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Study of Inverter Controller in Saps system for Grid Connected Load

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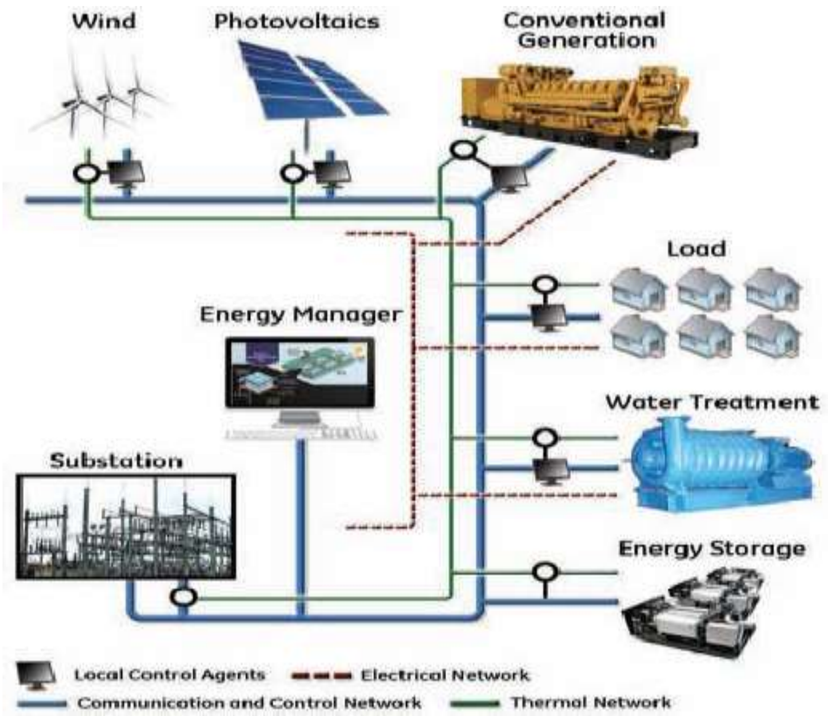
Abstract

Now a day's solar, wind are the best alternative solution for meeting the energy demand especially in areas were electrification is an great issue. They are combine to develop a hybrid power station. The main issue that arises in hybrid power generation using renewable energy sources is the conversion efficiency and performance. A lot of research is going on to improve the power quality on controllers and converters. Also lots of optimization techniques have been developed so far for maximizing the performance & minimizing the cost. This project is focused on the control structure of grid connected inverter as it is the important section for transmission &conversion of energy to meet grid requirement for interconnection. In this project, a simulation of grid connected control of converter is presented for hybrid power generation. The structure for the control at grid-side inverter is firstly discussed. Secondly, the space vector modulation SVM is presented. Thirdly, the synchronization for grid-connected inverters is discussed. Finally, the simulation of the grid-connected inverter system using PSIM simulation package and the system implementation are presented to illustrate concepts and compare their results.

Keyword: - Stand alone power system, PLL , Inverter

Introduction

General information regardinggird As electric distribution technology steps into the next century, many trends are becoming noticeable that will change the requirements of energy delivery. These modifications are being driven from both the demand side where higher energy availability and efficiency are desired and from the supply side where the integration of distributed generation and peak- shaving technologies must be accommodated



Power systems currently undergo considerable change in operating requirements mainly as a result of deregulation and due to an increasing amount of distributed energy resources (DER). In many cases DERs include different technologies that allow generation in small scale (micro sources) and some of them take advantage of renewable energy resources (RES) such as solar, wind or hydro energy. Having micro sources close to the load has the advantage of reducingtransmission losses as well as preventing network congestions. Moreover, the possibility of having a power supply interruption of end-customers connected to a low voltage (LV) distribution grid (in Europe 230 V and in the USA 110 V) is diminished since adjacent micro sources, controllable loads and energy storage systems can operate in the islanded mode in case of severe system disturbances. This is identified nowadays as a gird. Figure 1.1 depicts a typical gird. The distinctive gird has the similar size as a low voltage distribution feeder and will rareexceed a capacity of 1 MVA and a geographic span of 1 km. Generally more than 90% of lowvoltagedomestic customers are supplied by underground cable when the rest is supplied by overhead lines. The gird often supplies both electricity and heat to the customers by means of combined heat and power plants (CHP), gas turbines, fuel cells, photovoltaic (PV) systems, wind turbines, etc. The energy storage systems usually include batteries and flywheels [2].The storing device in the gird is equivalent to the rotating reserve of large generators in the conventional grid which ensures the balance between energy generation and consumption especially during rapid changes in load or generation[3].

From the customer point of view, girds deliver both thermal and electricity requirements and in addition improve local reliability, reduce emissions, improve power excellence by supportive voltage and reducing voltage dips and potentially lower costs of energy supply. From the utility viewpoint, application of distributed energy sources can potentially reduce the demand for distribution and transmission facilities. Clearly, distributed generation located close to loads will reduce flows in transmission and distribution circuits with two important effects: loss reduction and ability to potentially substitute for network assets. In addition, the presence of generation close to demand could increase service quality seen by end customers. Girds can offer network support during the time of stress by relieving congestions and aiding restoration after faults. The development of girds can contribute to the reduction of emissions and the mitigation of climate changes. This is due to the availability and developing technologies for distributed generation units are based on renewable sources and micro sources that are characterized by very low emissions [4]There are various advantages offered by girds to end-consumers, utilities and society, such as: improved energy efficiency, minimized overall energy consumption, reduced greenhouse gases and pollutant emissions, improved service quality and reliability, cost efficient electricity infrastructure replacement[2].

Technical challenges linked with the operation and controls of girds are immense. Ensuring stable operation during network disturbances, maintaining stability and power quality in the islanding mode of operation necessitates the improvement of sophisticated control strategies for gird's inverters in order to provide stable frequency and voltage in the presence of arbitrarily varying loads [4]. In light of these, the gird concept has stimulated many researchers and attracted the attention of governmental organizations in Europe, USA and Japan. Nevertheless, there are various technical issues associated with the integration and operation of girds.

Technical challenges in gird

Protection system is one of the major challenges for gird which must react to both main grid and gird faults. The protection system should cut off the gird from the main grid as rapidly as necessary to protect the gird loads for the first case and for the second case the protection system should isolate the smallest part of the gird when clears the fault [30]. A segmentation of gird, i.e. a design of multiple islands or sub- girds must be supported by micro source and load controllers. In these conditions problems related to selectivity (false, unnecessary tripping) and sensitivity (undetected faults or delayed tripping) of protection system may arise. Mainly, there are two main issues concerning the protection of girds, first is related to a number of installed DER units in the gird and second is related to an availability of a sufficient level of short-circuit current in the islanded operating mode of gird since this level may substantially drop down after a disconnection from a stiff main grid. In [30] the authors have made short-circuit current calculations for radial feeders with DER and studied that short-circuit currents which are used in over-current (OC) protection relays depend on a connection point of and a feed-in power from DER. The directions and amplitudes of short circuit currents will vary because of these conditions. In reality the operating conditions of gird are persistently varying because of the intermittent microsources (wind and solar) and periodic load variation. Also the network topology can be changed frequently which aims to minimize loss or to achieve other economic or operational targets. In addition controllable islands of different size and contentcanbeformedasaresultoffaultsinthemaingridorinsidegird.

InsuchSituations a loss of relay coordination may happen and generic OC protection with a single setting group may become insufficient, i.e. it will not guarantee a selective operation for all possible faults. Hence, it is vital to ensure that settings chosen for OC protection relays take into account a grid topology and changes in location, type and amount of generation. Otherwise, unwanted operation or failure may occur during necessary condition. To deal with bi-directional power flows and low short-circuit current levels in girds dominated by micro sources with power electronic interfaces a new protection philosophy is essential, where setting parameters of relays must be checked/updated periodically to make sure that they are still appropriate.

Methodology adopted

1 This chapter outlines the overall control strategy of the proposed renewable energy- based hybrid power system.
2 This system consists of a wind turbine, fuel cell, electrolyzer, battery storage unit, diesel generator and a set of loads.
3 The system's overall control strategy is based on a two-level structure.

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4 The top level is the energy management and power regulation (EMPRS) system. Depending on wind and load conditions, this system generates reference operating points to low level individual sub- systems.
5 It also controls the load scheduling operation during unfavorable wind conditions with inadequate energy storage in order to avoid system black-out.
6 Based on the reference operating points of the individual sub-systems, the local controllers control the wind turbine, fuel cell, electrolyzer, battery storage and diesel generator units.
7 The proposed control system is implemented with MATLAB/Simpower software and tested for various wind and load conditions.
8 Results are presented anddiscussed

Proposed System Parameter

The parameters used for the proposed hybrid stand-alone power system are shown in **Table**

Permanent Magnet Synchronous Generator	
Number of pole pairs	4
Rated speed (rpm)	1260
Rated power (kw)	1
Stator resistance (ohm)	5.8
Direct inductance (mh)	0.045
Quadrature inductance (mh)	0.102
Inertia	0.011
Wind turbine	
Rated power (kW)	1.1
Base wind speed (m/s)	12
Series inductance (mh)	13
Shunt capacitance (micro F)	20
Emergency Storage System (Section A)	
Number of battery in series	12
Number of battery in parallel	1
Rated voltage (volt)	4.2
Rated current (amp)	5
Rated capacity (amp-hour)	0.1
Emergency Storage System (Section B)	
Number of battery in series	12
Number of battery in parallel	200
Rated voltage (volt)	4.2
Rated current (amp)	5
Rated capacity (amp-hour)	20
Solar cell	
Nominal voltage (volt)	24.23
Nominal current (amp)	52
Number of cell	42
Operating temperature (Oc)	55
Rated power (kW)	1.26

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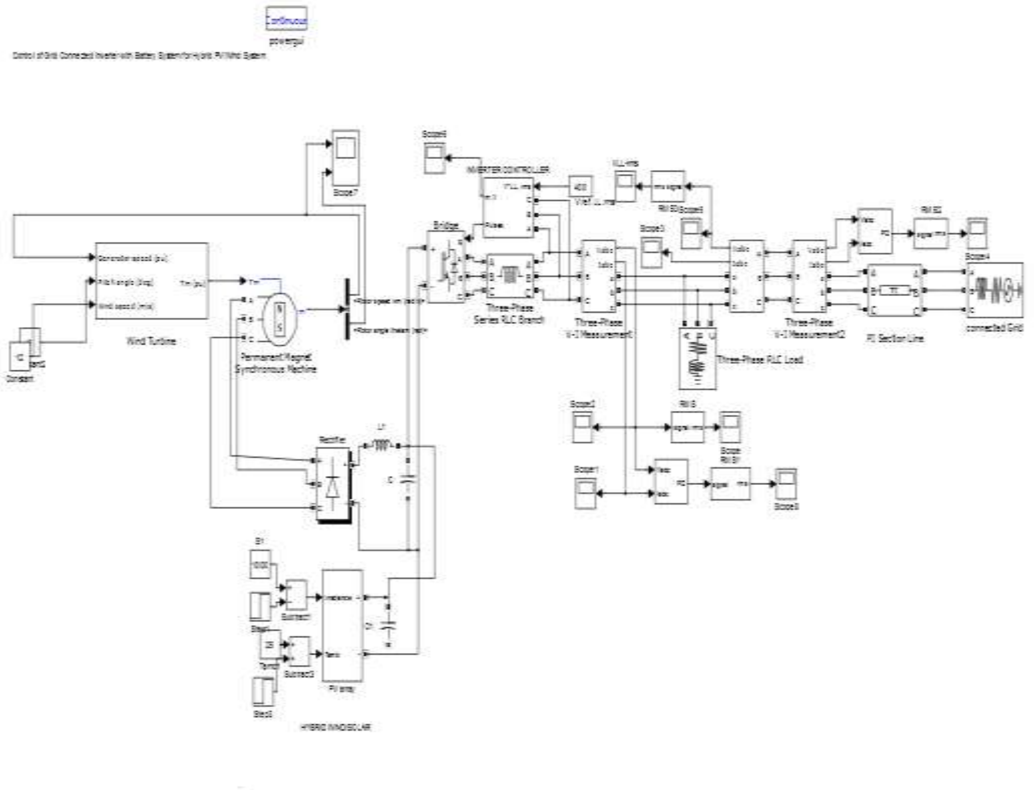
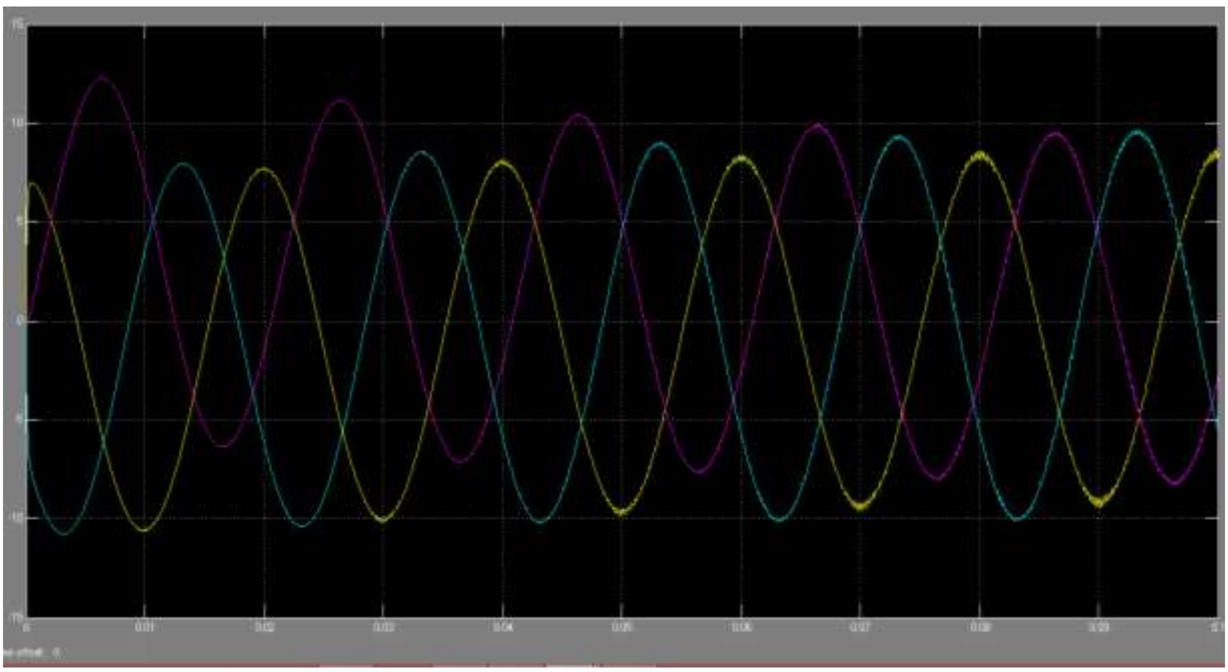
Results & Discussion

Simulation of grid connected inverter for standalone power supply system.

The modeling of SAPS system (PV/Wind Hybrid) is done in MATLAB. The simulation is further done using Phase lock loop for synchronization of grid and PID controller is used for inverter control.



Three phase current Waveform of inverter with respect to time



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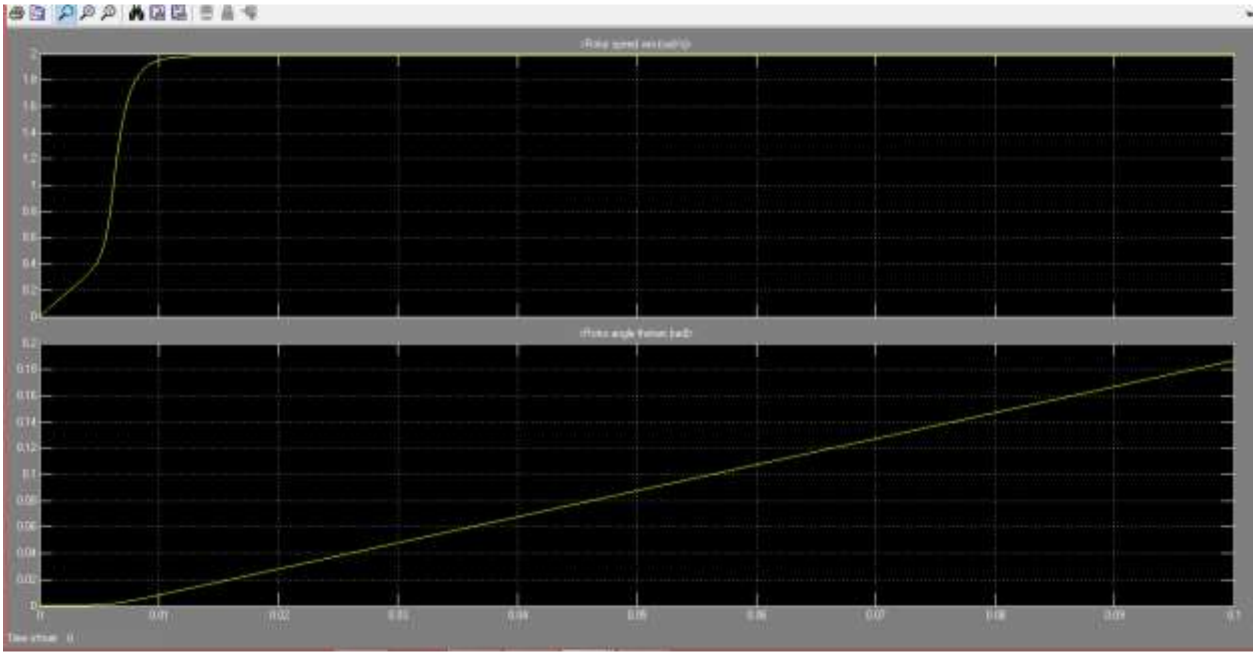
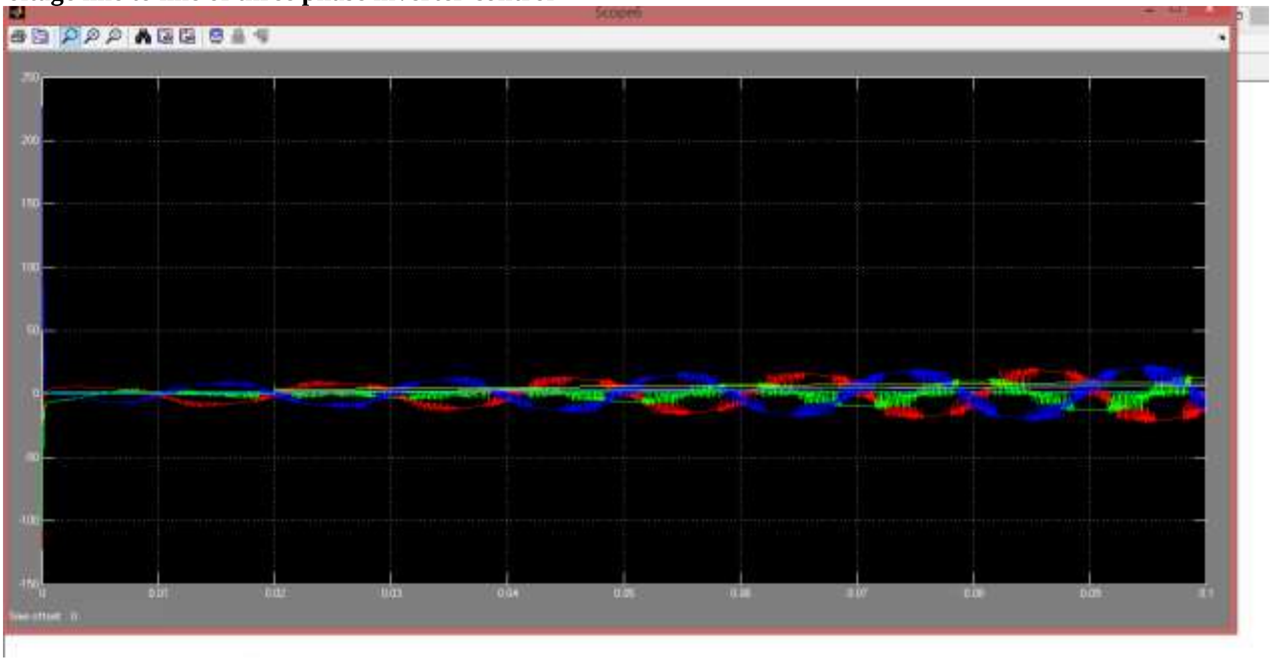
Output Voltage profile of Hybrid (PV/Wind) with respect to time



Voltage line to line of three phase inverter control



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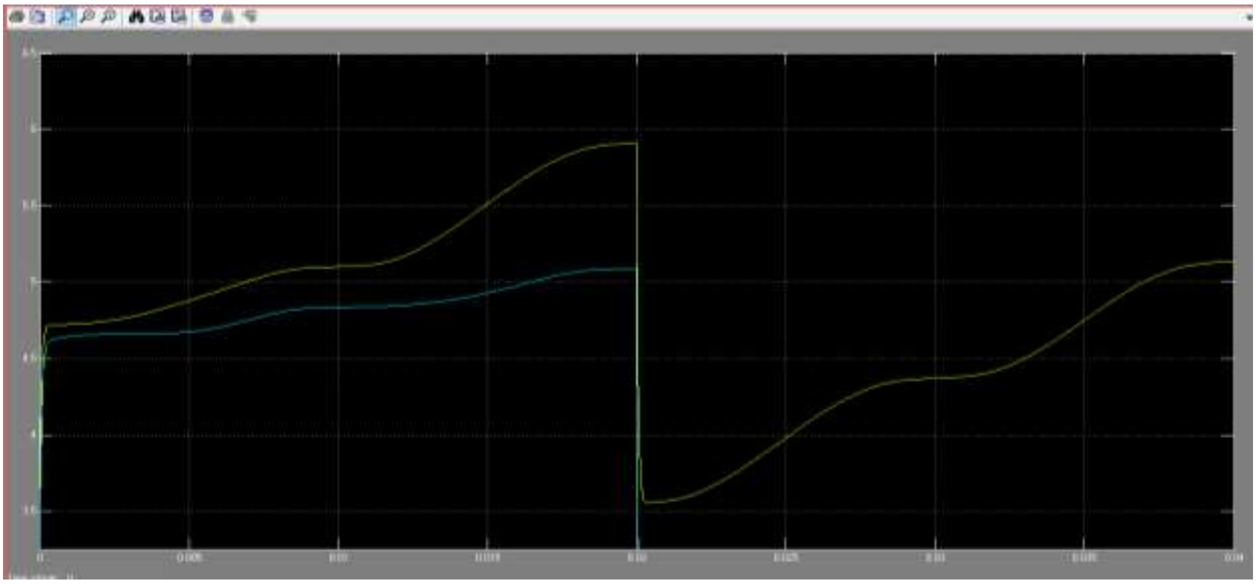
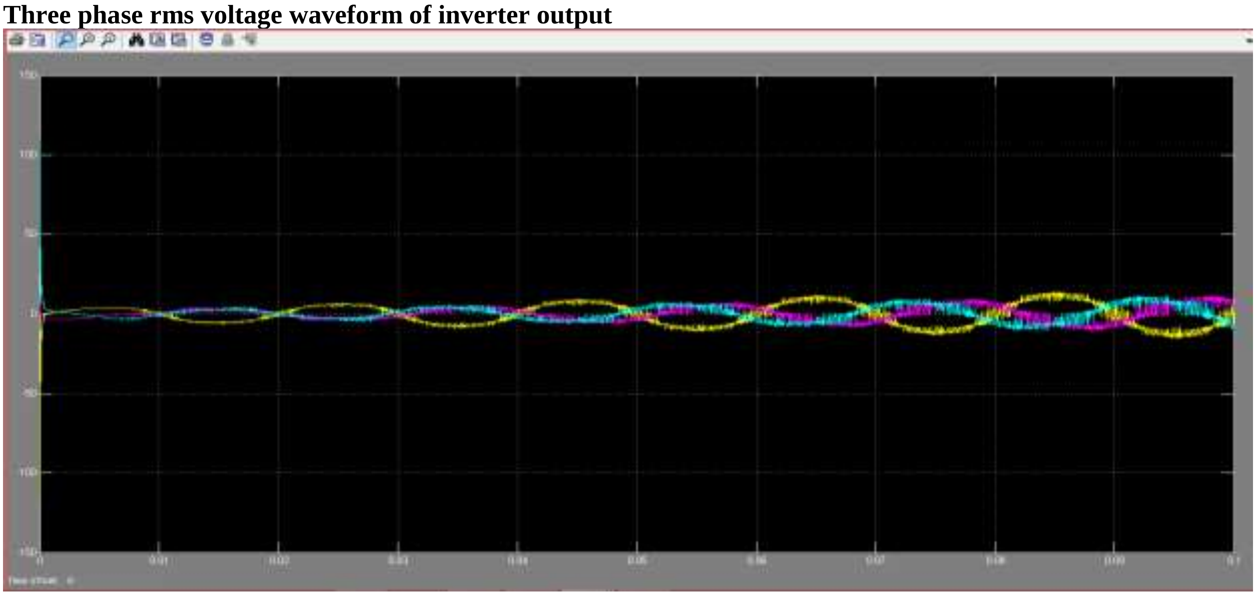
Waveform of signal rms voltage



Three phase rms voltage waveform of inverter output



Waveform of signal rms current

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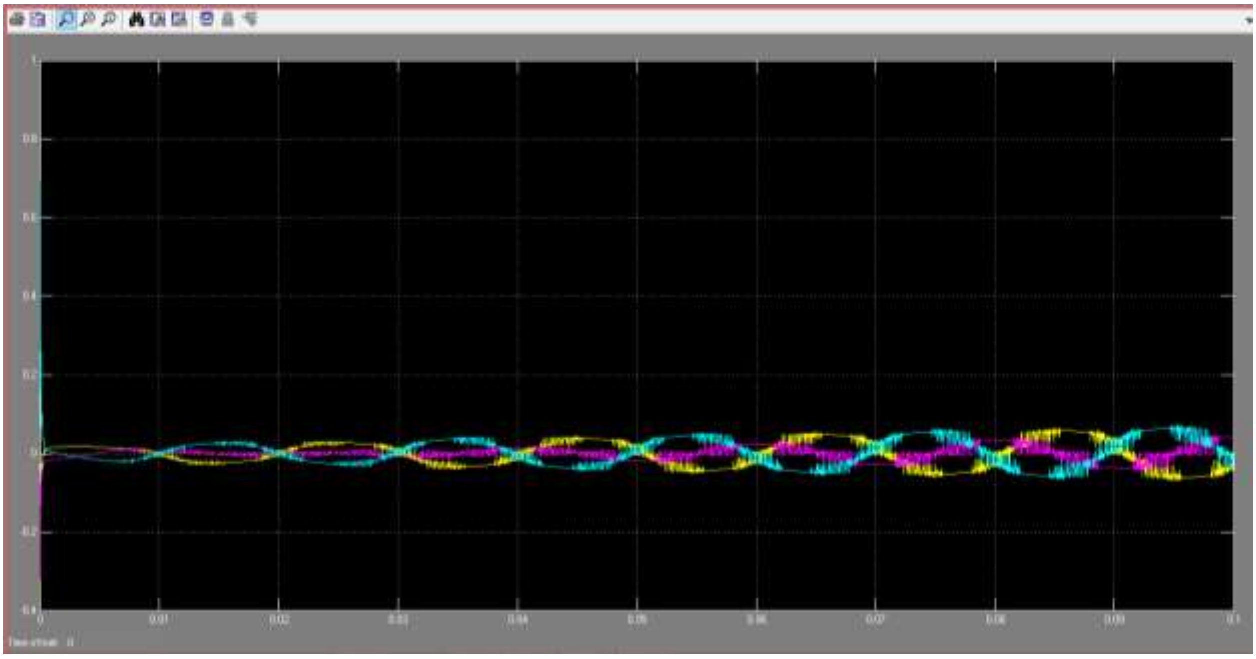
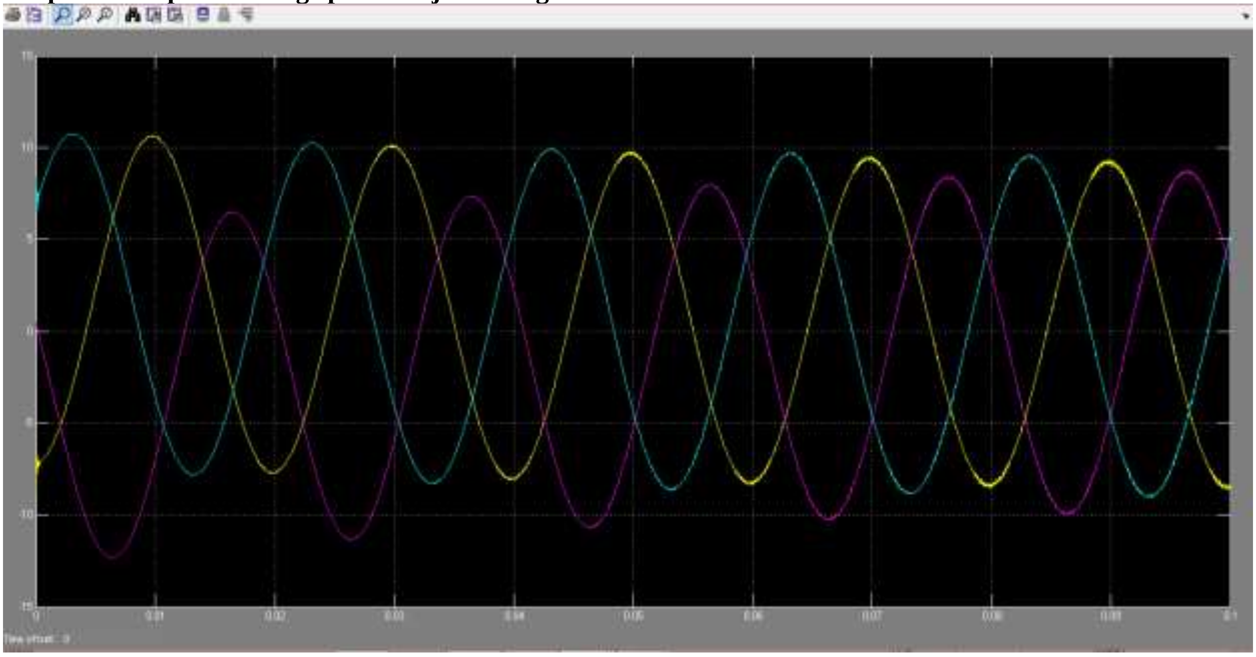
RMS waveform of inverter current



Output Three phase voltage profile injected to grid



Conclusion

The modeling of hybrid grid for power system configuration is done in MATLAB/SIMULINK environment. The present work mainly includes the grid tied mode of operation of hybrid grid. The models are developed for all the converters to maintain stable system under various loads and resource conditions and also the control mechanism are studied. MPPT algorithm is used to harness maximum power from DC sources and to coordinate the power exchange between DC and AC grid. Although the hybrid grid can diminish the processes of DC/AC and AC/DC conversions in an individual AC or DC grid, there are many practical problems for the implementation of the hybrid grid based on the current AC dominated infrastructure. The efficiency of the total system depends on the diminution of conversion losses and the increase for an extra DC link. The hybrid grid can provide a reliable, high quality and more efficient power to consumer. The hybrid grid may be feasible for small isolated industrial plants with both PV systems and wind turbine generator as the major powersupply

Future scope

In future intelligent devices like microprocessors, PLC (programmable logic controller) may be added to the system to keep the operating point (maximum power point) for maximum efficiency. If the hybrid system can control by using the same controlling method it will provide better performance and cost will be less

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