Open loop control of grid connected inverter

Priyanka Patel[1], Grishma Patel[2], Unnati Mali[3], Yashvi Parmar[4], Nitiksha Pancholi[5], Chand Thakor[6]

[1 3,4,5,6] Assistant Professor, Electrical Engineering Department, C. G. Patel Institute of Technology, Gujarat, India
[2] Assistant Professor, Electrical Engineering Department, Faculty of Engineering Technology & Research, Gujarat, India

---

Abstract - *The increase interest in renewable energy production together with higher and higher demand from the energy distribution companies regarding grid energy injection and grid support in case of a failure raises new challenges in terms of control for DC systems. In order to feed power to utility a grid connected inverter is required as interfacing equipment. This paper deals with the implementation of open loop control method for the grid connected inverter. 120-degree mode of inverter control is used in paper for simulation. The control method gives less THD in inverter output current and the inverter output current is in phase with grid voltage so it gives unity power factor operation.*

Key Words: Grid connected inverter, open loop control, VSI, 120 degree mode, grid , voltage source inverter

1. INTRODUCTION

Solar, wind and hydro are renewable energy sources that are seen reliable alternative to conventional energy sources. Consequently, the control structures of grid connected inverter as an important section for energy conversion and transmission should be improved to meet the requirements to grid interconnection. Alternative energy sources such as fuel-cell, photovoltaic, wind power etc. requires a grid-connected inverter. Grid-connected inverter as interfacing equipment to feed the AC power to utility. Now-a-days renewable energy sources are becoming more popular just because of their various advantages & applications. In order to generate power to utility, a grid connected inverter is required.

1.1 Block Diagram

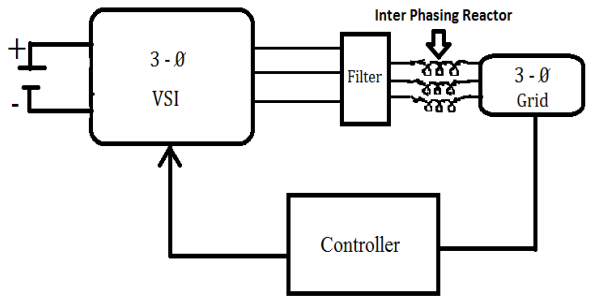

Fig -1: Block diagram of grid connected system

As shown in Fig- 1 DC voltage source is connected to voltage source inverter (VSI) which may be solar or wind and LC filter is connected to the output side of the VSI to reduce the output current harmonics. Inter phasing reactor is connected in series with LC filter to limit the high starting current and the output is supply to the grid. Different control strategies are used to control the grid connected inverter.

1.2 Objectives

- Inverter output current and grid voltage should be in phase.
- To achieve unity PF.
- Inverter output current should be pure sinusoidal.
- Total Harmonic Distortion of inverter current should be less than 5%.

2. OPEN LOOP CONTROL

Open Loop Control system also referred as non-feedback system, is a type of continues control system in which the output has no effect on the control action of the input signal. In other words, in an Open Loop control system the output is neither measured nor fed back for comparison with the input.

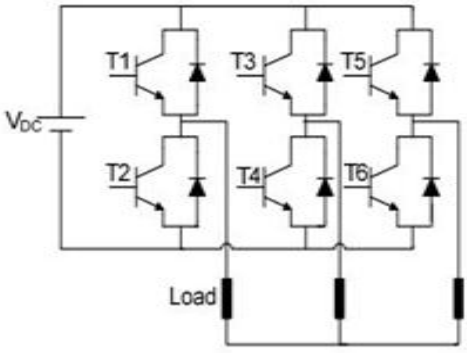

Fig -2: Voltage source inverter

Here in this paper 120 degree mode of operation is used. The 120 degree mode VSI, each IGBT conducts for 120 degree of a cycle. Like 180 Degree mode, 120 Degree mode inverter also requires six steps, each of 60 Degree

duration, for completing one cycle of the output AC voltage. During the first 120 degree, T1 conducts with T6 for 60 degree, and then conducts with T2 for another 60 degree. The T3 will conduct for 120 degree (from 120 to 240) for 60 (from 120 to 180) with T2 and then conduct another 60 (from 180 to 240) with T4. The T5 will conducts 120 (from 240 to 360) with T4 for 60 (from 240 to 300) and then conducts for another 60 (from 300 to 360) with T6. The conduction sequence can be written as follows: T6T1, T1T2, T2T3, T3T4, T4T5, T5T6, and T6T1. Fig-3 shows the gate pulses of 120 degree mode of operation.

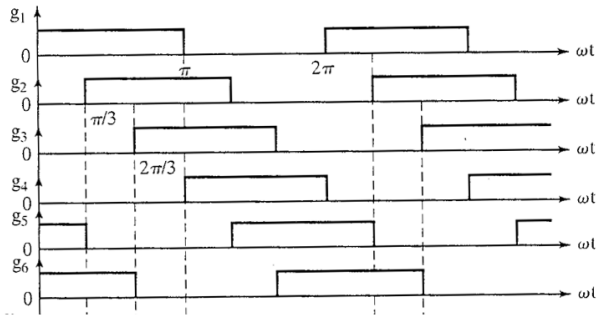

Fig -3: Gate pulses

3. SIMULATION AND RESULTS

3.1 Model of open loop control

Fig-4 shows simulation model of open loop control method.

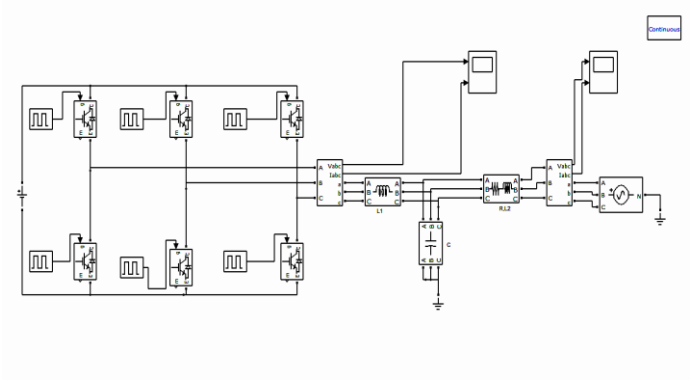

Fig -4: Simulation model

3.2 Parameters

- Vdc=676V;
- Vac=230v;
- f=50Hz;
- R=0.4ohm;
- C=0.01 microF;
- L1=200 mH;
- L2=0.1mH;

3.3 Waveforms

Fig-5 shows the waveforms of three phase grid connected inverter using open loop control method. Waveforms of inverter output current and grid voltages are shown.

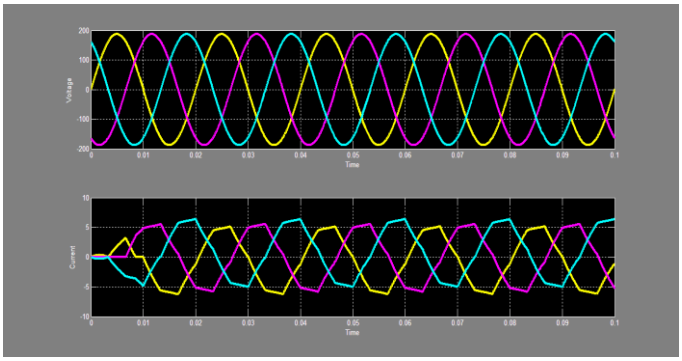

Fig -5: Waveforms of grid voltage and inverter output current

3.4 THD analysis

Total harmonic distortion of inverter output current is shown in figure.

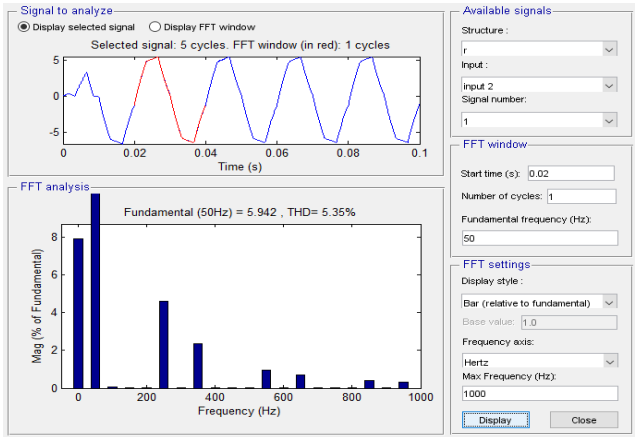

Fig -6: THD of inverter output current

As shown in figure THD of inverter output current is 5.35%.

3.4 Result analysis

Here simulation of grid connected inverter using open loop control is done. Waveforms of inverter output current and grid voltage are shown. Both the waveforms are in phase. So unity power factor operation is achieved but shape of inverter output current is not pure sinusoidal and THD of inverter output current is little bit more than 5%.

3. CONCLUSIONS

In open loop control power factor of inverter output current is good and THD is nearly about to 5% but shape of inverter output current is not pure sinusoidal.

REFERENCES

[1] Er. Shivani Dendavey and Er. Amol Barve, "Design of Renewable energy source based inverter with 120,150 & 180 degree mode of conduction with and without filter", International Journal of Science, Engineering and Technology Research (IJSETR), Volume-2, Issue-3, March 2013 ISSN: 2278-7798.

[2] A. Abobakr and A. Zekry. "Three phase grid connected inverter", PhD thesis. Cairo, Eygpt: Ain-Shams University, 2008.

[3] Qingrong Zeng and Liuchen Chang. "Study of Advanced Current Control Strategies for Three-Phase Grid-Connected PWM Inverters for Distributed Generation." Toronto, Canada : IEEE Conference on Control Applications, 2005