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A New Control Strategy for Three- Phase Inverter Applied To Induction Motor of Micro Grid

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Abstract: *The Distributed Generation can be done with linear and non linear loads in the previous papers but not the electrical drives. And the issue is addressed by proposing an induction motor as load that enables micro grid application. The control strategy used here is unified control strategy which is used for fast modes changing responses by using three phase inverter to generate pulses with the help of pulse width modulation. The load wave forms of the induction motor parameters were absorbed in different modes of distributed generation. Finally this paper proposes how an induction motor can work in different modes of operation in distributed generation and the proposed control strategy is validated by the simulation.*

Index terms: *Distributed generation (DG), unified control, pulse width modulation (PWM), Induction motor(IM), three-phase inverter*

I. Introduction

The Distributed Generation can be used to generate a customer's entire electricity supply, for peak shaving (generating a portion of a customer's electricity outside to reduce the amount of electricity purchased during peak price periods) for standby or emergency generation (as aback up to wires owner's power supply) as a green power source (using renewable technology) on for increased reliability.

The DG can be operated with renewable or Non-conventional energy sources are available such as photo voltaic cells, wind turbines, fuel cells, micro turbines, wind turbines. This source of supply can be connected to the load through power electronic converters [5]. The pulses are generated at the end of the inverter by the work done in the control circuit in the synchronous reference frame. LC filters are used that removes frequencies from a power supply and smoothens or clean it so the equipment being powered gets a clean power source.

Here the wave forms of grid current and load voltage are distorted under no- linear loads, this issue is compensated with De couplings in the synchronous reference frame [4]. The output of the inner current loop ddq together with the decoupling of capacitor voltage denoted by 1/kpwm, sets the reference for the standard space vector modulation that controls the switches of three phase inverter. So by doing this the wave forms of the grid currents and load voltages improve with no- linear loads also.

DG can be either operated in Islanded mode and Grid-tied operating mode [1]. In this paper both modes of operation can be controlled by Brakers (Isolators). The control strategy used here is the Unified control strategy. And we are using Induction motor to overcome the utility which comprises an Micro grid [2].

Finally in this paper an Induction motor performance is seen in both islanded and grid tied modes. The parameters like Speed, Motor currents, and the electromagnetic torque of an induction motor are observed with simulation.

II. Basic Operation

This paper enables a unified control strategy for three phase inverter in distributed generation to operate in both grid-tied and islanded modes. The DG is connected with three phase inverter in which an LC filter is terminated with inverter [1]. The primary source is the dc which is then converted to ac with the help of inverter. The ac side is equipped with load and Induction motor as utility both are controlled with isolator switches.

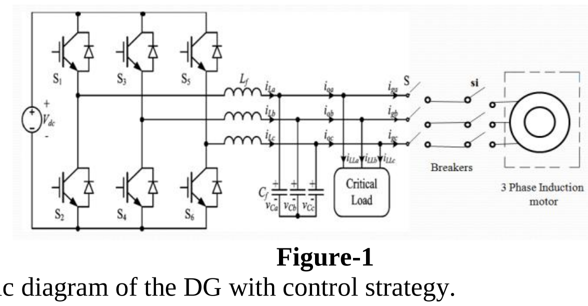

Figure-1

Figure 1 shows the schematic diagram of the DG with control strategy.

From the abovefigure due to the renewable energy as source dc supply is used for the inverter input, inverter comprises of three phase i.e, three legs which equipped with IGBT switches for generating pulses.
The three phase inverter used here is to convert dc supply to ac which is further used by the load and the induction motor. The LC filter is connected next to the inverter which is used to remove unwanted frequencies which makes the power supply clean.

With the help of the control circuit the six pulses are generated i.e, S_1, S_2, $S_{3,}$ $S_{4,}$ S5, S6. By the three phase inverter, control circuit includes an synchronous reference frame in which 'θ' is used for transformation which transforms three phase to two phase for decreasing the compatibility and whenever the pulses are ready to generate again the transformation takes place from two phase to threephase which helps out to generate three phase pulses S_1, S_2, $S_{3,}$ $S_{4,}$ S5, S6 at the end of the inverter [3].

Here from the schematic diagram we can also absorb the two switches S and Si which are load enable and induction motor enable switches, the function of these two switches are different. There are two operating modes in this paper named Grid-tied and Islanding modes. The two modes are controlled with a unified control strategy with the help of two switches. When the utility which is Induction motor is normal then both switches S and Si are in ON condition, and the distributed generation is in grid tied mode which injects power to the induction motor. When the IM is in fault, switch Si is tripped instantly, and now the Islanding mode is formed then the switch S is disconnected after the confirmation of islanding mode. After the IM fault is compensated again the switches S and Si will be ON then the power is utilized by the Induction motor.
Here induction motor is either asynchronous or wound rotor induction motor

III. Control Strategy

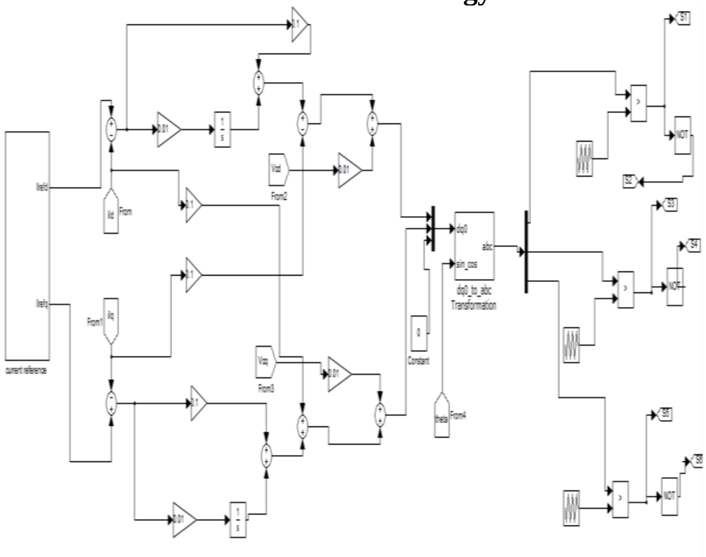

Figure-2

The above figure shows the control circuit for the Simulink diagram of this project [2]. The pulses aregenerated with three steps they are Current reference generation, Inductor current loop, and Decouplings. Firstly inductor current iLabc, the induction motor voltagesvgabc, the load voltage vCabc, and the load currents iLLabc are sensed then the three phase inverter is controlled in the synchronous reference frame.

At starting the grid voltage, converter voltage and load currents are transformed from three phase to two phase with the help of angle θ to decrease the compatibility in generating pulses, the transformation is done in the Phase Locked Loop [7]. i_{Lrefd} and i_{Lrefq}two reference signals in the form of D and Q-axis are generated by the current reference generator which are further given to the inductor current loop, an error detector is used here to detect the errors from the signals, A PI controller to eliminate errors detected by the detector is connected in the inductor current loop from this block the signals are next connected to the decoupling's in which signals are compared with gain quantities to increase the signal strength, now d_d and dq quantities are generated finally the are transformed to three phase values for our requirement then da, $d_b$and dc, these three phase signals are compared with carrier wave known as Pulse Width Modulation, Sinusoidal Pulse Width Modulation technique is used here.
Finally the six signals are generated and a not gate is connected between S_1 S_2, $S_{,3}S_{4,}$ and S_5 S_6.

IV.SIMULINK MODEL

The Simulink model consists of two modes of operation. In this representation we are obtaining the results of induction motor output currents, speed of the motor, and electromagnetic torque.

The above said quantities are observed in two modes i.e, in islanded mode and grid-tied mode and the output waveforms are observed under these conditions without any disturbances in the waveforms [8].

The two modes are named as

1) Grid tied mode
2) Islanding mode

Firstly we will see the grid tied mode Simulink model

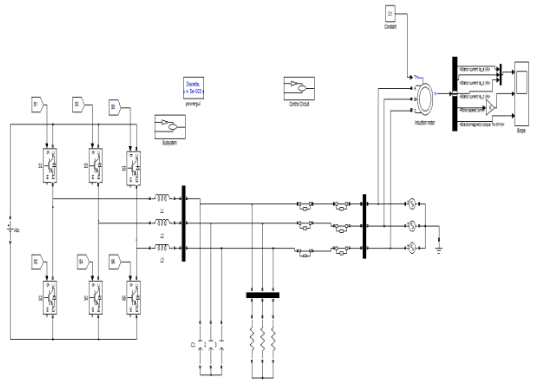

Figure-3

From the above Simulink model it is seen that islanded mode operation. The dc source voltage at the inverter is 400V; three phase pulses are generated by the inverter with the help of control circuit as shown in the figure 2. The output peak voltage from the inverter is 179V As it is grid tied mode the voltages are send to the induction motor as it is voltage controlled mode. In this mode from the figure 3 the breaker switches are in off condition which enables grid tied operation. The induction motor Implements a three-phase asynchronous machine (wound rotor or squirrel cage) modeled in a selectable dq reference frame (rotor, stator, or synchronous). Stator and rotor windings are connected in wye to an internal neutral point [7]. Induction motor stator currents of three phase, rotor speed and the electromagnetic torque waveforms are observed without any fluctuations in the waveforms because of control strategy.If the required voltagesare formed from the source then the grid tied mode is formed.

Now after the required voltages are formed then the transition takes place from islanding to grid tied it shown as follows.

2) Grid tied operation:

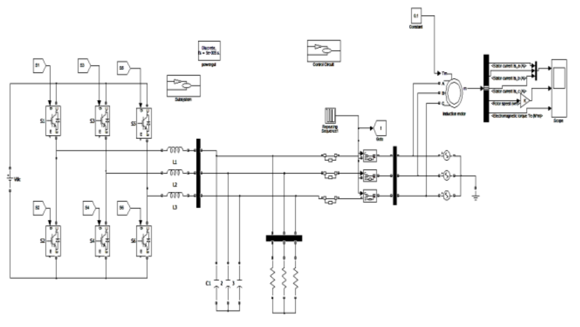

Figure-4

Figure 4 Simulink diagram shows that the operation has been transited from grid to islanding with the help of isolator switches as seen from the above diagram. In this mode also we are obtaining the Induction motor stator currents of three phase, rotor speed and the electromagnetic torque waveforms are observed without any fluctuations.

For both operating modes the control circuit is same as shown in the figure 2, the inverter generates the pulses with the help of pulse width modulation, the pulse width modulation technique used here is sinusoidal pulse width modulation (spwm) [5].

As seen from the above diagram at the utility or induction motor side the isolator switches are connected between load and the induction motor. The breakers are associated with repeating sequences in which Implements a circuit breaker with internal resistance Ron. Ron is required by themodel and cannot be set to zero. When the external control mode is selected, a Simulink logical signal is used to control the breaker operation. When the signal becomes greater than zero the breaker closes instantaneously. When it becomes zero, the breaker opens at the next current zero-crossing So from the above two operating modes we are mainly targeting on the induction motor characteristics i.e, stator currents, rotor speed and electromagnetic torque, and these parameter waveforms are observed in the scope that connects with induction motor without any fluctuations.

V. Results

The output waveforms of inverter and induction motor performances are as follows.
From the figure 5 it is shows the waveform under grid tied operation when the grid currents are decreased from 9A to 5A.

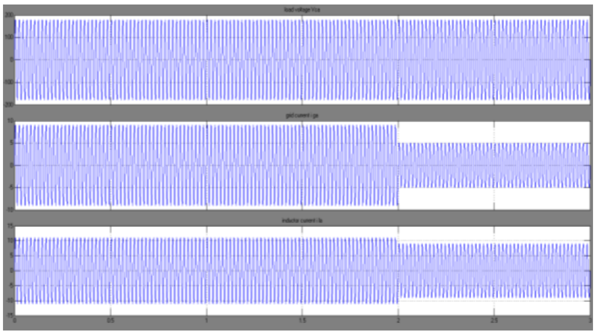

Figure-5

As seen from the waveform the currents are decreased linearly by using control strategy.

Figure 6 waveform shows when the grid tied is transited to islanded mode

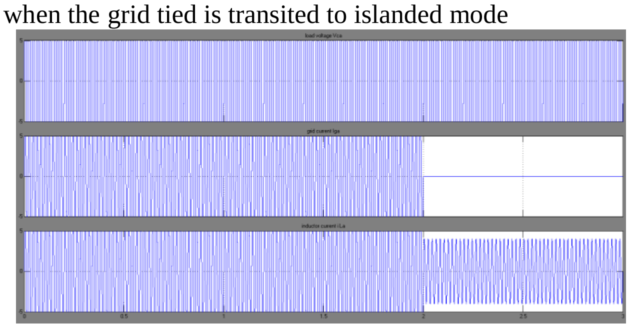

Figure-6

As we seen from the above waveform the load voltage, grid current and inductor current are shown without harmonic contents by using unified control strategy.

Induction Motor Results

Figure 7 shows the induction motor waveforms when operated in grid tied mode. The waveform consists of stator three phase currents, rotor speed and torque.

Figure-7

Figure 8 shows the induction motor waveforms when operated in grid tied mode. The waveform consists of stator three phase currents, rotor speed and torque.

Figure-8

The total harmonic distortion of the simulink diagram shown in the figure-9 is 0.35%.

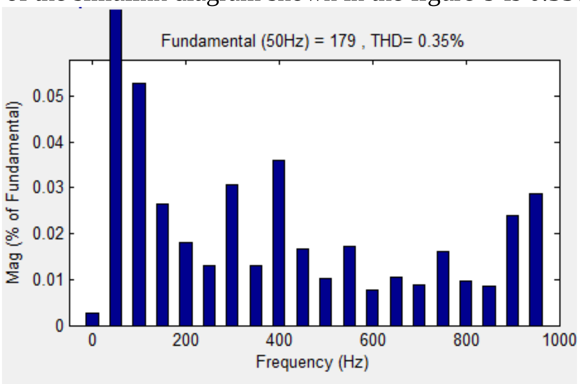

Figure-9

VI. Conclusion

From the above simulation results we can conclude that the induction motor performance in both grid tied and islanded modes are same without any fluctuations in the waveforms are observed. Therefore the unified control strategy used in this paper is reliable for both the grid tied and islanded modes. By using this control method reduces the compatibility of the simulation circuit, and the quality of the waveform in both grid tied and islanded are improved.

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