SINGLE STAGE QUASI SWITCHED CASCADED H-BRIDGE FIVE LEVEL BOOST INVERTER WITH PID CONTROLLER

Ch srisailam[1], T Srinivas[2], T Srihari[*]
1. Asst.Professor, EEE Department, Gurunanak Institutions Technical Campus, Hyderabad, T.S
2. Asst.Professor, EEE Department, Sri Indu college of Engineering and Technology, Hyderabad, T.S
*Corresponding Author, Asst.Professor, EEE Dept, Gurunanak Institutions Technical Campus, Hyd, T.S

ABSTRACT
Multilevel inverter is a power electronic device which is capable of providing desired AC output voltage using Multiple lower level DC voltages at input.Multilevel inverters have many advantages compared to Conventional inverters.It has low Harmonic Distortion and Electromagnetic Interference. Cascaded multilevel inverters synthesize a medium-voltage output based on a series connection of power cells which use standard low-voltage component configurations. This project presents a control strategies and modulation techniques used by these inverters. A PID controller is used to control the Capacitor Voltage.Quasi Switching Reduces the Electromagnetic Interference.The output voltage is the sum of the voltage that is generated by each bridge. The switching angles can be chosen in such a way that the total harmonic distortion is minimized.

INTRODUCTION
Now a day's many industrial applications have begun to require high power. Some appliances in the industries however require medium or low power for their operation. Using a high power source for all industrial loads may prove beneficial to some motors requiring high power, while it may damage the other loads. Some medium voltage motor drives and utility applications require medium voltage. The multilevel inverter has been introduced since 1975 as alternative in high power and medium voltage situations. The Multi level inverter is like an inverter and it is used for industrial applications as alternative in high power and medium voltage situations. The need of multilevel converter is to give a high output power from medium voltage source. Sources like batteries, super capacitors, solar panel are medium voltage sources. The multilevel inverter consists of several switches. In the multi level inverter the arrangement switches angles are very important The Multi Level Inverters are mainly Classified into Three types.They are

- Diode Clamped MultiLevel Inverter
- Flying Capacitor MultiLevel Inverter
- Cascaded H-Bridge MultiLevel Inverter

A) Diode Clamped Multi Level Inverter:
Diode clamped multilevel inverters use clamping diodes in order to limit the voltage stress of power devices. For a N level diode clamped inverter needs ($2N$ – 2) switching devices, (N – 1) input voltage source and (N – 1) (N – 2) diodes in order to operate.In Diode Clamped Multi Level Inverter the Output is half of the Input.

B) Flying Capacitor Multi Level Inverter:
The configuration of this inverter topology is quite similar to Diode Clamped Multi Level Inverter except the difference is here flying capacitors are used in the place of diode to limit the voltage. The input DC voltages are divided by the capacitors . A N level flying capacitor inverter with ($2N$ – 2) switches will use (N – 1) number of capacitors in order to operate. It has very poor Output Efficiency.The control of capacitor voltage is difficult.

C) Cascaded H-Bridge Multi Level Inverter:
This inverter uses several H-bridge inverters connected in series to provide a sinusoidal output voltage. Each cell contains one H-bridge and the output voltage generated by this multilevel inverter is actually the sum of all the voltages generated by each cell. If there are N cells in a H-bridge multilevel inverter then number of output voltage levels will be 2N+1. This type of inverter has advantage over the other two as it requires less number of components as compared to the other two types of inverters and so its overall weight and price is also less.The efficiency is also improved when compared to Diode Clamped and Flying Capacitor Multi Level Inverters.

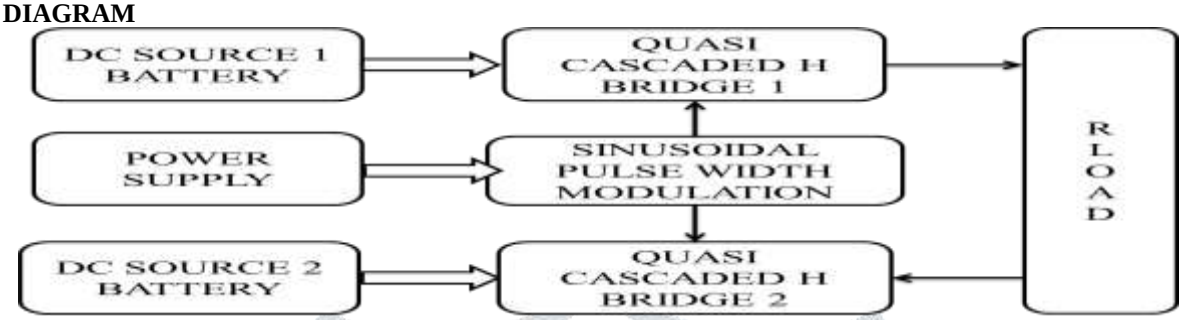
DESCRIPTION OF THE PROJECT
In the Proposed system i.e, SINGLE STAGE QUASI SWITCHED CASCADED H-BRIDGE FIVE LEVEL BOOST INVERTER WITH PID CONTROLLER we have many advantages when compared to Conventional one.In order to overcome the disadvantages of conventional System we desgining the new Techniques.
The number components Requried in this system are Comparitively less.The list of components Required in this System are as Follows:

Component Name	Quantity
Capacitor Filter	1
Inductor Filter	1

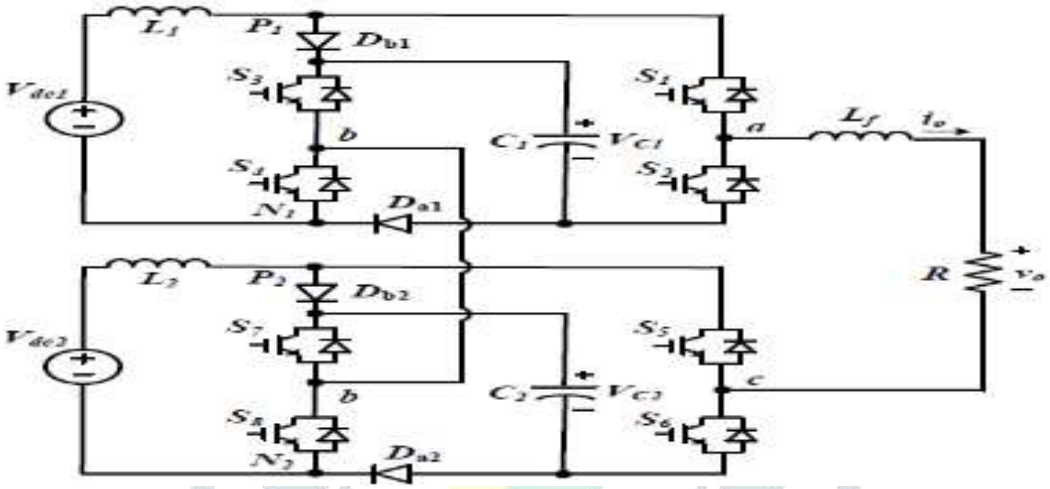
DC Source	2
Capacitor	2
Boost Inductor	2
Switches	8
Diode	4

,One Capacitor,Four Switches,One Boost Inductor and Two Diodes are Connected Together to get one Quasi Switched Boost Inverter.In this Project we require Two Boost Inverters with Quasi Switching.

BLOCK DIAGRAM

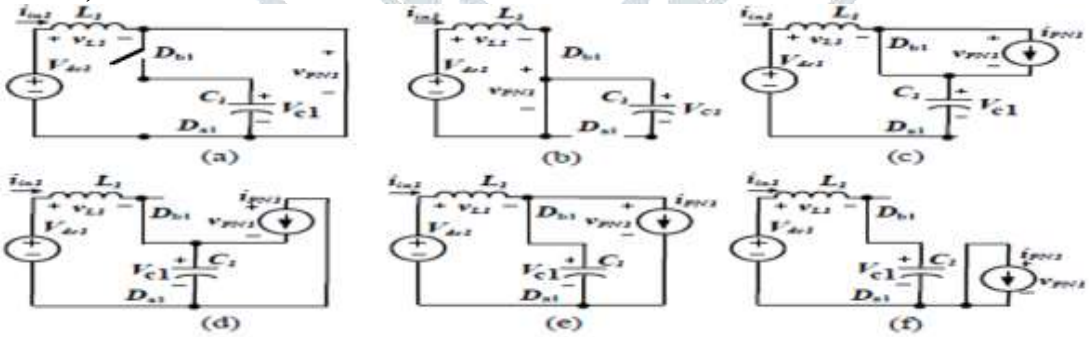


CIRCUIT DIAGRAM



Operation:

As we have two modules in the circuit diagram.for the operation of the inverter we are considering the first module,and the operation is shown as,



Operating States of Module-1

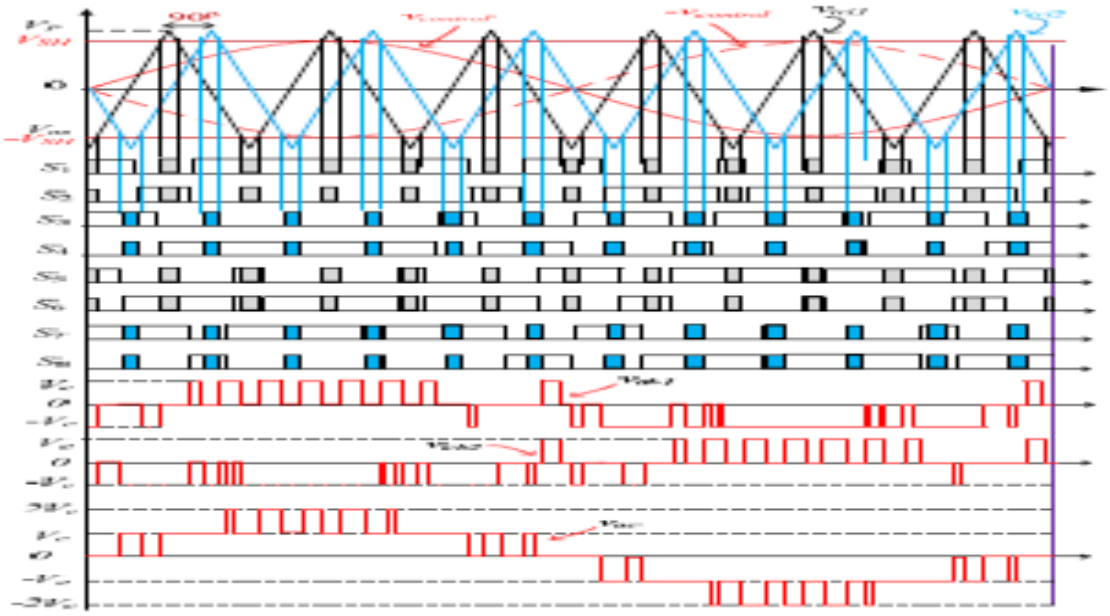
(a)	Shoot Through State 1
(b)	Shoot Through State 2
(c)	Non Shoot Through State 1
(d)	Non Shoot Through State 2
(e)	Non Shoot Through State 3
(f)	Non Shoot Through State 4

In order to Operate the single stage quasi switched cascaded H-Bridge Five Level Inverter with PID Controller we need to have the both Modules with same parameters.

In (a),Both S1 and S2 are turned on simultaneously which results in the conduction of Da1 which means that the Db1 is Blocked.The Inductor L1 is charged when the supply is turned on and the Output voltage is VC1.

In (b),Both S3 and S4 are Turned ON Simultaneously which results in the conduction of Db1 which means that the Da1 is Blocked.The Inductor L1 is also Charged in this state and Output Voltage is VC2.
In (c), Both S1 and S3 are Turned ON Simultaneously and the Output Voltage is Zero.
In (d), Both S2 and S3 are Turned ON Simultaneously and the Output Voltage is –VC1.
In (e), Both S1 and S4 are Turned ON Simultaneously and the Output Voltage is VC1.
In (f), Both S2 and S4 are Turned ON Simultaneously and the Output Voltage is Zero.

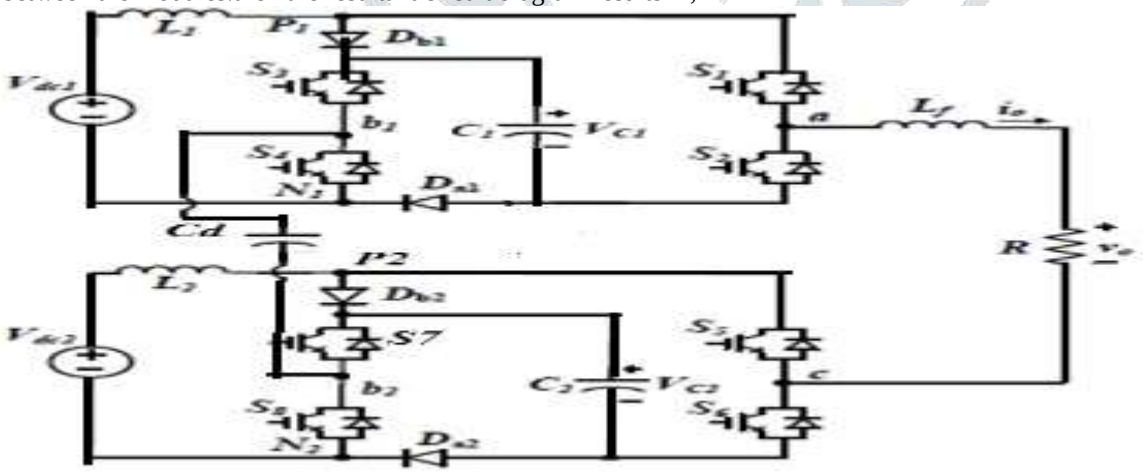
PULSE WIDTH MODULATION:



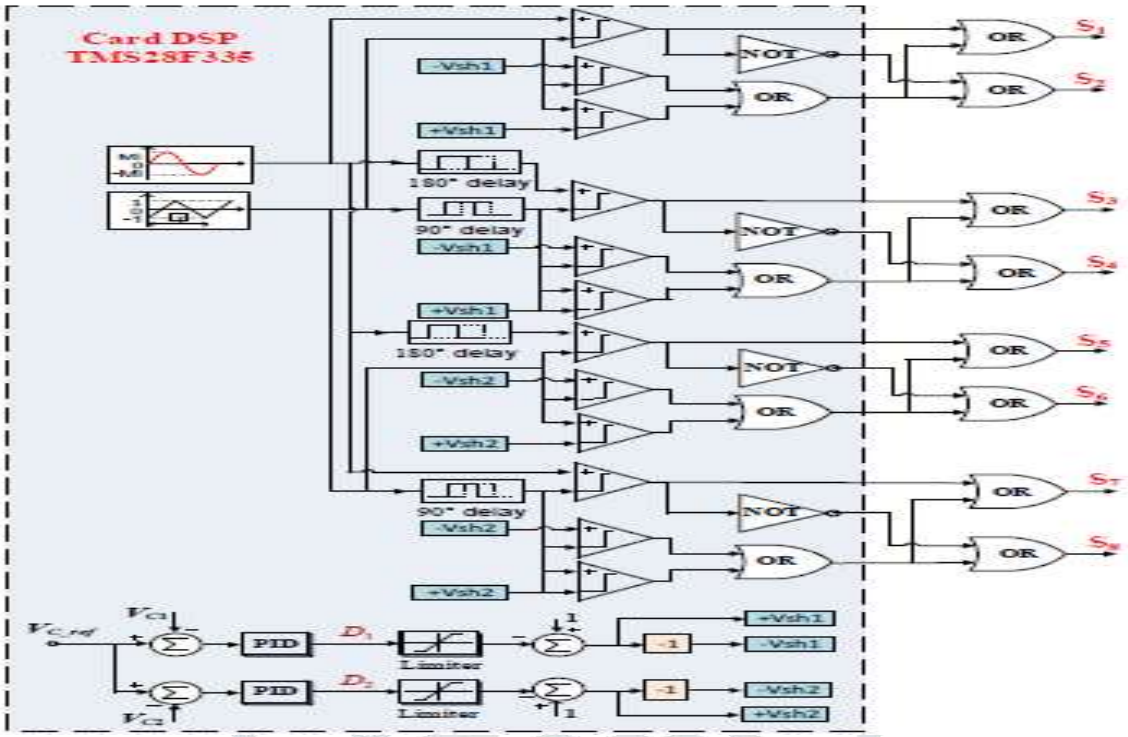
As we Know For Each Module in the Operation of single stage quasi switched cascaded H-Bridge Five Level Inverter with PID Controller we require Four switches and the number of Shoot Through states for each Module is four.The operating frequency of single stage quasi switched cascaded H-Bridge Five Level Inverter with PID Controller is FOUR times that of Switchinng Frequency.It has High Frequency Current Ripples.

Balancing the Problems in DC Source:

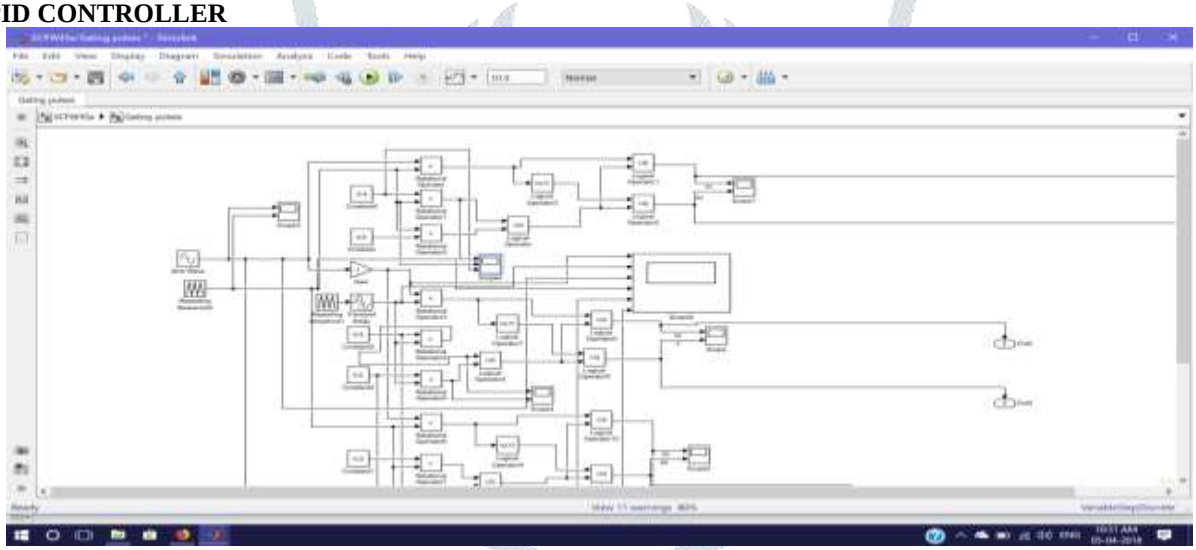
The main aim of Balaning the Problems in the Dc source is to get the good and desirable Output.In order to achieve this first we need to have the Same Capacitor voltage in each module.We are using a PID Controller to control the capacitor voltage.The Shoot Through Duty Cycles should be equal in order to control the Capacitor voltage i.e,D1=D2.If we get D1 and D2 different then it generates the DC off-set Voltage.So,to eliminate the DC off-set Voltage and additional capacitor filter is need to be added in between the modules.then the resultant circuit diagram results in,



Gating signal generation circuit with capacitor voltage controller.

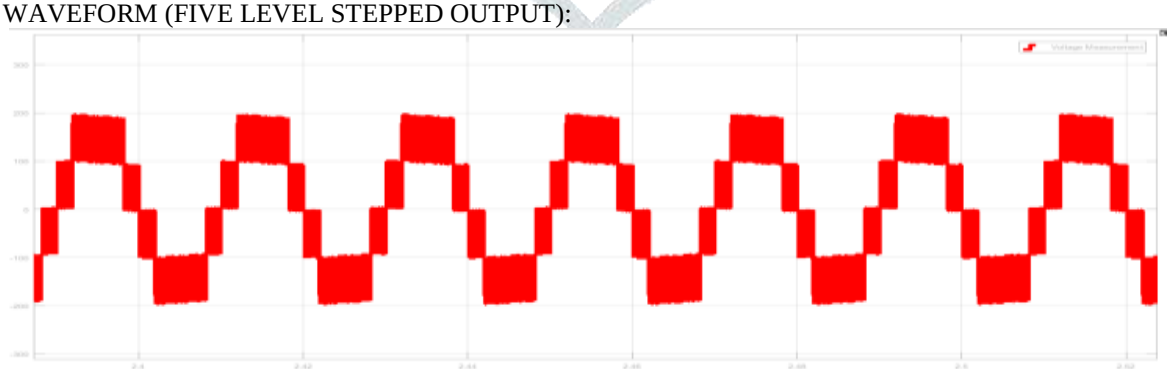


SIMULATION OF SINGLE STAGE QUASI SWITCHED CASCADED H-BRIDGE FIVE LEVEL BOOST INVERTER WITH PID CONTROLLER

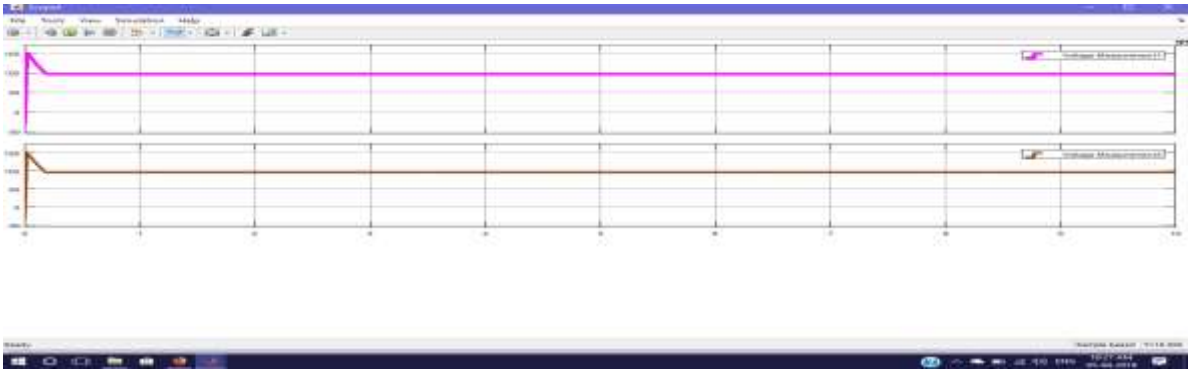


OUTPUT WAVEFORMS:

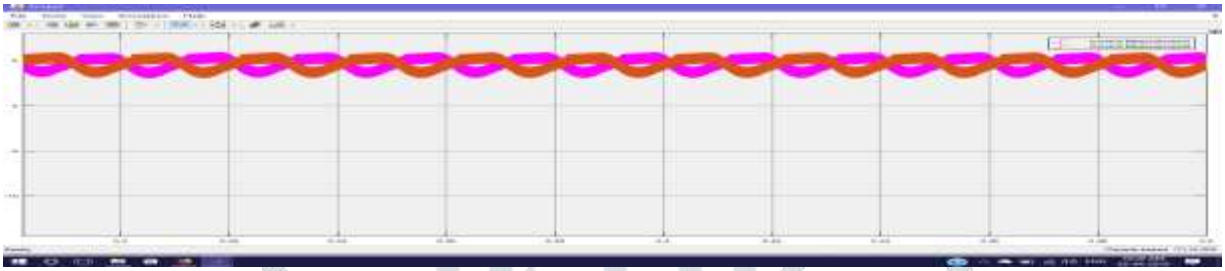
OUTPUT WAVEFORM (FIVE LEVEL STEPPED OUTPUT):



VOLTAGE OF CAPACITORS



CURRENT OF INDUCTORS



EXPERIMENTAL RESULTS

CASE(i):Consider Vdc1=Vdc2=50V

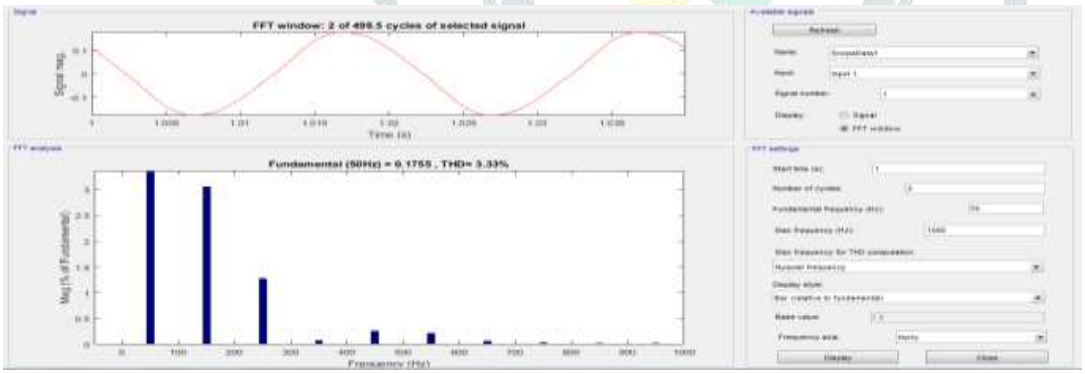
We have Taken the Both Voltages equal i.e,50v.As the Output Voltage of SINGLE STAGE QUASI SWITCHED CASCADED H-BRIDGE FIVE LEVEL BOOST INVERTER WITH PID CONTROLLER is Five Level,the measured load Voltage will be 110v. Measured capacitor *C*1=129v, *C*2=129v and Cd=*0*v ,In the steady state.

CASE(ii):Consider Vdc1=50V &Vdc2=60V

Now,we have taken the Unbalanced Inputs.The Output Load Voltage of the Inverter will be 110v.The capacitor voltages are C1=129V,C2=129V,Cd=7v in Steady State.

THD ANALYSIS

Total harmonic distortion (THD), is defined as the sum of all harmonic components of the voltage or current waveform which is compared against the fundamental component of the voltage or current wave. THD calculations can be obtained from the SIMULINK. The switching pattern that is used in this project for all of the multilevel inverters is Sinusoidal PWM technique. In this method the switching angles for switches should be calculated in such a way that the dominant harmonics are eliminated . For a 5-level inverter the 5th harmonic will be eliminated.



APPLICATIONS

- HVDC Grid Application.
- Solar Power Systems.
- Industrial and Residential Applications.
- Renewable Energy Conversion.

CONCLUSION

SINGLE STAGE QUASI SWITCHED CASCADED H-BRIDGE FIVE LEVEL BOOST INVERTER WITH PID CONTROLLER has the efficiency more than that of the Conventional MultiLevel Inverters.As we have seen it uses less number of components with smooth switching process.The Total Harmonic Distortion and also the Electro Magnetic Interference are also Eliminated.It has various Industrial applications also.

REFERENCES

[1] M. Coppola, F. D. Napoli, P. Guerriero, D. Iannuzzi, S. Daliento, and A. D. Pizzo, "An FPGA-based advanced control strategy of a grid-tied PV CHB inverter," *IEEE Trans. Power Electron*, vol. 31, no. 1, pp. 806–816, Jan. 2016.

[2] E. Villanueva, P. Correa, J. Rodríguez, and M. Pacas, "Control of a single-phase cascaded H-bridge multilevel inverter for grid-connected photovoltaic systems," *IEEE Trans. Ind. Electron*., vol. 56, no. 11, pp. 4399–4406, Nov. 2009.

[3] G. Farivar, C. D. Townsend, B. Hredzak, J. Pou, and V. G. Agelidis, "Low-capacitance cascaded H-bridge multilevel StatCom," *IEEE Trans.Power Electron*, vol. 32, no. 3, pp. 1744–1754, Mar. 2016.

[4] F. Khoucha, S. M. Lagoun, K. Marouani, A. Kheloui, and M. E. H. Benbouzid, "Hybrid cascaded H-bridge multilevel-inverter induction-motor-drive direct torque control for automotive applications,"*IEEE Trans. Ind. Electron*., vol. 57, no. 3, pp. 892– 899, Mar. 2010.

[5] S. Vazquez, J. I. Leon, J. M. Carrasco, L. G. Franquelo, E. Galvan, M. Reyes, J. A. Sanchez, and E. Dominguez, "Analysis of the power balance in the cells of a multilevel cascaded H-bridge converter," *IEEE Trans. Ind. Electron*., vol. 57, no. 7, pp. 2287–2296, Jul. 2010.

[6] J. Napoles, A. J. Watson, J. J. Padilla, J. I. Leon, L. G. Franquelo, P. W.Wheeler, and M. A. Aguirre, "Selective harmonic mitigation technique for cascaded H-bridge converters with nonequal DC link voltages," *IEEETrans. Ind. Electron*., vol. 60, no. 5, pp. 1963–1971, May 2013.

[7] Y. Yu, G. Konstantinou, B. Hredzak, and V. G. Agelidis, "Operation of cascaded H-bridge multilevel converters for large-scale photovoltaic power plants under bridge failures," *IEEE Trans. Ind. Electron*., vol. 62, no. 11, pp. 7228–7236, Nov. 2015.