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CONTROL OF GRID TIED INVERTER FOR HYBRID SYSTEM USING PLLAshish Kumar¹, Chirag Gupta²

1ME Scholar

Department of Electrical Engineering
Vedica Institute of Technology, Bhopal, MP (India)

2Assistant Professor

Department of Electrical Engineering
Vedica Institute of Technology, Bhopal, MP (India).**Abstract**

In order to meet the requirements for grid interconnection, it is necessary that the control of Distributed Power Generation systems (DPGSs) should be improved. Therefore, grid synchronization algorithms play a vital role for Distributed Power Generation Systems (DPGSs). This paper discusses one of the synchronization strategies that use Phase Locked Loop (PLL) and its various types for synchronization of the grid - side converter. Different PLL implementation structures and their major characteristics are pointed out. The primary application of the proposed synchronization method is for the distributed generation units with renewable energy sources, which utilize power electronic converters as an integral part of their systems. The synchronization is usually carried out with respect to the voltage, frequency and phase angle of voltage (or current) signal(s) of the utility system.

Keywords: Hybrid energy; Inverter; PLL strategies; Amplitude, frequency and phase control

Introduction

The Hybrid System designed is for the purpose of rural electrification. The Hybrid system consist of Solar/ Wind generator. The output of the hybrid system is feed to the inverter & than grid for transmission of power. The control techniques include voltage and current control of grid-tie inverter.[1,2] During grid connected mode, grid controls the amplitude and frequency of the inverter output voltage, and the inverter operates in a current controlled mode. The current controller for grid connected mode fulfills two requirements –

(i) During light load condition the excess energy generated from the PV inverter is fed to the grid [4]

(ii) During an overload condition or in case of unfavorable atmospheric conditions the load demand is met by both inverter and the grid. [5,6]

In order to synchronize the inverter with the grid a dual transport delay based phase locked loop (PLL) is used.

The main objective of this paper are design system for rural electrification, design inverter controller to feed the output of hybrid system to grid, Phase Lock Loop is implemented for grid synchronization, PID controller is used for inverter control in the simulation.[7,8] The voltage injected to grid should be in permissible limits.

Proposed system:

Specification of PV Module			Specification of Wind Turbine			
1	Power Rating	P=200W	1.	Rated Power	10 KW at 11m/s(25 mph)	3 blade up wind
2	Voltage at maximum power	V(Pmax)=35.16V	2.	Rated Annual Energy	13600Kwh at 5m/s(11mph)	None, fixed pitch
3	Short circuit current	Isc=5.92A	3.	Max. Design wind speed	60m/s (134 mph)	240V Ac 1phase 50HZ
4	Open circuit voltage	Voc=43.75V	4.	Cut in wind speed	2.2m/s(5mph)	-40to +60deg C
5	Operating voltage	V(operating)=24V	5.	Nominal Power	10Kw at 12 m/s(27 mph)	Permanent magnet alternator

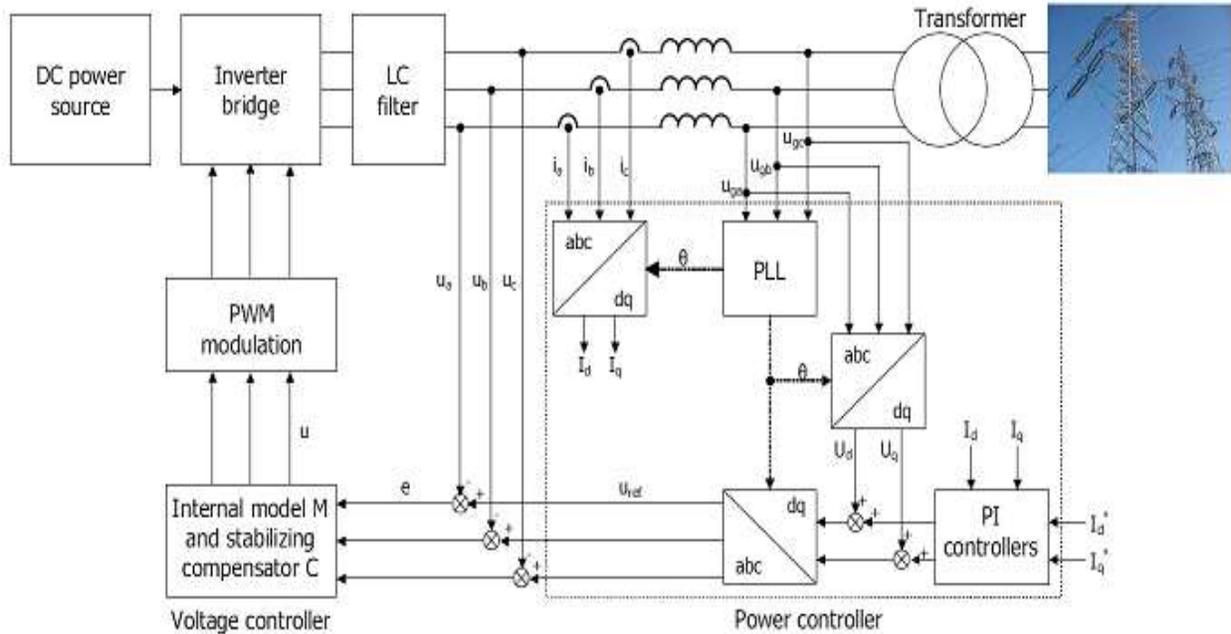


Fig.1 Structure of grid connected system with PLL

It is designed using solar/wind with hybrid controller. The inverter is synchronized with the help of PLL. The synchronization is compared with and without PLL.[9,10] Voltage source inverters connected to the grid in applications such as active power filters require synchronization with the grid voltage. Since in practice the grid voltage can be unbalanced and distorted, but the operation of the whole active filter control system is strongly dependant on precise estimation of grid voltage phase, the fundamental positive sequence phasor of the grid voltage has to be extracted. In this paper a system for smooth estimation of the position of the voltage phasor at the point of common coupling of a parallel active filter system is presented using a sinusoidal signal integrator and simple software PLL.[11,12,13] The performance of the proposed system is verified by simulation and experimental results. The proposed PLL scheme can also be used in other vector oriented control systems.

Electrical ratings for PV module & wind

Table-1 Electrical Specification of Hybrid System

Results and Discussion

Output voltage of Hybrid system is used as the input for inverter and the inverter is synchronized with PLL. The results are compared with and without PLL.

Table-2 Output of Hybrid System

S.No.	Terms	Ratings
1.	Total power output	1.4 KW
2.	Output Voltage Solar Module	24 V DC
3.	Output Voltage Wind Turbine Generator	230 V AC
4.	Output Voltage Diesel Generator	24 V DC
5.	Load Current	100 A

6.	Transformer (for wind output)	1:10 Stepped Down
7.	Converter	3 Phase (IGBT), 24 V DC

The output waveforms of voltage injected to grid, current injected to grid and active and reactive power with and without PLL are shown:

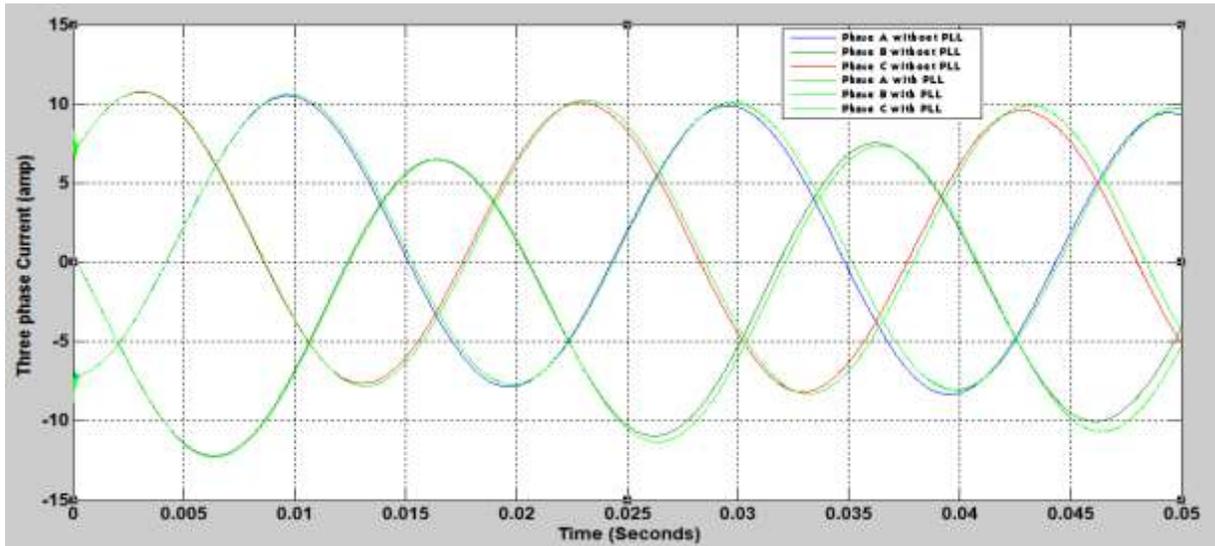


Fig.-2 Three phase current injected to grid

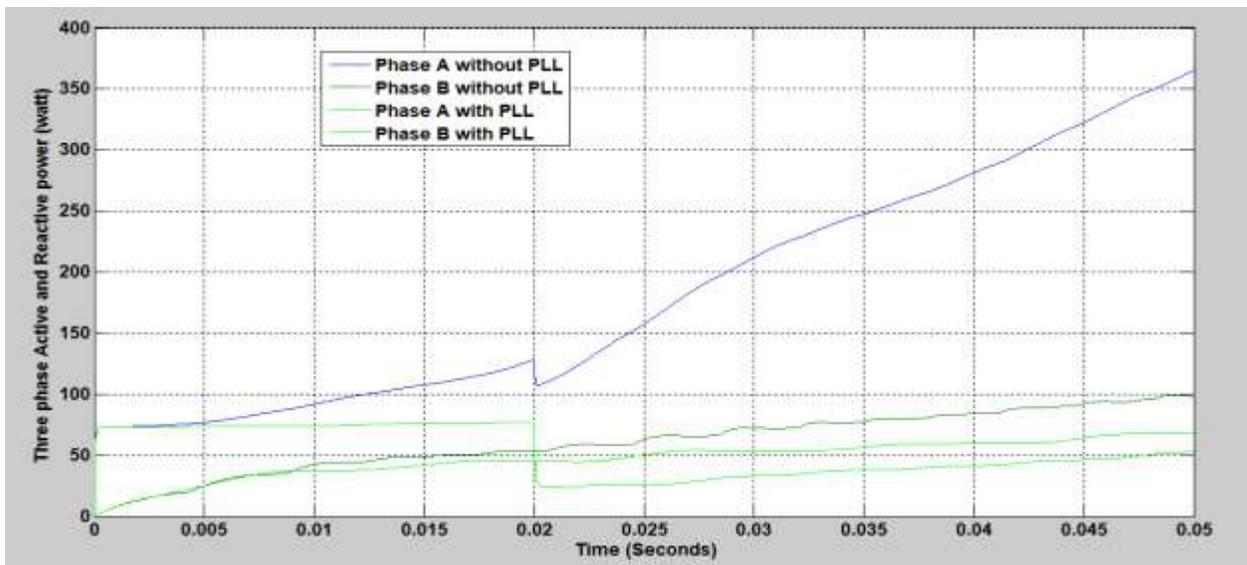


Fig.-3 Three phase Active and Reactive power

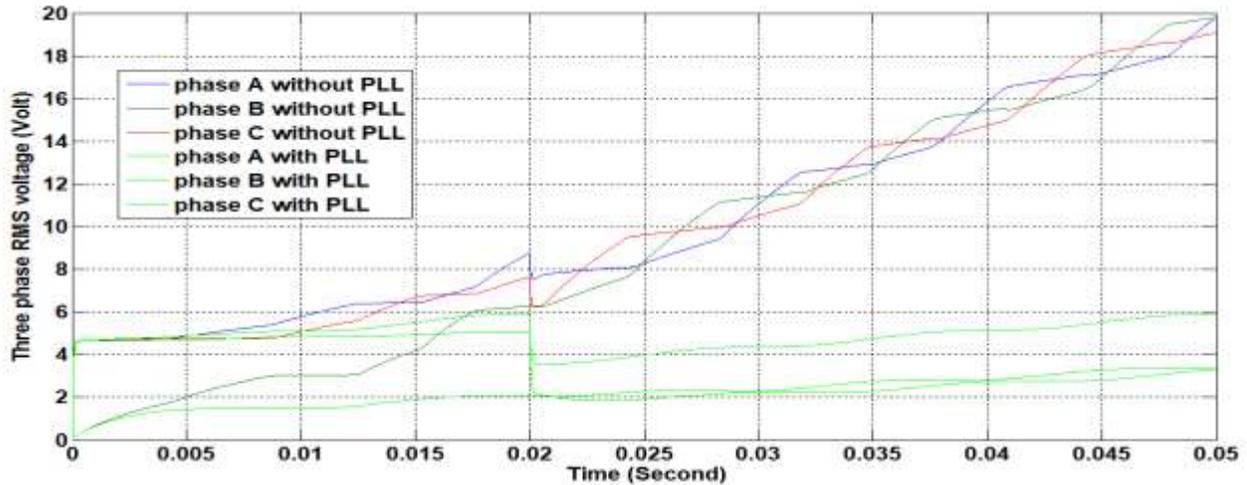


Fig.-4 Three phase RMS voltage

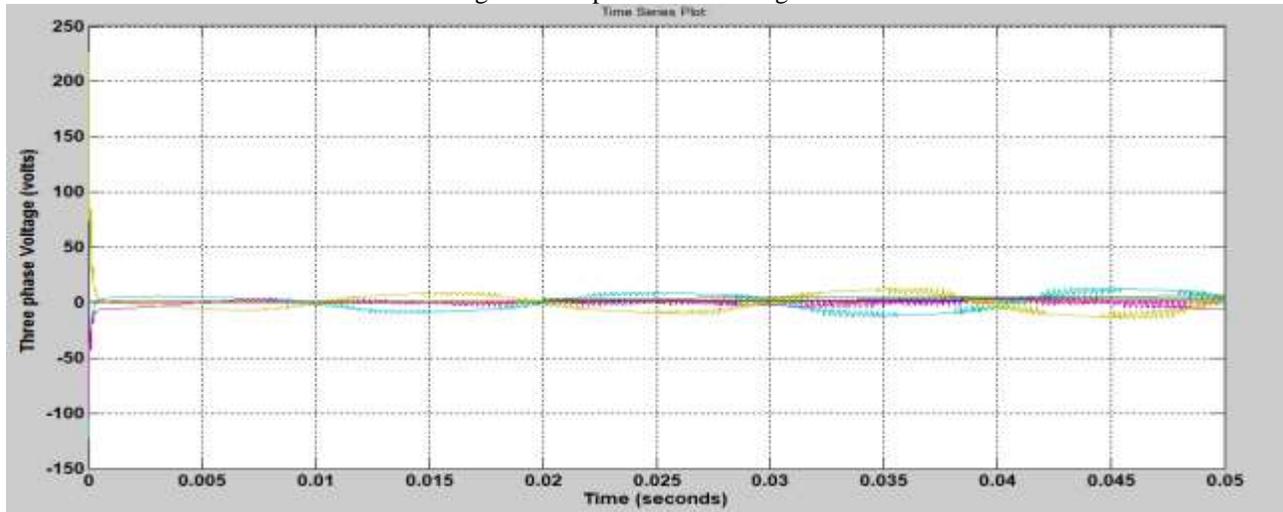


Fig.-5 Three phase Voltage injected to grid

The three phase voltage injected to grid is found within the permissible limit of 5% and frequency variation is of 2.5% which are under limit with the use of PLL.

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