Design and Implementation of Advanced Control Scheme of Cascaded Multilevel Inverter for Power Quality Improvement

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***Abstract*:- This paper discusses the use of a cascaded multilevel converter for flexible power conditioning in smart-grid applications.The main feature of the proposed scheme is the use of independent dc links with reduced voltages, which makes such a topology an ideal candidate for medium-and high-power applications with increased reliability.The advantages of CHB inverter are low harmonic distortion, reduced number of switches and suppression of switching losses.CHB converters are being considered for the increasing number of applications due to their high power capability associated with low output harmonics and low commutation losses.The modified inverter can produce a better sinusoidal waveform by increasing the number of output voltage levels.Byserial connection of two modified H-bridge modules,it is possible to produce 9 output voltage levels including zero.From the results,the proposed inverter provide higher output quality with relatively lower power loss as compared to other conventional inverters with the same output quality.**

Keyword:- Cascaded H bridge multilevel inverter(CHB),Pulse width modulation, Total Harmonic Distortion(THD).

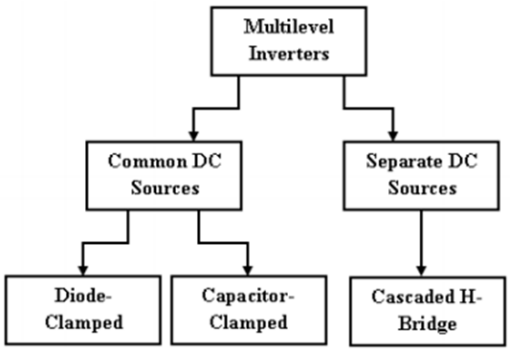
I.INTRODUCTION

Nowadays world is most importance of electrical energy only without electrical supply world cannot be imagined.At the same time the quality and continuousness of the electric power supplied is also very important for the efficient functioning of the end user equipment.Many of the commercial and industrial loads require high quality undisturbed and constant power.Thus maintaining the qualitative power is topmost important in today's world.The problems which affect the power quality in distribution systems are pertaining to the specification of the loads.Some most popular effect are:the harmonics generated by non linear loads and unbalanced loads and the low power factor of the loads.A part from non linearloads,events like motor starting,capacitor switching and unusual problems.CHMC requires the fewest number of components among all multilevel converter topologies.Nowadays the power quality draws more attention of many researchers on power distribution systems due to the increased usage of the polluting power electronic equipments in industries and in domestic applications.Due to more number of variable speed drives in industry the reactive power demand and unbalanced current result in serious problem in power distribution systems like increased line losses,decreased power system voltage and others.Today the research on transmission capacity,decreased marginal stability of power system,decreased/increased,reactive power compensation,harmonic current mitigation on power distribution system and electrical drive applications attracts all researchers due to its high voltage application.multilevel inverter for real powercontrol

Multilevel power conversion has become increasingly popular in recent years due to advantages of high power quality waveforms,low electromagnetic compatibility(EMC).concerns,low switching losses, and high voltage capability however, it increase the number of switching devices and other components,which results in an increase of complexity problems andsystem cost.There are different types of multilevel circuits involved.The firsttopology introduced was the series H-bridge design.

II.TOPOLOGY OF MULTILEVEL INVERTERS

Multilevel inverters have an arrangement of power switching devices and capacitor voltage sources. Multilevel inverters are suitable for high-voltage applications because of their ability to synthesize output voltage waveforms with a better harmonic spectrum and attain higher voltages with a limited maximum device rating.There are three main types of multilevel inverters:diode-clamped (neutral-clamped),capacitor-clamped(flying capacitors),and cascaded H bridge inverter.



Multilevel Inverter Topologies

Cascaded H-Bridge Inverter

The cascaded H-bridge inverter has drawn tremendous interest due to the greater demand of medium-voltage high-power inverters.The cascaded inverter uses series strings of single-phase full-bridge inverters to construct multilevel bridge is shown. The output of each H-bridge can have three discrete levels,results in a staircase waveform that is nearly sinusoidal even without filtering.A single H-bridge is a three-level inverter.There is a growing interest in multilevel topologies since they can extend are the most attractive technology for the medium to high voltage rang,which includes motor drives,powerdistribution,power quality and power conditioning applicationsphase legs with separate dc sources.A single H-electronics systems to higher voltages the application of power and power ratios.Multilavel inverters .

III.NINE LEVEL CASCADED H-BRIDGE MULTILEVEL INVERTER

Symmetric multilevel inverters are characterized by the face that the voltages across the different dc link capacitors are equal. In the symmetric inverter,four cells consists four switches are needed to generate Nine-level voltage is shownin fig. Asymmetric multilevel inverter is same as symmetric multilevel inverter circuit configuration;the only difference is the dc link voltages.Using different dc link voltages in different power cells and application the appropriate switching methods , the number of output voltage levels increases.Therefore,with less number of H bridge cells,more output voltage levels can be obtained.It is important to mention that the switches applied in the symmetric inverter have the same off-stage voltage,but in the asymmetric inverter, the number of switches can be different.Hence asymmetric cascaded H-bridge inverter increases the number of output voltage levels.

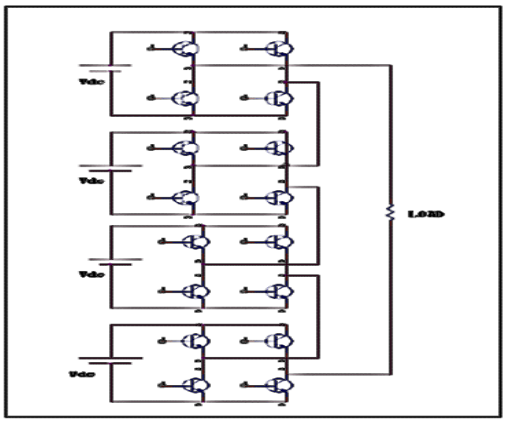
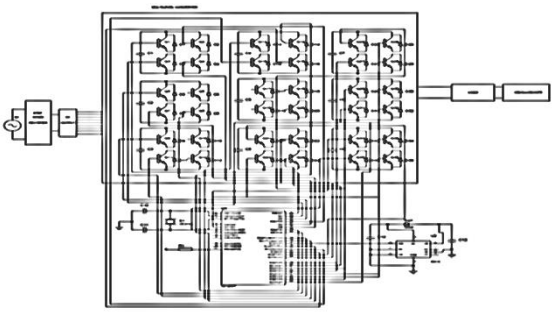


Fig.2 Nine level symmetric multilevel inverter

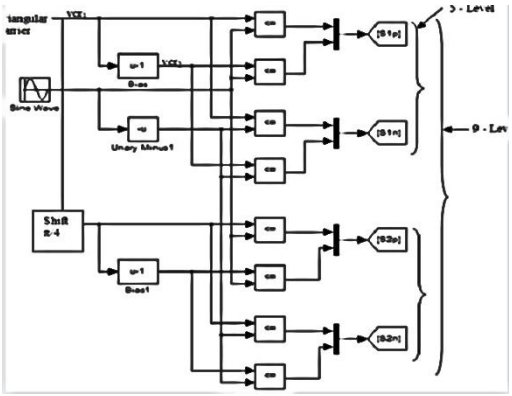
CIRCUIT DIAGRAM



In proposes system the control of a cascaded multilevel inverter with individual H-bridge DC-link voltage regulation,applied for selective compensation or minimization of particular load disturbances,under a variety of voltage condition.The presented control method is modular,and it can be adapted to any number of modules in series.CPT is used as an alternative for generating a variety of current references in the stationary frame,for selective disturbances mitigation and if needed,active power injection.The proposed system increases the level of system seven level to nine level for reduced THD of system.

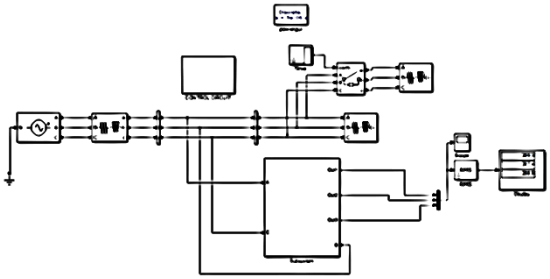
V.CONTROL STRATEGY

The proposed Nine-level CHMI is controlled to regulate the dc-link voltage of case H-bridge cell,and to compensate current load terms related to disturbing effects.The voltage controller output,from H-bridge cells,is multiplied by the PCC voltage,so as to define an additional current reference to be added to the reference of the disturbance currents.The resulting current referenceis directed to the current controller output of the active filter.Thus,the active filter must act as a high power factor controlled rectifier during transient load conditions.and as a current compensator under steady-state conditions.Notice that there is no need for any type of coordinate transformation or synchronization algorithm to provide the reference signals.Assuming one phase of the CHMI,the control strategy for dc voltage controllers of each H-bridge cell ,which is comprised of inner and outer control loops.The inner loop regulates the inverter output current at the desired reference,and the outerloop regulates the dc-link voltages in each H-bridge.



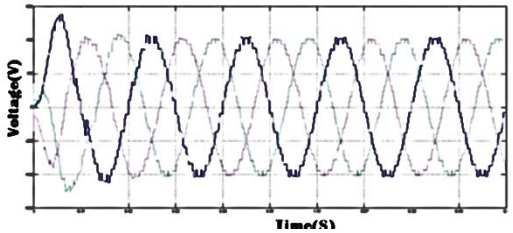
Control strategy fig

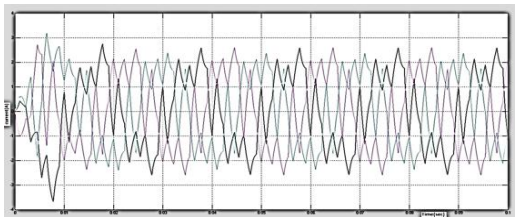
SIMULATION RESULT



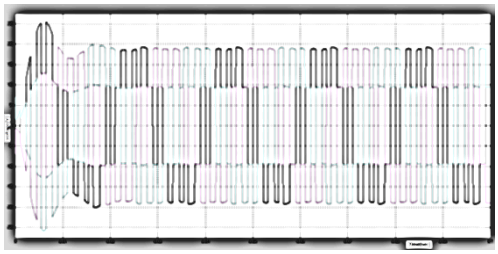
.. Fig:simulation proposed diagram

The simulation is done for different levels in order to obtain the optimum solution on the quality of the output waveforms. The same control technique is used to simulate the different levels with different carrier frequencies irrespective of the levels,5kHz results better performance when compared to other carrier frequencies.Therefore the same carrier frequency is considered for the simulation irrespective of the cascaded configuration.

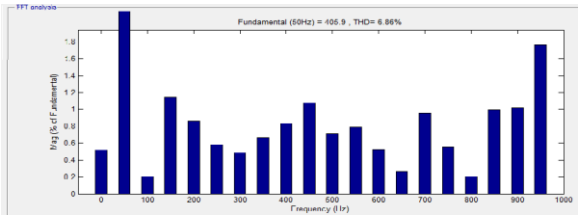




Current wave form



Voltage wave form



Total harmonic distortion

CONCLUSION

Multilevel inverters have become an effective and practical solution for increasing power and reducing harmonics of Ac wave form. This project deals with the design an implementation of Three-phase nine-level cascaded H-bridge multilevel inverter for RL load with PWM modulation method.The simulation of 9-level cascaded H-bridge is done and also power quality improvement.Accordingly,the compensation strategy should meet the overall goals,within limits defined by regulatory standards,electricity operating constraints,and that is still favorable from the viewpoint of cost.This is important regarding the appropriation of responsibilities in the case of smart microgrids or modern power grids.

REFERENCES

[1] G.Farivar,B.Hredzak,and V.G.Agelidis,''Decoupled control system for cascaded H-Bridge multi level converter basedSTATCOM,''IEEE Trans.Ind.Electron., vol.63,no.1,pp.322-331,Jan.2016.

[2] S.Kouro et al.,''Recent advances and industrial applications of multilevel converters,''IEEE Trans.Int.Electron.,vol.57,no.8,pp.2553-2580,Aug.2010

[3] M.Reyes, P. Rodriguez, S. Vazquez, A. Luna, R. Teodorescu, and J. M. Carrasco,"Enhanced decoupled double synchronous reference frame current controller for unbalanced grid voltage conditions,"IEEE Trans. Power Electron.,vol.27,no.9,pp.39343943,Sep.2012.

[4] H.Sepahvand,J.Liao,M.Ferdowsi,and K.A Corzine,''Capacitor voltage regulation in single-DC-source cascaded H-Bridge multilevel converters using phase- shift modulation,''IEEE Trans.Ind.Electron., vol.60,no.9,pp.3619-3626,Sep.2013.

[5] E. Villanueva, P. Correa, J. Rodriguez, and M. Pacas,''control of a single-phase cascaded H-bridge multilevel inverter for grid-connected photovoltaic system,''IEEE Trans.Ind. Electron., vol.56,no.11,pp. 4399-4406,Nov.2009.