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A REVIEW ON P-Q CONTROL THEORY FOR A SINGLE PHASE GRID CONNECTED CONVERTER FOR DISTRIBUTION SYSTEM WITH DISTRIBUTED GENERATION

Mr. S.JAGADISH KUMAR[1], RAJARAPU NAGARAJU[2]

[1]Assistant professor, Department of Electrical and Electronics Engineering Department, JNTUH College of Engineering, Jagtial, Telangana, India,Email:jagadishkumar1@gmail.com

[2]M.Tech student, Department of Electrical and Electronics Engineering Department JNTUH College of Engineering, Jagtial, Telangana, India,Email:rajarapunagaraju@yahoo.com

Abstract— In this paper improvement in power quality is discussed with power control of a grid interactive inverter .In this voltage control and current control and also power control is used to reduce total harmonic distortion .The distortion in current waveform is due to presence of nonlinear load. The transformer less grid interactive inverter improves the power factor by supplying sinusoidal current waveform and also it delivers active power and reactive power to the load. Literature survey is done in order to find the various applications by using single phase transformer less grid connected to power system network.

Keywords: Grid interactive inverter, voltage control, current control, power control, total harmonic distortion.

1. INTRODUCTION

Distributed generators [DG] uses the renewable energy sources like solar, wind, hydro power in order to provide energy to the increasing consumer load demand, and it doesn't violate the environment. Regulations and these are small in size with active power generating capacity of 1kw to 100mw range. And these are connected at distributed level. By the usage of photovoltaic [PV roof top] technology to meet the increasing load demand and reduce the electricity bill of the customer. And the cost of PV module and solar based distributed generators these are playing important role in future.

The usage of power electronic technology plays a key role in changing vertical power system to horizontal power system, and distributed power generators used to provide load balancing, voltage support, and reactive power support. The main components of electrical power system are power electronic converters, synchronous machine and asynchronous machine, so the controlling strategies to the distributed generation are important to study.

The power factor deterioration can be avoided by activate and reactive power interaction between AC grid and distributed generating system. And the grid interactive inverter can be used as current controller and as well as voltage controller. Voltage source inverter with current control is used for reactive power compensation in grid connected solar based distribution generator.

Transformer less grid connected inverter topology is used as a control. And switching strategy of a single phase roof top grid connected PV system capable of improving power quality in terms of power factor and low THD. And as the system is grid connected a pure sinusoidal current and voltage waveform is achieved even when the nonlinear load is connected so by which THD is improved.

II. Literature Review

In this paper, different applications of single phase transformer less grid connected power system network of many researchers is discussed.

G.JOOSDE [1] In this he demonstrated the potential of distributed generation systems equipped with an appropriate power electronic interface to perform functions other than the supply of real power to the grid. These additional functions however require the use of dc/ac self commutated PWM

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inverter interfaces, such as are found in the newer distributed generation systems.. Finally, either in the STATCOM or DVR configurations, the Distributed Generator can compensate for voltage sags resulting from faults on the power system.

FREDE BLAABJERG [2] In this he used more and more dispersed generation units are being integrated into power systems. The difference in the characteristics between the dispersed generation units and the load/system demand requires a conditioning system. Power electronic converters play a vital role in the integration. The developments of modern power electrons have been discussed. The applications of power electronics in various dispersed generation units, in particular wind turbine generation systems and offshore wind farms, fuel cells and PV generators have been reviewed and it is clear that power electronics is the enabling technology for dispersed power generation.

R.GONALEZ [3] In this Grid**-** connected photovoltaic systems usually include a line transformer in their power conversion stage. This transformer guarantees us the galvanic isolation between the grid and the PV system, thus providing personal protection and avoiding leakage currents between the PV system and the ground. Furthermore, it also ensures that no continuous current is injected into the grid. However, because of its low frequency (50HZ), the transformer is big, heavy and expensive. The evolution of the technology has made possible the use of an inverter without the line transformer and no impact on the characteristics of the system concerning personal safety and grid integration.

THOMAS ACKERMAN [4] In this research work he explained a comparative analysis of the three main single-phase transformer less inverter topologies, NPC having efficiency of around 98%, ANPC having efficiency of around 99.75% and HERIC having efficiency of around 97% is performed. The analysis was focused on the common mode currents, efficiency and size. Based on above criteria analysis was carried out.

YONG YANG [5] In this research work he presented a PV model for grid connected system and analysis was done by simulation. For feeding sinusoidal current to the grid an indirect current control strategy was used. The grid normal and faulty conditions analysis was also done by simulation.

ARUL DANIEL [6] In his research work have presented a single stage PV inverter common ground transformer less. The converter was made using techniques of CUK converter and Watkins-Johnson converter. The inverter circuit have been analysed and simulated and the results are explained.

MAREI [7] He designed a inverter coupled to the grid based on the phase shift of the output voltage with respect to the mains voltage to control the power. The document used the active and reactive power control strategy and designed a digital control phenomenon to control power using the least number of digital sinusoidal pulse width modulation based on FPGA patterns. Te technique must be used correctly.

III. System configuration and control

In conventional grid connected system, the power conversion unit is directly connected to the grid without using any load. Fig 1 shows the schematic diagram single phase distributed generator operating is grid connected mode. The system consists of DC source, voltage source inverter, filter, load, grid and controller.

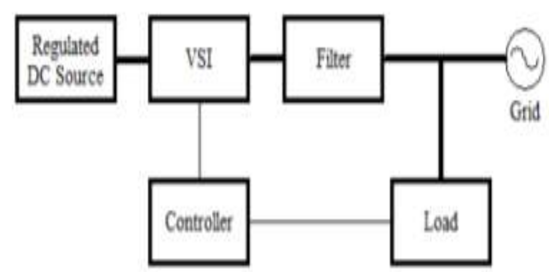

Fig: 1 Schematic diagram of grid connected system

The usage of DG system is to supply power to its load in addition to grid power, to achieve high power factor current is sinusoidal and the DG transfers to the grid should be balanced and sinusoidal and have low THD value. And the distortion in grid voltage is because of nonlinear load that is present in power system.

A model of grid connected DG system is developed. VSI of DG is modeled as voltage source

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VSI and the inverter transfer a grid current I_g to grid v_g with load R_f and L_f are equivalent resistance and inductance of inductor

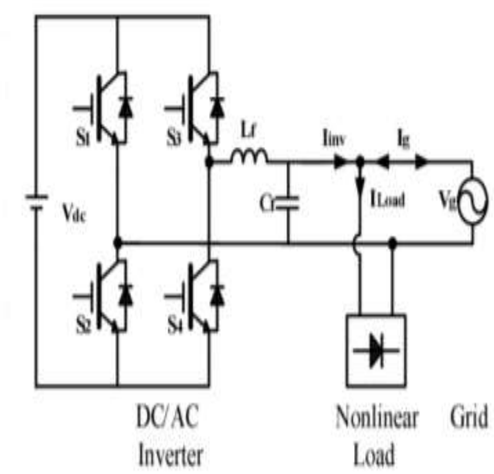

Fig: 2- Grid tie inverter

In this single phase grid interactive inverter with nonlinear load which is connected in parallel to the grid is considered. Constant frequency modulation is used for generation of gate signal for full bridge inverter. The output filter is used to reduce high frequency harmonics in current waveform due to PWM switching.

S1	S2	S3	S4	output V0
ON	OFF	OFF	ON	V0
OFF	ON	ON	OFF	-V0
OFF	ON	OFF	ON	0
ON	OFF	ON	OFF	0

Table 1: Switching strategy of Inverter switches

The full bridged inverter which consists of upper part switches s1 and s3 and lower part switches which has s2 and s4 they are controlled to be ON only two at a time are conducting and remaining two are not conducting which by using PWM switching modeling

The voltage equation of system

$V_i - V_g - L_f\, d_{ig}/dt - R_f * Ig = 0$ (1)

Sine these have fundamental voltages of harmonic components then we are write the corresponding equations.

$V_i = V_{i1} + \sum_{h\neq 1} V_{ih}$ (2)

$V_g = V_{g1} + \sum_{h\neq 1} V_{gh}$ (3)

Equating fundamental and hormonic components into equation-1.

$V_{i1} - V_{g1} - L_f\, di_{g1}/dt - R_f * i_{g1} = 0$ (4)

$\sum V_i h - \sum V_g h - L_f\, digh/dt - R_f * Igh = 0$ (5)

The local load is represented as below equations

$I_{DG} = I_L + I_g$ (6)

$I_L = I_{DG} + I_g$ (7)

$I_L = I_{L1} + \sum_{h\neq 1} I_L h$ (8)

$I_{L1} + \sum_{h\neq 1} I_L h = I_{DG} + I_g$ (9)

$I_{L1} + \sum_{h\neq 1} I_L h - I_{DG} = Ig$ (10)

IV. Grid synchronization – Phase Locked Loop [PLL]

PLL has a major role in the variation for phase angle and adopting the charging conditions on the grid. It maintains the active and reactive power accuracy in the power system. The DC link voltage controller is used to control the voltage loop to produce the DC reference current.

The load current and grid voltage and used to the PQ controller block to generate the active current component of the load current. Te load current and required grid connected current amplitude which is multiplied by sinwt are used to produce the inverter reference current command. This reference is used to control the reactive power and THD of the load. Then the PWM inverter decides the PWM switching pattern via the PI current controller which have the reference current and the real output current of the inverter as the inputs. And the controllers inside the system are PI based topologies.

V. Role of Distribution Generator

It is essential in meeting future energy needs, it has lot of importance in power system network because of lot of reasons which are as follows

:(a) It will provide flexibility to the consumer in planning and developing the installation at its consumer end. This is particularly very important for sensitive and critical loads in environments subjected to interruptions.

(b) Because of distributed generation the cost of production of power is cheapest. Power companies can add the generating near by consumer ends so because of which it results in expansion of power system network easily possible.

(c) So because of which the consumer can also produce energy by using these generators so that he can also sully power to load ends with cheaper rate thus saving on the utility bill so because of this competitiveness profit can be also achieved.

(d) With the decreasing nature of costs, independent power producers (IPP) can install generation and connect to the nearest power grid and so that they can sell energy at a profit.

(e) It has the power of providing some of the ancillary services that has been identified as a result of deregulation on power system network. The IPP and as well as consumers having independent generation could provide these services at cheaper rate.

VI. Distributed Generation

Some of the distributed generation systems that hold the greatest technical potential, table 2, are described with reference to the types of power electronic interfaces ad the their rang of usage in power system

Type	Power range
Micro turbines	25kw-1mw
Wind energy system	100kw-2mw
photovoltaic	5kw-100kw
Fuel cells	100kw-2mw

Table2: Principal types of distributed generation systems.

VII. Conclusion

From the above review researchers developed different applications by using single phase transformer less grid connected systems ,And in this the importance of Distributed generators is clearly mentioned and its types that are generally used in the power system network ,In order to reduce the electricity bills at consumer ends .And the importance of usage of distribution generators is clearly mentioned in this review paper.

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AUTHORS PROFILE

MR.S. JAGADISH KUMAR, Assistant Professor, Department of EEE, Jawaharlal Nehru Technological University Hyderabad College of Engineering jagtial (T.S), INDIA

Mr. RAJARAPU NAGARAJU, PG Scholar, Dept of EEE, Jawaharlal Nehru Technological University Hyderabad College of Engineering jagtial(T.S),INDIA