Simulation and Analysis of Efficient Multilevel Inverter for Solar Panel

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Abstract: *In recent years, multilevel inverters have gained more attention for high power applications. A multilevel inverter not only achieves high power ratings, but also enables the use of renewable energy sources. Single phase inverter is widely used for stand-alone systems and micro-grid application. The major limitation faced by multilevel inverters are, number of switches required large which leads to higher switching losses. There are many limitations in extracting power from renewable energy resources. To minimize the power demand and scarcity we have to improve the power extracting methods. Multilevel inverter can be used to extract power from solar cells. In these paper we work on design cascade (5 type, 7 type) multilevel inverter for increase performance of existing system and apply on grid with solar panel. It synthesizes the desired ac output waveform from several dc sources. The main objective of this paper is to study the 5-level and 7-level Cascaded Multilevel Inverter. In this paper the different parameters like voltage, current, THD in 5-level and 7-level Cascaded Multilevel Inverter and analysis on solar panel.*

Keywords: *Solar Panel, Multilevel Inverter, PWM Control, Renewable energy.*

1. INTRODUCTION

Among renewable energy sources, photovoltaic energy is one of the most considerable sources because of its advantages like being widely available and cost free, clean and abundant.

1.1 Current – Voltage Curve for PV cell

The Current – Voltage characteristic curve of a PV cell for a certain irradiance at a fixed cell temperature is shown in image-1. The current from a PV cell depends on the external voltage applied and the amount of sunlight on the cell. When the PV cell circuit is short, the current is at maximum and the voltage across the cell is zero. When the PV cell circuit is open, the voltage is at maximum and the current is zero.[12]

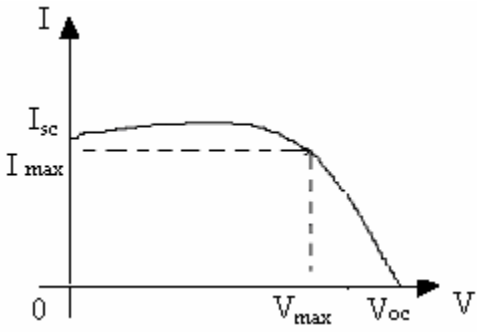

Image-1: Current – Voltage curve

1.2 Introduction to Multilevel inverter

The idea of multilevel Inverter is kind of modification of two level inverter. In multilevel inverters we don't work with the two level voltages as a replacement for in order to generate a smoother stepped output waveform, more than two voltage levels are combined

together. Smoothness of the waveform is directly proportional to the voltage levels, as we increase the voltage level, the waveform becomes smoother but the difficulty will be bigger.

Types of Multilevel Inverter:

Multilevel inverters are three types.

- Diode clamped multilevel inverter
- Flying capacitors multilevel inverter
- Cascaded H- bridge multilevel inverter

Cascaded H-bridge Multilevel Inverter Topology

A single-phase structure of 5-level cascaded inverter is illustrated in image-2. Each separate dc source is connected to a single-phase full bridge, or H-bridge, inverter.

The outputs of this H bridge blocks are connected in series in such way that the produced waveform of voltage is the sum of all of the individual block outputs. The output voltage of inverter is given by V = V1 + V2, Where the output voltage of the first H bridge block is V1 and the output voltage of the second H bridge block is V2. There are five level of output voltage i.e. 2V, V, -V, -2V and 0. Where the input dc source voltage is V.

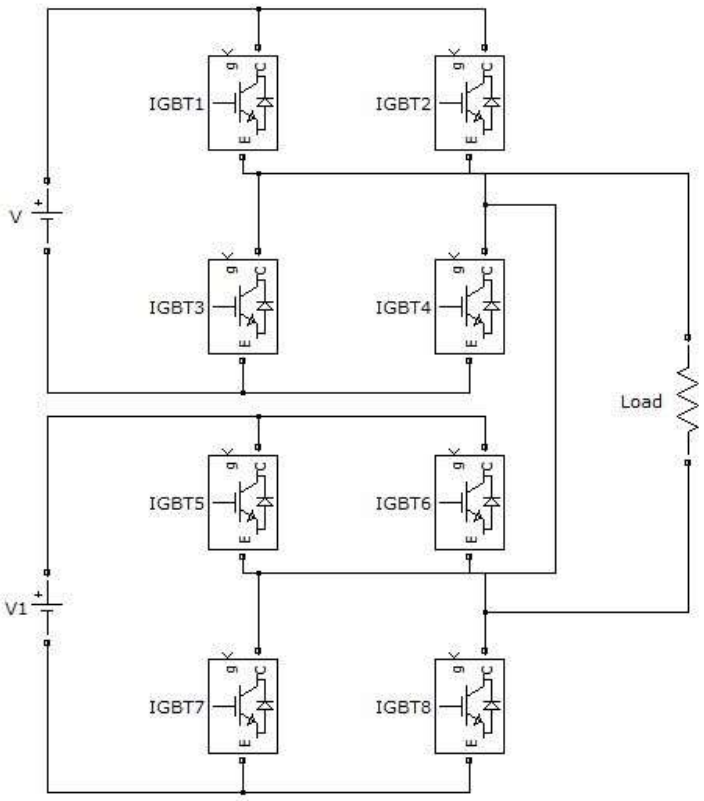

Image-2: Single-phase structure of 5 level cascaded H-bridge multilevel inverter

2. Pulse Width Modulation

Pulse-width modulation (PWM) is the basis for control in power electronics. The theoretically zero rise and fall time of an ideal PWM waveform represents a preferred way of driving modern semiconductor power devices.

Pulse width modulation is a technique in which a fixed input dc voltage is given to the inverter and a controlled ac output voltage is obtained by adjusting the on and off periods of the inverter components. This is most popular method of controlling the output voltage and this method is termed as pulse width modulation technique. PWM is an internal control method and it gives better result than an external control methods.

Types of PWM techniques

- Single PWM

In single pulse-width modulation control, there is only one pulse per half-cycle and the width of the pulse is varying to control the output voltage. The single pulse-width modulation converts the reference signal to the square wave signal.

- Multiple PWM

In multiple pulse-width modulation control, there is several pulses in each half-cycle of output voltage. The gating signals are produced by comparing reference signal with triangular carrier wave. The frequency of the reference signal sets the output frequency and carrier frequency determine the number of pulses per half cycle.

- Sine PWM

In single-pulse and multiple pulse modulation techniques the width of all pulses are same but in sinusoidal pulse width modulation the width of each pulse is varied in proportion to the amplitude of a sine wave. In this technique the gating signals are generated by comparing a sinusoidal reference signal with a triangular carrier wave.

3. PROPOSED SYSTEM

Here Matlab simulation is done for PWM to generate control signal for h -bridge multilevel inverter.

This PWM waveform are given to the single phase as well as three phase cascaded H Bridge inverter to get five level output. This Matlab simulation is as below.

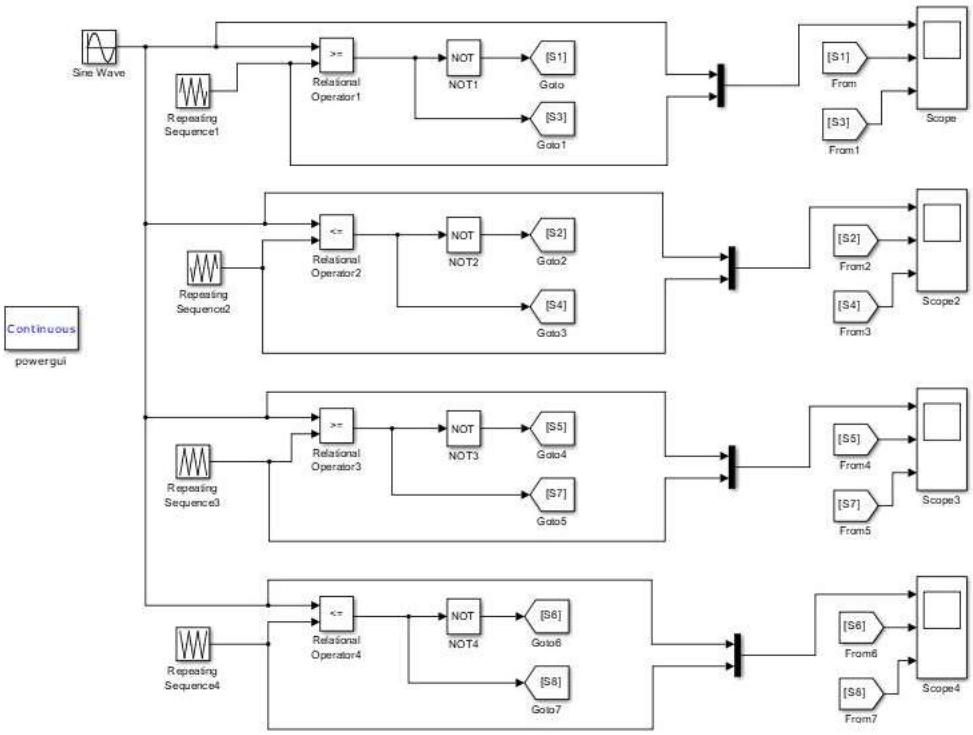

Image-3: Simulink Model PWM Control circuit

Simulink Output:
Sine Wave: 50Hz, 1V
Triangular Wave: 1000HZ, 1V

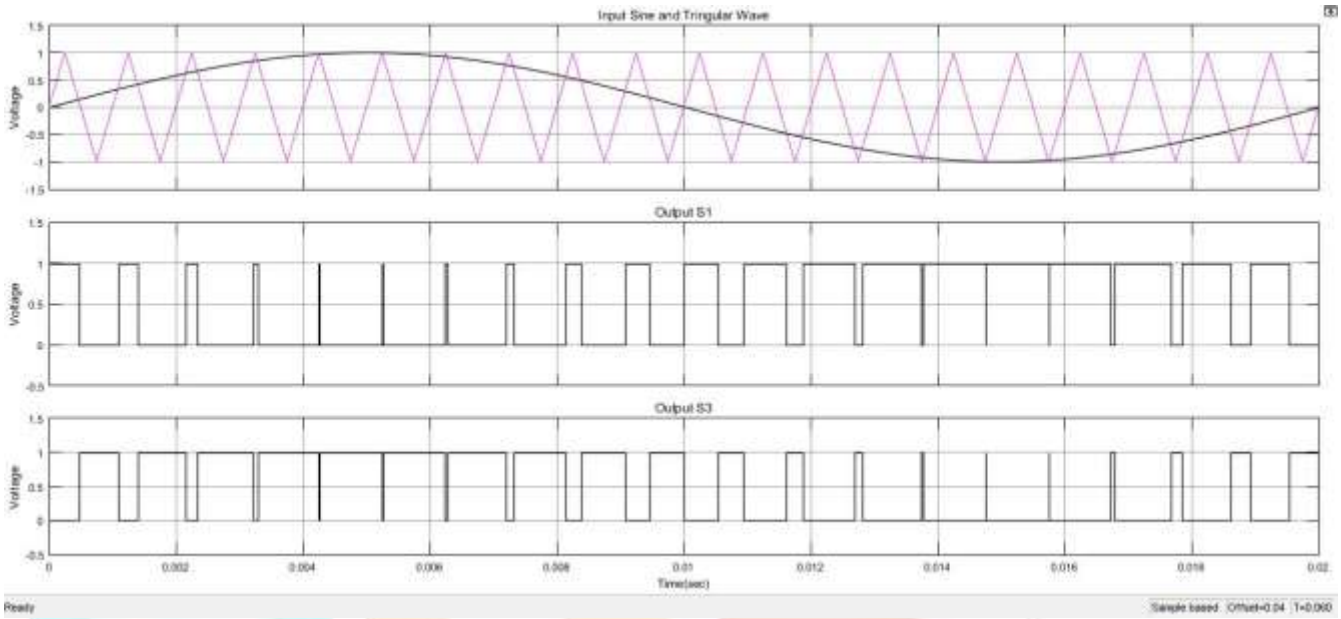

Image-4: Output for S1 and S3

Here Sine wave and triangular wave are compared and we will get the PWM output pulse for switch S1 and S3 as shown above.

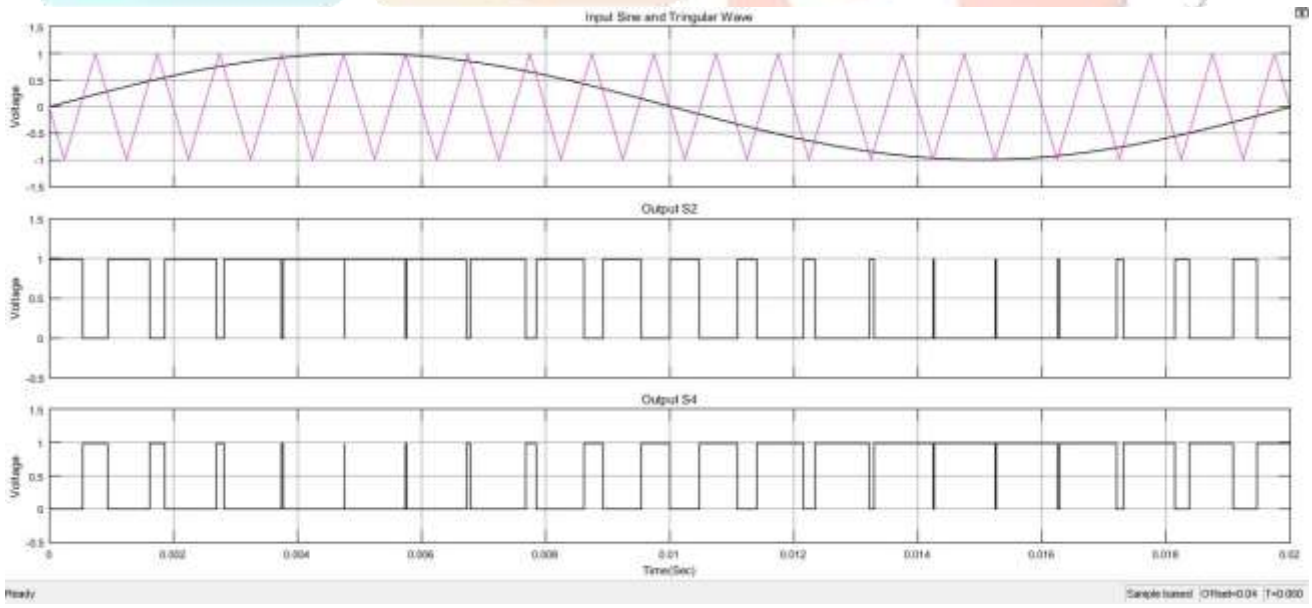

Image-5: Output for S2 and S4

In above figure we get output pulses for switch S2 and S4

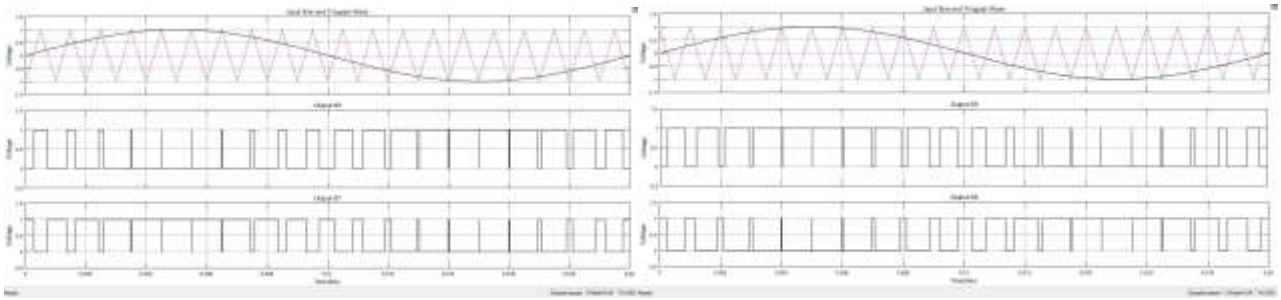

Image-6: Output for S5, S7 and S6, S8

As shown in below figure two h bridge are connected in cascaded configuration and all switches of this are control by pwm. Output of this inverter are compared with the reference sine wave.

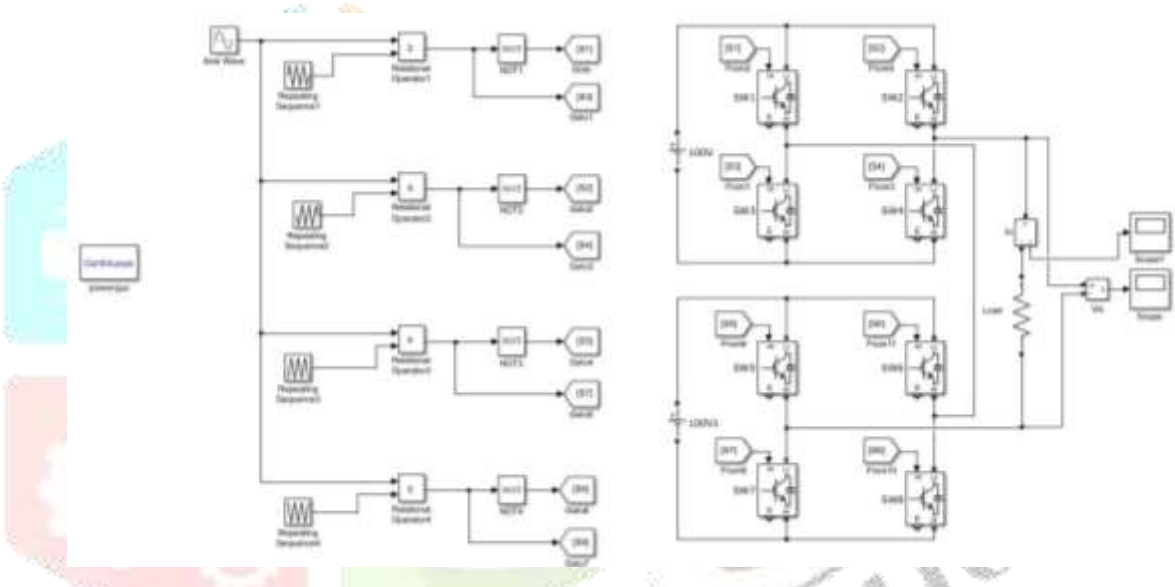

Image-7: Single phase cascaded five level H - Bridge

In the output we get the five voltage level as shown in below

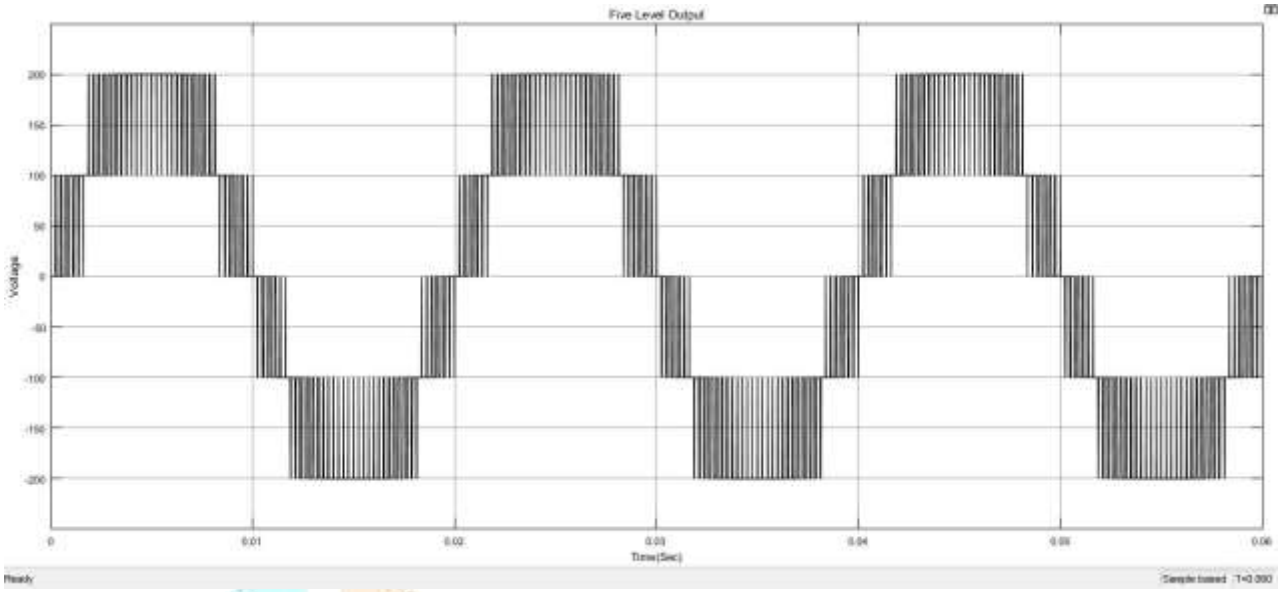

Image-8: Single phase five level output

There are five voltage level as below

V=200v, V=100v, V=0v, V=-100v, V=-200v

This simulation is done for the 0.1sec time period in this time period five output cycle is generated. Each output cycle gat 0.02 sec time. In each cycle five output voltage are generated.

This simulation is also done for Single phase cascaded seven level H – Bridge. The output waveform of this Single phase cascaded seven level H – Bridge multilevel is as shown in below.

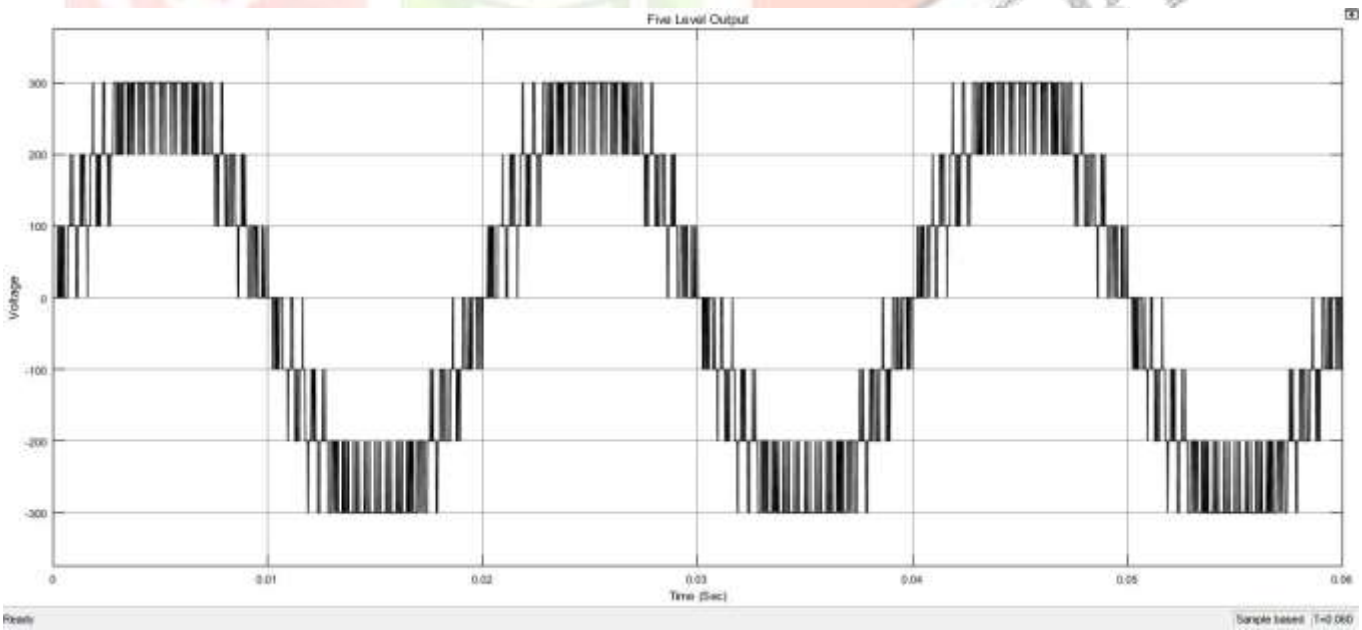

Image-9: Single phase seven level output

Result Analysis

Here result analysis is done for the output of Matlab simulation for both Single phase five level and Single phase seven level. This analysis is done with different value of modulation index and get minimum Total harmonic Distortion (% THD). The table for simulation analysis is as shown in below.

Table-1 Percent THD comparison for 5 and 7 level

Modulation index	%THD for 5 level	%THD for 7 level
0.95	15.46	14.45
0.98	14.34	13.51
1	13.68	12.95
1.1	12.34	11.86
1.11	12.33	11.89
1.15	12.46	12.08
1.2	12.9	12.6

In this simulation we get total harmonic distortion THD for five and seven level as shown in below figure

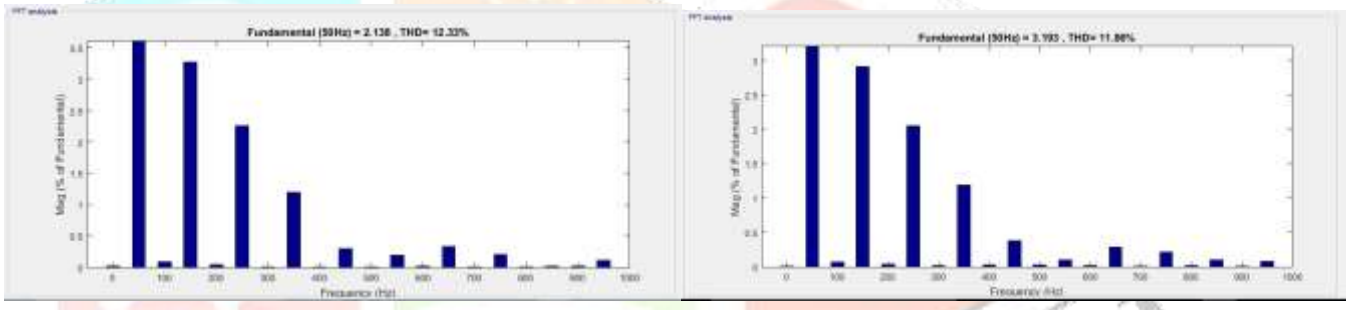

Image-10: THD output from five and seven level

4. CONCLUSION

According to literature analysis solar is one of the main resource of renewable energy and number of application already design based on it. Survey we found certain limitation in existing system like high THD, power loss, efficiency, etc. If number of level increase, the THD content of output is reduced. In these paper we woek on design inveter for solar system and we successfully design 5 level and 7 level inveter with low THD as compared to exisiting one. so as result shown our system acheive better result as compared to existing system

5. REFERENCES

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