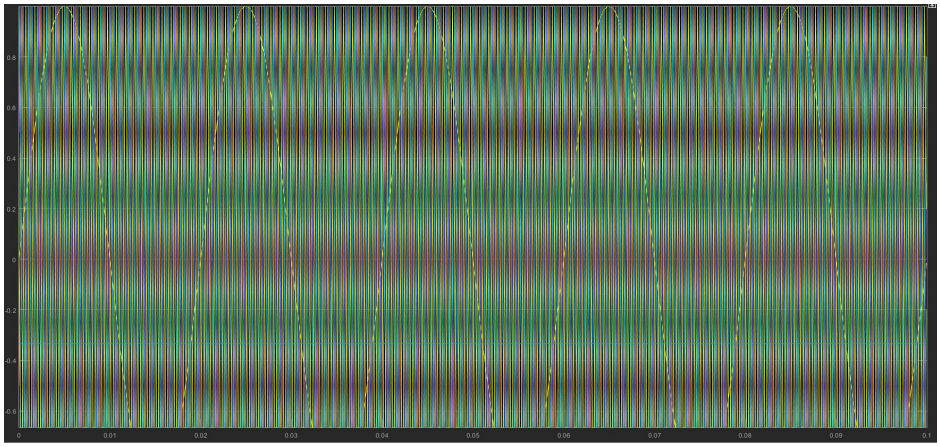

Figure 4.8: Input for PSCPWM 9 level

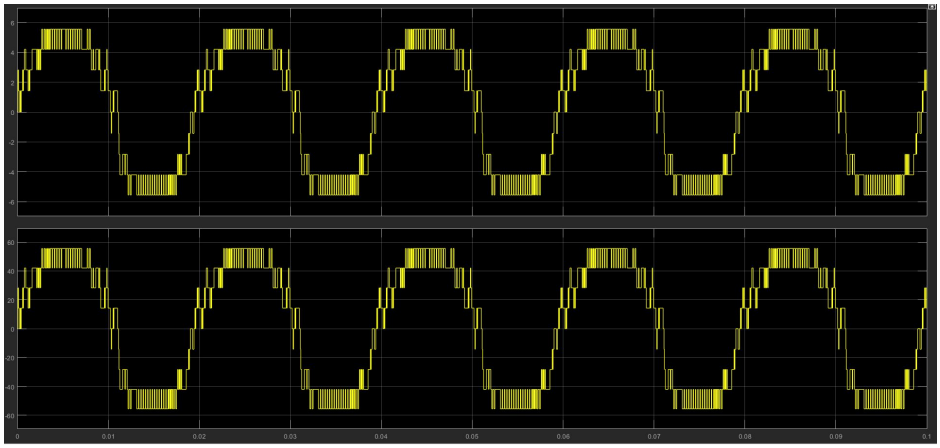

Figure 4.9: Output for PSCPWM 9 level

2 Level Shifted Carrier Based PWM (LSCPWM)

2.1 5 level

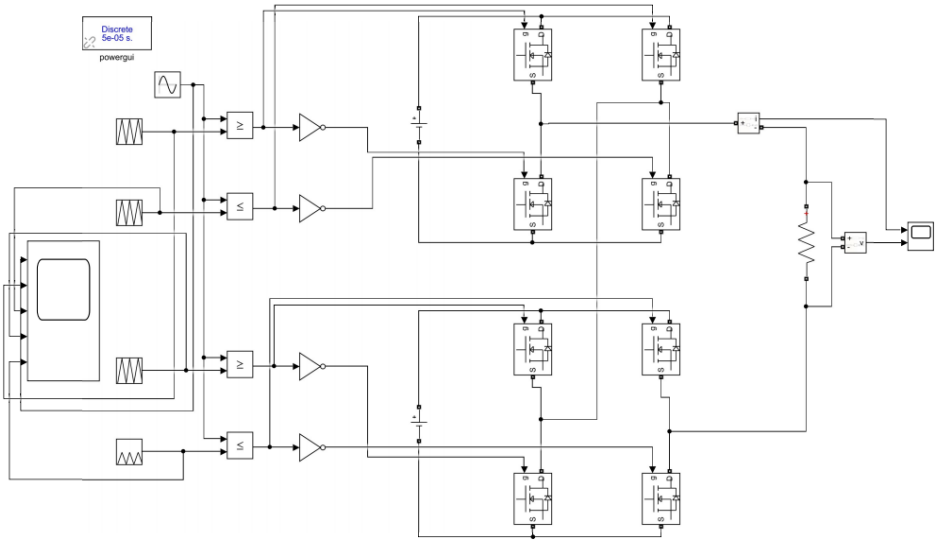

Figure 4.10: Circuit Diagram in Simulink for LSCPWM 5 level

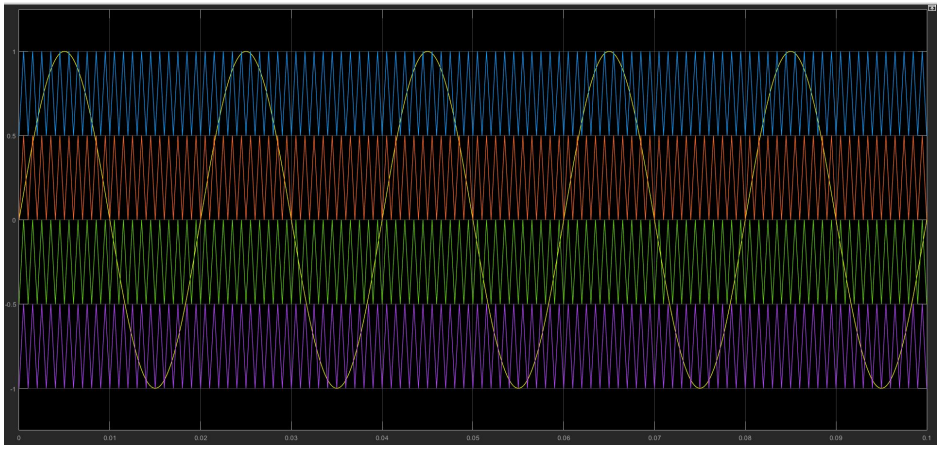

Figure 4.11: Input for LSCPWM 5 level

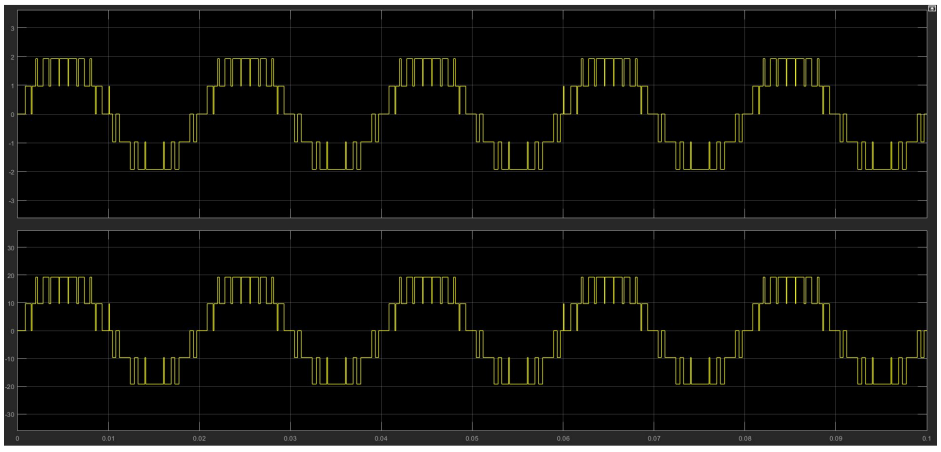

Figure 4.12: Output for LSCPWM 5 level

2.2 7 level

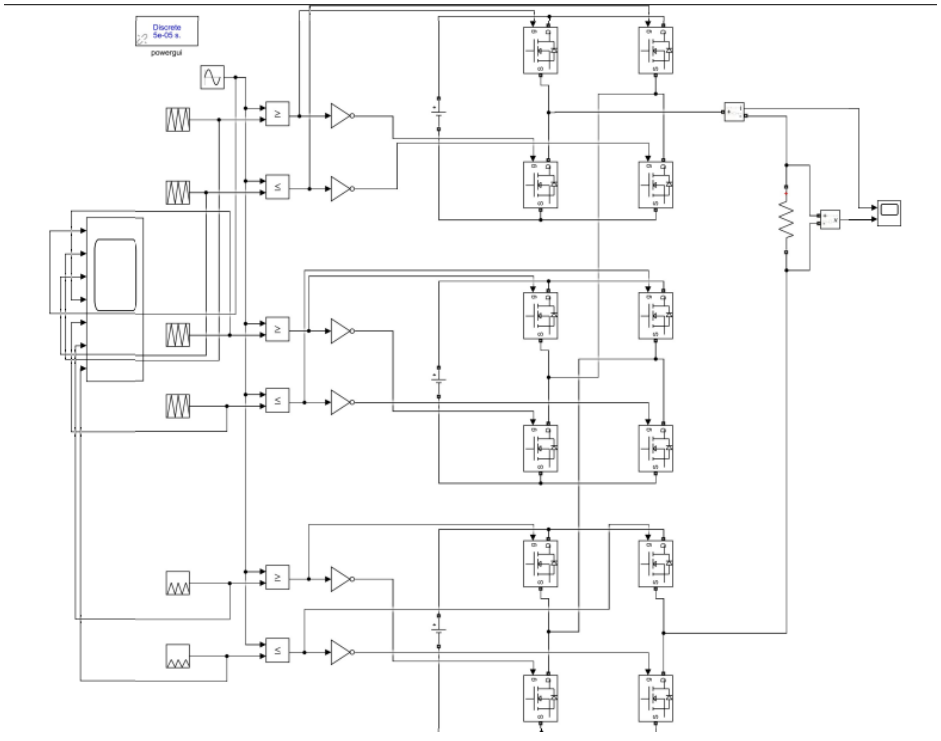

Figure 4.13: Circuit Diagram in Simulink for LSCPWM 7 level

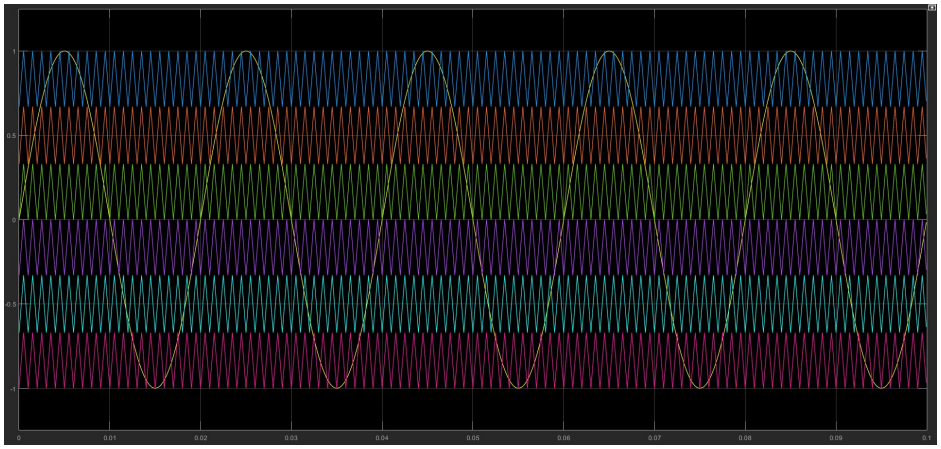

Figure 4.14: Input for LSCPWM 7 level

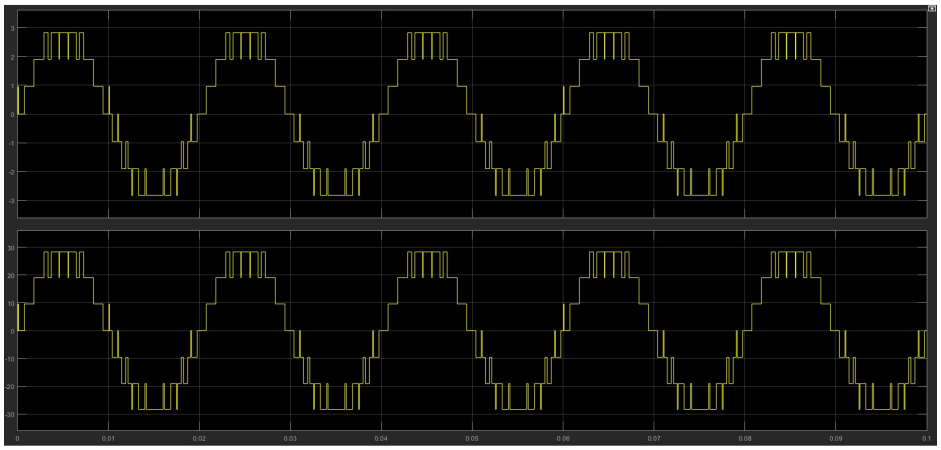

Figure 4.15: Output for LSCPWM 7 level

2.3 9 level

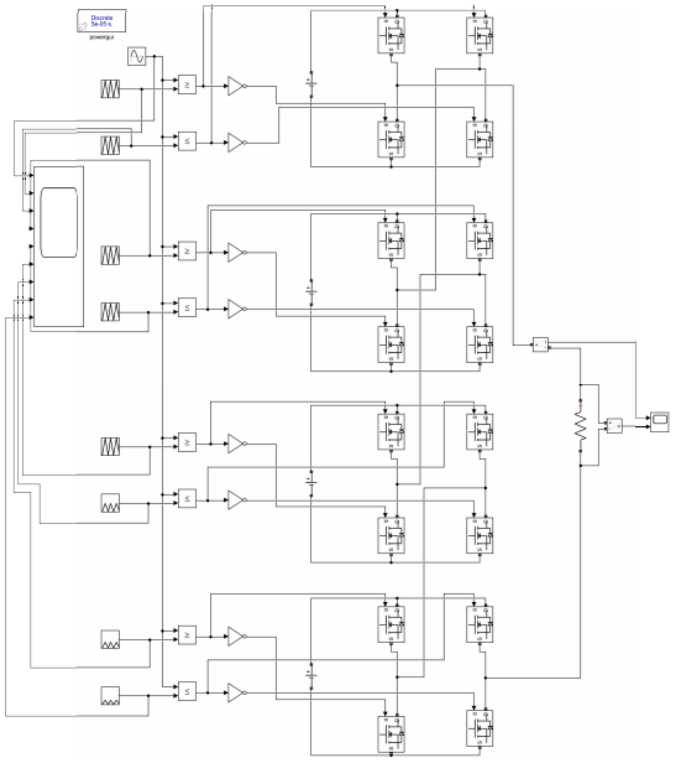

Figure 4.16: Circuit Diagram in Simulink for LSCPWM 9 level

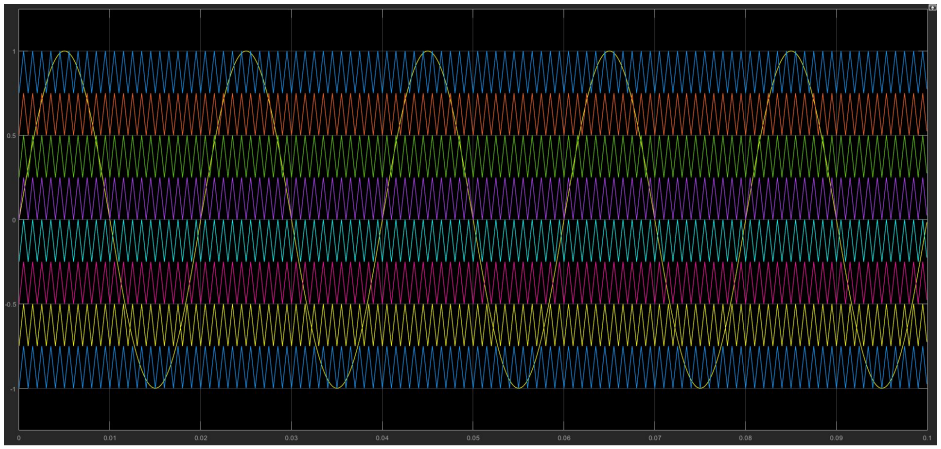

Figure 4.17: Input for LSCPWM 9 level

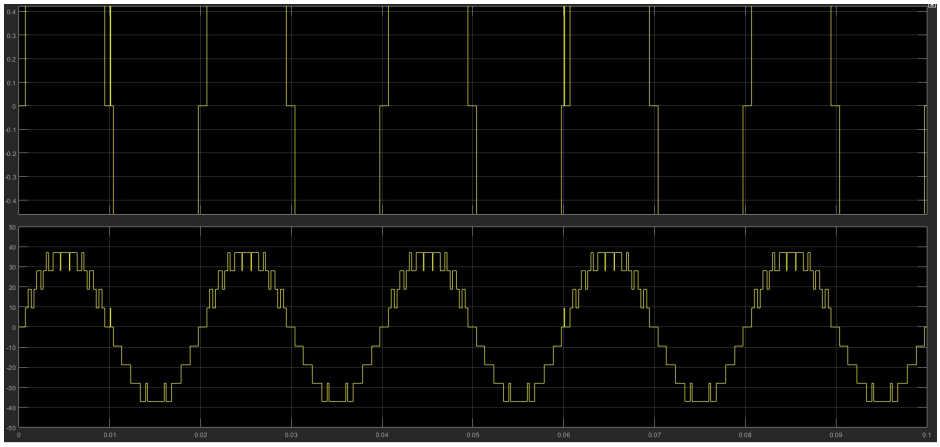

Figure 4.18: Output for LSCPWM 9 level

Chapter 5

Hardware Implementation

1 PCB hardware picture

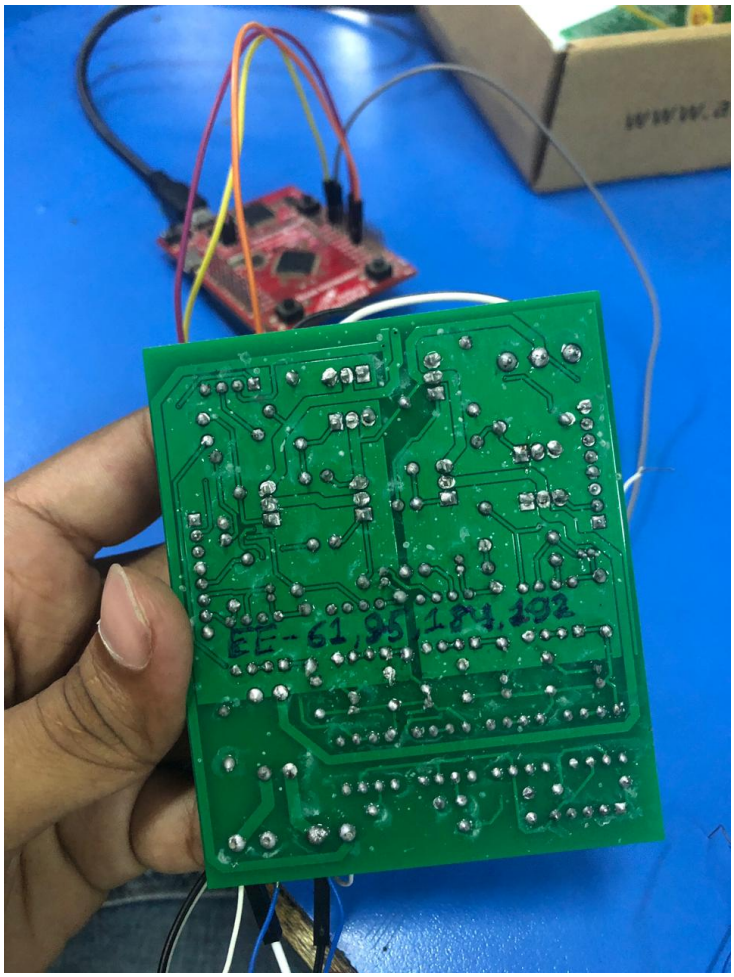

Figure 5.1: Hardware-back

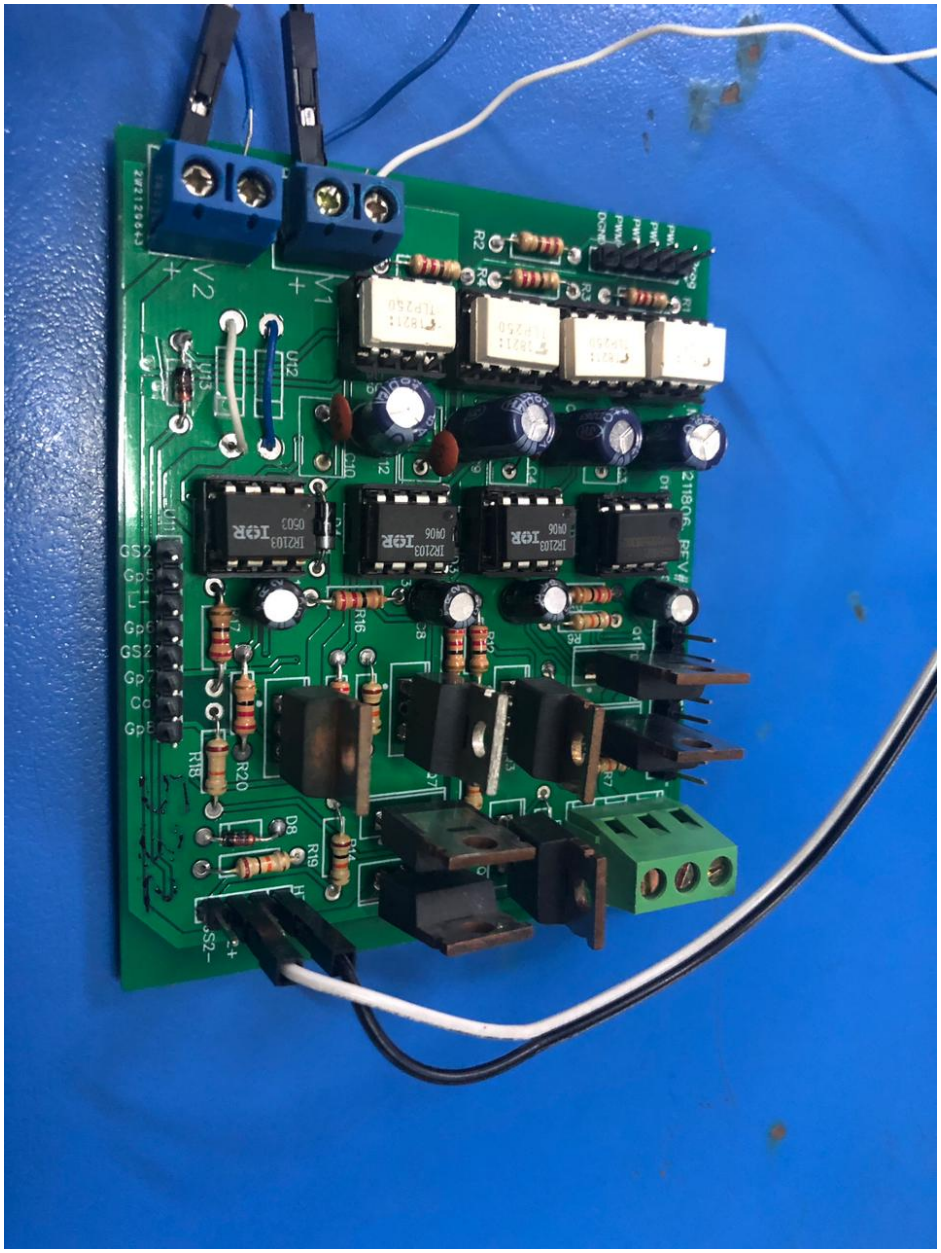

Figure 5.2: Hardware-front

2 Hardware Video Link

https://drive.google.com/file/d/1DasTcqgbAHbQ-pj51t$_t$$wFGN_hCSk8BW/view?usp = sharing$

Chapter 6

Results and Discussion

Many industrial applications have begun to require highpower. Some appliances in the industries, however, require medium or lowpower for their operation. Using a high power source for all industrial loadsmay prove beneficial to some motors requiring high power, while it may dam-age the other loads. Some medium voltage motor drives and utility appli-cations require medium voltage.The multi-level inverter has been introducedsince 1975 as an alternative in high power and medium voltage situations.TheMultilevel inverter is like an inverter and it is used for industrial applicationsas an alternative in high power and medium voltage situations.A multilevel inverter is a power electronic device which is capable of provid-ing desired alternating voltage level at the output using multiple lower levelDC voltages as an input.The cascaded H-bride multilevel inverter is to use capacitors and switchesand requires less number of components in each level. This topology consistsof a series of power conversion cells and power can be easily scaled. Thecombination of capacitors and switches pair is called an H-bridge and givesthe separate input DC voltage for each H-bridge. It consists of H-bridge cellsand each cell can provide the three different voltages like zero, positive DC,and negative DC voltages. One of the advantages of this type of multi-levelinverter is that it needs less number of components compared with diodeclamped and flying capacitor inverters. The price and weight of the inverterare less than those of the two inverters. Soft-switching is possible by someof the new switching methods.Multilevel cascade inverters are used to eliminate the bulky transformerrequired in case of conventional multi-phase inverters, clamping diodes re-quired in case of diode clamped inverters and flying capacitors required incase of flying capacitor inverters. But these require a large number of iso-lated voltages to supply each cell. Example: 5- H-bridge multilevel inverter,9- H-bridge clamped multilevel inverter.Applications of Cascaded H-Bridge Multilevel Inverter are Motor drives,Activefilters,Electric

vehicle drives,DC power source utilization ,Power factor com-pensators,Back to back frequency link systems Interfacing with renewableenergy resources.

Chapter 7

Conclusions and Future Works

The use of multilevel inverter in PV system was accepted in power systemsince it gave a lot of advantages. More number of levels of multilevel inverter will give better performance in the system.The five-level inverter can perform the functions of regulating the dc bus volt-age, converting solar power to ac power with sinusoidal current and in phasewith the utility voltage, balancing the two dc capacitor voltages, and henceovercome the main limitations of the conventional power electronic interfacefor photovoltaic power generation system. Main advantages of proposed fivelevel grid connected PV inverter are,Less switching power loss,Reduced har-monic distortion,Simplified control circuit,Better power efficiency,Capacityof output filter can be reduced Cheaper, lighter and more compact.From the simulations and the results, 7- level multilevel inverter had givenmore efficient performance in terms of the power factor, THD and its effi-ciency than 5-level multilevel inverter.Similarly the 9 level multilevel inverterwill provide better perfoormance compare to level 5 level 7 inverters.Inverter are finding increased attention in industry and academia as one ofthe preferred choices of electronic power conversion for high power applica-tions. They have made their way successfully into industryand therefore canbe considered a mature and proven tech-nology. Currently, they are commer-cialized in standard and customized products that power a wide range of ap-plications,such as: compressors, extruders, pumps, fans, grinding mills,rollingmills, conveyors, crushers, blast furnace blowers, gasturbine starters, mixers,mine hoists, reactive power compen-sation, marine propulsion, HVDC trans-mission, hydro pumpedstorage, wind energy conversion, and railway tractionetc. The control technique for multilevel power converters can be furthersimplified and generalized to different levels and other class of power con-verters and inverters. The levels of multilevel configuration can be increasedand further improvements in terms of performance and power quality issues can be broadly

studied and could be implemented with hardware circuits

Chapter 8

References

https://core.ac.uk/download/pdf/26794478.pdf
https://www.elprocus.com/multilevel-inverter-types-advantages
https://engineering.electrical-equipment.org/electrical-distribution/cascaded-h-bridge-multilevel-inverters.html
https://www.sciencedirect.com/science/article/pii/S2214785320391884
https://www.researchgate.net/publication/237843317$_{Ac}omparative_{s}tudy_{o}f_{5}-level_{a}nd_{7}-level_{m}ultilevel_{i}nverter_{c}onnected_{t}o_{t}he_{g}rid$