THREE PHASE INVERTER DESIGN FOR RENEWABLE ENERGY SOURCE BASED ON SVPWM TECHNIQUE

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Abstract

This paper has two main concepts adaptive and stabilizing control based on which inverter topology is configured. The adaptive control does not directly control time variable of stable variables .But the stabilizing method asymptotically controlling the error with the dynamics of the system response. The fourth order optimal load current observer control avoids the need of current control and also the support has been providing stability and control on the system reliability and size. Thus the stability of the system and current observer control are given by Lyapunov theory . The system design has a proper control and also fast small steady state error and total harmonic distortion could be recovered with higher dynamic response during balanced and unbalanced load conditions. The proposed system strategy properly provided with the help of simulation and also hardware system is provided with help of DSP processor.

Key Words*: Lyapunov theory, optimal load current observer control, DSP processor*

1. Introduction of DGS

Nowadays the energy demand is an exponential growth with respect to the future need for this the main reason is shortage and depletion of non-renewable sources; for overcoming the energy demand we may utilize the renewable energy sources instead of unrenewable, at present the power production using renewable source is major part in power production systems. The following resources are used for the power production as follows, wind power, PV system, bio mass, wave energy and small hydro power plant and so on, by comparing other energy resources the wind power production method is very the majority suitable due to economic viability of the renewable energy source.

For the production of small intermittent power generation (the production ranges from 20 kW to 20 MW) uses Distributed generation (DG) based on renewable energy system. For reducing the transmission cost and retrieving the line losses the power generating units may place at the end of customer / user end. For the reduction of transportation cost for the production and utilization points are minimized while the production system has been installed at the utilization end. The operation of a grid connected system and in inaccessible method with no lattice correlation that means micro grids are preparable in this type of power generating system. The block diagram for the following sketch shows the Distributed Power Generation System (DPGS) in Fig.1

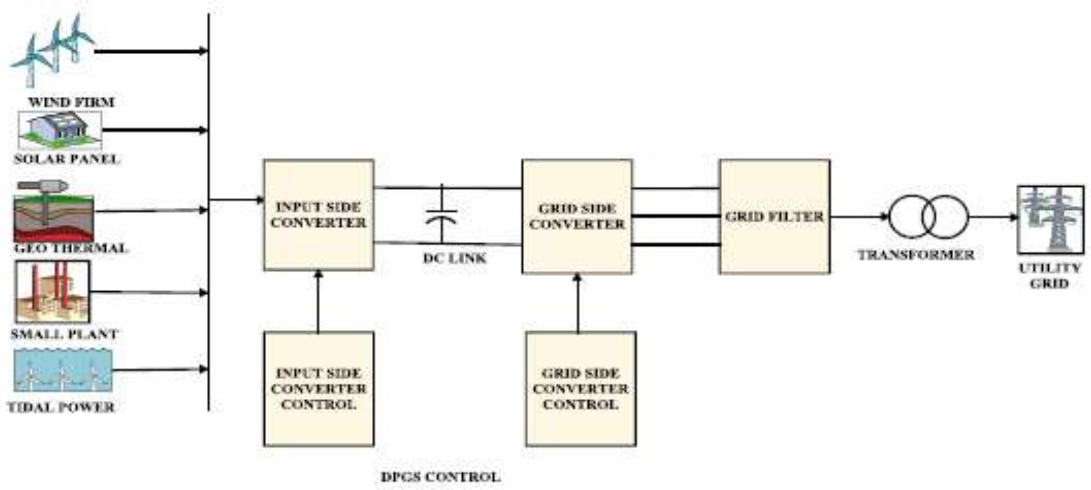

Fig.1 Block diagram for Distributed Power Generation system

The following sources are used as solar panel, geothermal, tidal turbine, and other small power plants as depicted in the above figure by giving as key in to the DPGS can be sourced by the wind firm. The control output voltage and frequency due to repugnance are produced by back to back converters connected to the input source to meet up the load and the grid fundamentals. It supplies to the power flow betwixt the source to grid and grid to source. The maximum power from the renewable source is recovered from this converter topology and to be depicting the power to grid side converter. The power flow control is achieved by grid side converter. And also this converter design technique helps to maintain its output voltage and frequencies based on the demand identified. The grid filters is nothing but the filter system which has been synchronized with the grid supply system. High switching frequencies are needed for these filters for the weak grid to achieve higher level harmonics, where the grid voltage is sensible for the load fluctuations. The three phases PWM inverter involves two steps control techniques, the first one is selection of intonation schemes which correspond to the open loop control scheme, the one is conception of dynamic close loop control scheme. Moreover, the main issue of the DPGS is reactive power control. For the few more control technique used for the reactive power control is in the transmission lines and generating units has been identified in the probe of the lose consciousness occur in U.S. and Canada in 2003 it was established that the cascade outages. To draw from the miniature signal sculpt scheme for single phase inverter design topology for on out-of-the-way approach and its routine by way of the multiple controllers' the platform is focused in this paper. In additional, this exertion is lengthened for the modelling of three phase grid connected Voltage Source Inverter and their appropriate transfer function are achieved by elaborating this project and we have used bode plots for deducing from the model of The controller design is based on the analysis of the system performance through well-known beginning of the control systems. The proposed system output is achieved and imitation by using MATLAB-Simulations.

2. Research Motivation

For the past few more years of the power demand has consistently exceeds in India has been increased and improved by the supply and substantial energy and peak shortages prevailed in 2009-10. The wind energy is to promising source of renewable energy system for recent power production methodology. At present India has got fifth place in installed capability of wind power plant. The wind energy availability is seasonal and region based that's why it wasn't such a dependable on condition that the Power Electronics were not highly developed a lot. At present, by comparing other renewable energy resources the interface between the Power Electronics has been made with the usage of the wind power organism one of the trustworthy source. The new control technique can be used for the stability and synchronization with utility to the grid. The voltage source inverter used for this one.

3. Distributed Generation Systems

The renewable energy sources of (such as the wind turbine, PV array structures, biomass production, and battery cells) are used for The Distributed generation systems (DGSs). For replace existing fossil fuels based power production and reduces global warming gas emissions the DGS electric power production is fitted for the

requirement. In recent days, the grid-connected applications are use the DGSs, for the purpose behind this one is most preparable for the rural and remote islands, for they are more economical adaptable system in a stand-alone operation. An uninterruptible power supply (UPS) is used in unrelated system based applications and the inverter of the DGS connected with this.

In recent years the researchers are focusing the new control technique in stand-alone DGSs and UPSs. The inverter output voltage and regulation and performance of the system is fed to the calculated load supply demand and the usage of nonlinear load. In this project has been investigated the conventional proportional–integral (PI) type of controller. On the other hand, the output voltage of the DGS has the steady-state error is considerable amount and its THD is not in specified range in the case the transient response time, steady-state error and total harmonic distortion (THD). What is more, the inverter output voltage is extremely unnatural in their quality by different type of loads such as sudden load change, unbalanced of nonlinear load. The $H\infty$ loop-shaping be in command of the schemes which are presented in also can't effectively extenuate under nonlinear load by the THD of the output voltage. Hence, the advanced control algorithms are developed to achieve better voltage parameter, concert, under the sudden changes of load load-side inverters. It must be needed for the reduction of the production systems' disturbance, unbalanced load, and nonlinear load etc.

In recent, a variety of sophisticated control strategies comprise be executed in load-side inverters for the DGS and UPS applications. During a monotonous direct system is used to manage UPS inverters, but the universal difficulty with a monotonous organize is the system has slow reaction and be short of of methodically scheme to become stable for the dynamic errors.

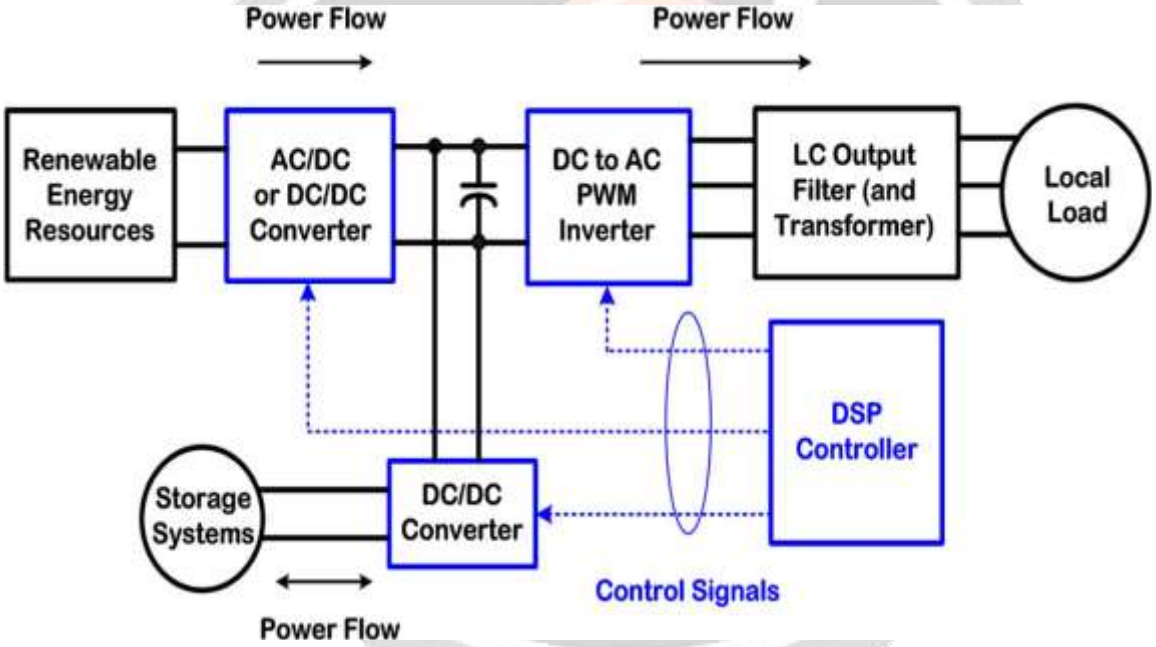

Fig.2. Constellation for stand-alone operating system of DGS

In this paper the view of linearization be in command of methodologies are planned. Even if the following methods can be achieved high act of the output voltage, the control plan schemes give the impression for the problematical one. Here we can describe two iterative learning control techniques are presented. For achieving high response the above stated methodologies are very useful. Nevertheless, the switching frequencies of the inverters are extremely soaring, so it has comparatively massive switching losses in its result. In this copy analytical run with a load is proposed in with the help of current observer. While its controlling methods are simplest, When the THD of the output voltage is high. Here one more extrapolative control technique is proposed; here the nonlinear load isn't investigated. In a full-bodied, PI controller is proposed for a self-governing DG production division. The results are presented in this case of unstable *RLC* load, other than the outcome regarding nonlinear load aren't presented. Sliding-mode control technique is applied for the inverters manipulative. Within this experimental results are show that the output voltage THD is still high under nonlinear load. Even though high-quality presentation can be achieved, the controller blueprint method are only for single-phase inverters and the results of nonlinear load aren't

presented. In a rich servomechanism control (RSC) control technique is second-hand to run three-phase inverters of a DGS in individual method. Still despite the fact that these control procedure can get hold of the good quality routine and it is pretty complex in addition to the requirements demand variables' values of *RLC* load. In this paper we propose the control methodologies so as to consist of an RSC uses the controlling methods of outer loop and a sliding-mode control in an inner loop. The mock-up and investigational outcome are illustrating superior voltage show, but the control move toward is extremely problematical.

The proposed control method can be achieved excellent voltage regulations such as fast transient behaviour, small steady-state error, and low THD underneath unexpected load change, deranged load, and nonlinear load. In favor of a proportional revise structure, the reaction of linearization for the multi input and the multi output (FL-MIMO) control methods are enforced in this paper. Simulations are done in Matlab/ Simulink software.

For on-site generation the DGs are used, it can generate electricity from many small energy resources. For the small generating units of ranges betwixt 30MW the DGs are applicable or it is used to near customer sites to meet specific customer needs, this can be supporting the economic operation of the existing distribution systems. Reliability of the overhaul and the quality of power has been improved by the propinquity to the purchaser. Whereas central power system remains critical to the supply scheme of a particular nation's energy Demand and then its flexibilities are restricted. To achieve the better response and reduced capital cost for the investment for installing DG it can be used to the incremental jump of power supply system in power demand. The improvement of the effective utilization of the generated electric power production is achieved by interconnecting the grid and DG systems. The peak shaving, renewable portfolios, transmission and distribution infrastructure deferral are a bunch of financial, ecological factor and incentive like, which gives further, distributed generation. There are many types like traditional in addition to up-and-coming technology of (fuel cells, micro-turbines, sterling engines, PV, wind turbines) used for the distributed power generation, there are two types of interfaces for grid interconnection are available in this present scenario: the first method is rotating machines which has been included the synchronous machine and induction machine. The overall power-conditioning system is the subsequent method of design as a part of the inverter; for the conversion of variable frequency, AC sources is variable voltage or the regulated DC supply is produced to achieve the frequency/voltage control of AC sources can be achieved by interconnecting inverters with the grid. Here we are focusing on the installation of new distributed generation.

For avoiding the debasement of power quality, consistency, along with the organize of the convenience arrangement of the DG units are needed. For the large-scale generation and transmission system, due to the complexity of the operation conditions DGs are creating difficulties in evaluating reliability indices. The most and very big issue is maintaining power quality in the power production over the last few decades of years due to the constantly escalating the use of power electronics applications and perceptive load apparatus. The real and reactive power flow can be controlled by an inverter interlink with a grid-connection is the great importance and interest. The power flow studies and dynamic analysis of distribution systems are very necessary for the distributed generation there is a possibility of quality power production. The stability of the power system can be affected by the connection between the DG to the grid, i.e. angle, frequency and voltage stability. Due to the unpredictability of voltage fluctuation in interconnecting DG and grid may cause to instability. The performance of a large system isn't to the highest degree exaggerated by an in-between incremental or detrimental of power production in the generating system. The short term disturbance could be lead to an uncontrolled state for generating system when the system is relatively small. For the control of voltage level at nodes when the DG units are in stand-alone mode. The relay protection creates the significant impact by connecting DG. Under normal operating condition and under fault condition the system's power flow by including the DG can change the direction. For the detailed study of the impacts the power flow factors are necessary. The conventional power generating system is differs with this and the performances, power quality constraints, market participation strategy and to manage the equipped strategy. The main reasons are:

- Steady-state and dynamic characteristic of DG unit is different from the other conventional large turbine-generator units.
- By interlinking the single-phase loads and DG units adds importantly to the voltage imbalance of the micro-grid supply system.
- The micro-grid interface of DG with the Wind-based units is uncontrollable sources of energy so it could produce unstable voltage.
- The energy storage units are the basic things for the control and operation of a micro-grid.
- The connection and disconnection of DG units are the economic considerations and they are generally prescribed by their operation.
- The quality power levels are pre-determined in certain loads. The micro-grid has to stickout by this.

4. Islanding

Among all the technical issues are produced by DG interconnections are the problem of islanding. The condition of islanding is that which has a portion of the utility system consisting of both load and generating units are isolated from the take it easy of the effectiveness of the structure and then continue to work under its own. The reliability of the utility grid and the safety measures must meet with the technical requirements of the PV system installer. The design methodology of culpableness and isolated operations are made with the grid-connected micro-grids, the grid-parallel operation with the standalone operation can be challengeable one. In some other cases, the DG unit can be continued to supply local loads when the occurrence of the shutdown of the main grid is cut-off. The local loads shares the power outage betwixt the time duration of seconds and minutes, depends only that the production property in attendance surrounded by the micro-grids power distribution. The disturbance or transient effects are to the loads with the micro grids isn't acceptable while considering so many conditions. For a flawless transition control technique is required negligible disturbance. The intentional islanding could be derived from the transition process.

While demonstrating fast transient disturbance rejection qualities of voltage and frequency regulations are the causes for the intentional islanding control. The huge voltage and frequency transients are prevented from the main grid that generally follows. The load demand and the magnetizing inrush motor current are excess while before connecting to the DG and also it can be able to support the transient. While making grid-connected and micro-grids the premeditated islanding is one of the most considerable challenges and which one is the attractive solution for high-reliability customers. While entering into the DG market the main consideration is standards compliances are focused. The voltage regulation and integration all are must meet the technical requirements in various standards, the utility operator with area EPS grounding should be matched. The inter-connection interfaces are must required some basic system design features such as harmonics, DC injection, and anti-islanding. In some other situations where the primary system and the intentional islanding are concentrated by the substantial engineering attempt and the island includes a part of in it, for that it could need the control and communication systems. The negative impacts on protection system may cause by the following kind of islanding conditions in various parameters change occurring in the operational strategies of and management of power transmission and distribution systems. For that reason, it is essential to cram the islanding surroundings and method for disconnect DG from the distribution system. The disengagement of the DG from the set of connections has been addressed up to that time for an assortment of conditions is discussed. In earlier stage by implementing the standards and recommended practices are to establish the system requirements. While installing us have to consider the new standards and here there are not well-established practices and solutions for this problem. The unintentional islanding is the main requirements of design consideration.

The grid-protection devices, equipment harm, and even personnel safety hazards are the power quality issues results from the unintentional islanding. We must study the various anti-islanding methods for preventing power transmission system from the islanding phenomenon, which are differentiated by passive and active methods. The OV/UV relay inverters are equipped with the OF/UF relays, the basic passive anti-islanding methods are used in this type of inverter. These passive schemes have relatively large NDZ for the reason that of it can only monitor the voltage enormity or frequencies of the 6 PCC at the PV based inverter outputs are monitored by the passive anti islanding method.

5. System Impacts of DGS

In urban distribution and transmission lines networks have the effect of line or cable resistance on voltage drop is small while comparing its specific magnitude is generally much less than the reactance of the transmission and distribution networks. Thence, the voltage drop and line losses are the most important parameters of the transmission line. the reactance change is respect to the line constraints. In rural power distribution systems, the resistance in the distribution lines is over and over again outsized. The distribution line resistance causes an important quantity of the voltage drop by the side of with the distribution lines and the line losses. The influence on the local voltage level is based on the connection of DG.

6. Modeling of 3-Φ Inverter

For the interfacing of distributed power generation between dc and ac systems used the three phase VSIs. For the continuous dc link voltage dissimilar control technique has been applicable for the control of active and reactive power the length of the three phase grid associated VSI. On the other hand, modelling of a regulator with

help of a diminutive warning sign representation is a distinguished practice within dc-dc converter. While designing a control system the control variables are manipulated from the transfer functions derived from the control system based system design. And then by using averaged switched modelling technique the transfer functions are deduced. In recent technology improvements all the applications are operated with the help of power electronics devices. At present moment in time of design a linear feed-back control technique used for the multiple power stage must be literalized in order to development of better performance.

6.1 Power Stage Model

The power circuit model is represented in multiple power production stages. The synchronous rotating reference frames used for the grid connectivity parameters and the elimination of unwanted disturbances are reduced by the use of second order LC filter.

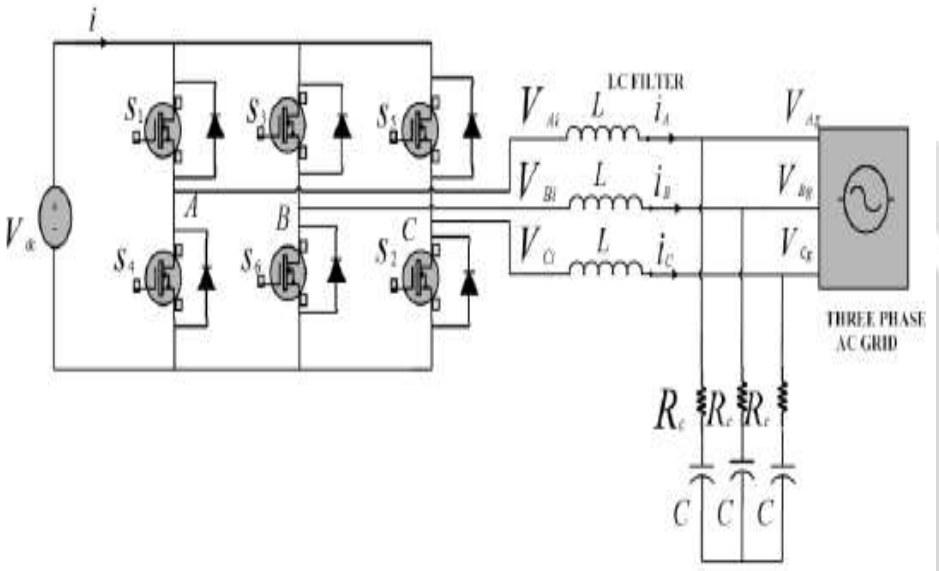

Fig.3 The grid connected VSI with LC filter for three phase inverters' functional block diagram.

In Fig.3 three phase grid connected VSI is shown with the addition of LC filter. VAi, VBi and VCi are the voltages at the inverter output and VAg ,VBg, VCg are the voltages at the grid end. By applying voltage balance equation

$$\Rightarrow \begin{bmatrix} V_{Ai} \\ V_{Bi} \\ V_{Ci} \end{bmatrix} = L\frac{d}{dt}\begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix} + \begin{bmatrix} V_{Ag} \\ V_{Bg} \\ V_{Cg} \end{bmatrix}$$

where L= inductance with negligible resistance.

$$\Rightarrow \begin{bmatrix} V_{di} \\ V_{qi} \end{bmatrix} = L\frac{d}{dt}\begin{bmatrix} i_d \\ i_q \end{bmatrix} + \begin{bmatrix} V_{dg} \\ V_{qg} \end{bmatrix} + \omega L \begin{bmatrix} -i_q \\ i_d \end{bmatrix}$$

7. Result and Discussion

7.1 Adaptive Voltage Controller Design

In this proposed Adaptive voltage controller design has the following remarks:

Remark 1: The controller gains are preferred based on the remark discussed in the references. The adaptive gains *mdi* and *mqi* are included in the recompense the control terms *uffd* and *uffq* as depicted. To realize the transient response in the adaptive gains are tuned to fat standards.

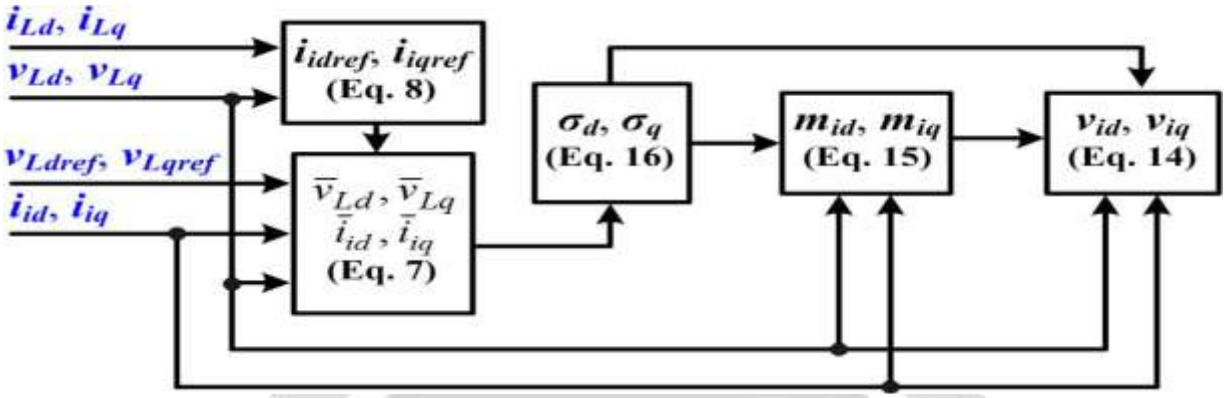

Fig.4 Schematic diagram for the proposed adaptive voltage control method.

Alternatively, the feedback terms of *ufbd* and *ufbq* given, *σd* and *σq* are further defined, a proportional–differential (PD) controllers' feedback response can be registered. The controllable parameter *αd*, *αq*, *δd*, and *δq* can be determined based on the fine-tuning rule. In conclusion, all the tuned quantities of the *αd*, *αq*, *δd*, *δq*, *φdi*, and *φqi* must be following procedure:

1) For tuning the parameters of *αd*, *αq*, *δd*, and *δq* the tuning rule must be used.

2) The set values for the following variable *φdi* and *φqi have the large response*

3) The transient performance is inacceptable range it could be carry covered by the current control variable methods.

Remark 2: From the proposed voltage controller technique which includes two parts: the first method is feedback terms and the second method is adaptive compensation expressions. The dynamic and static errors of the proposed system are achieved by the control methodology of feedback term. Consequently, the proposed control procedure can accomplish superior concert by means of the subsistence of the constraint and suspicions and noises in put into practice.

7.2 Simulation result

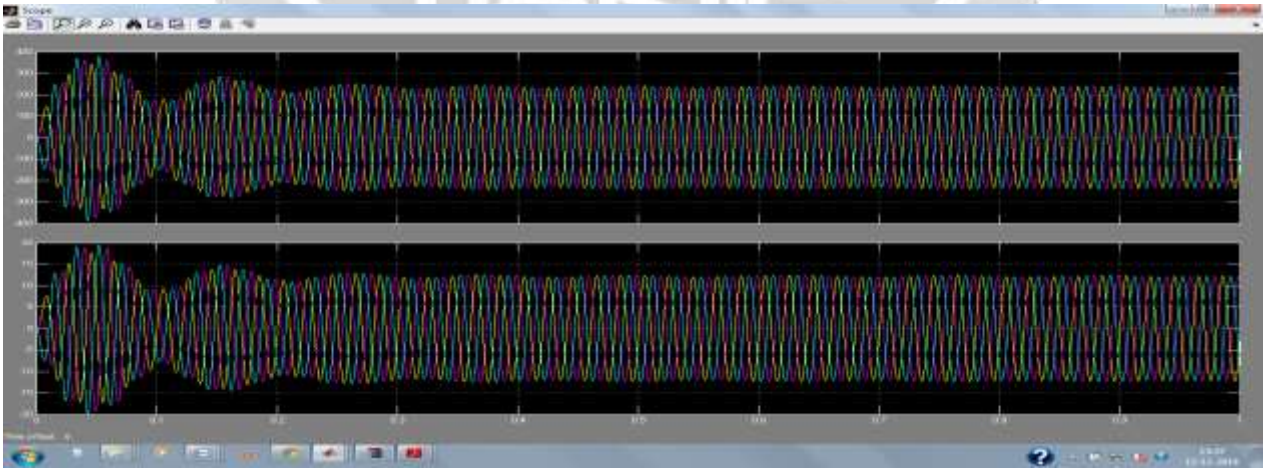

Fig:5 Source voltage & source current

8. Conclusion

The proposed system will have a proper voltage control followed by having Three phase PWM inverter for DGS system Three phase PWM inverter for DGS system. The load current information was obtained from fourth order optimal observer which has the proper provision to control. The system optimal load current observer and the stability studies are provided by means of Lyapunov theory .The proposed system for linear and non linear load is provided by means of the adaptive control with MIMO topology . Thus the simulation results clearly say the system is ideal and has good control.

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