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AN INTELLIGENT CONTROLLER BASED OPTIMIZATION OF MICROGRID AND DG SYSTEM

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***Abstract*--This paper presents the utilization of intelligent techniques for optimally design power distribution system. The intelligent controller controls the grid-side voltage and frequency with two additional loops for smooth transition of islanding and resynchronization operations in a distributed-generation (DG) system. The phase lock loop (PLL) is used to lock the value get from the utility grid for synchronization. The PI and fuzzy code is built using the MATLAB software program. The real and reactive power control also simultaneously performing. The validity of the proposed system is verified by the simulation results which are performed using simulink.**

***Indexterms- Distributed Generation (DG), Proportional Integral(PI) Controller, FUZZY Controller*.**

I. INTRODUCTION

Distributed Generation is refer to small-scale 1KW- 50 MW electric power generator that produce electricity at a site close to customer or that are tied to an electric distribution system. DG system is less costly as it eliminates the need for expensive construction of distribution and or transmission line. A micro grid is a localized grouping of electricity generation energy storage and load that normally operate connected to traditional centralized grid. A microgrid consist of several DG system and local loads. The DG system may consist of small source such as wind turbine, fuel cells, photovoltaic system, and energy storage system. In DG system operates two mode one grid- connected distributed generation (DG) system and islanding mode of operation. Islanding take place when DG system is electrically separated from the utility grid. Islanding is an issue that is of concern by power industries. If Microgrid fails to operate it might lead to a number of problems to DG system and local loads such as power quality issue and also problem to power system. The successful islanding and grid reconnection will improve the system reliability. The need for Distributed generation is rapid growth in loads and fossil fuels reduction. The fuzzy controllers and proportional integral controllers are used in many control applications. The PI controllers are mostly used in industrial application due to low cost, simple structure and easy design. PI controllers will eliminate forced oscillation and used in on-off operation. The fuzzy controller is used for checking the condition to measure. If and then rule is used for

process. The phase lock loop is used to collect the magnitude and phase angle and frequency and do the synchronization process. The DG system output is in DC form so to convert AC universal bridge is used. The phase angle of the utility side is tracked to measure and control the flow of active and reactive power and to turn on and off power devices. The grid inverter operation is determined by grid side voltage, phase angle, amplitude

and frequency. The PI and fuzzy controller are used to measure the phase angle deviation by calculating the dq0 axis from three phase voltage to dq0 transformation. In this study the PI and fuzzy controller are used for controlling the dq0 axis for synchronization. Phase lock loop is used to collect the frequency and phase angle voltage from both grid and DG system. The effective frequency matching and resynchronization are performed by this two loop. The effectiveness of proposed PI and fuzzy control is build using the MATLAB software program. The simulation result is performed by simulink.

II. MODEL SYSTEM

The block diagram of the DG system is shown in figure 1.the system consists of a DG unit, which may be wind, solar and battery energy storage system. Here battery energy storage system is taken. The several AC and DC loads are connect to the system.

The grid side converter is used to perform islanding and grid resynchronization operation of the DG system. The DG system data is shown in table1, with the rated voltage of 6.6kv.

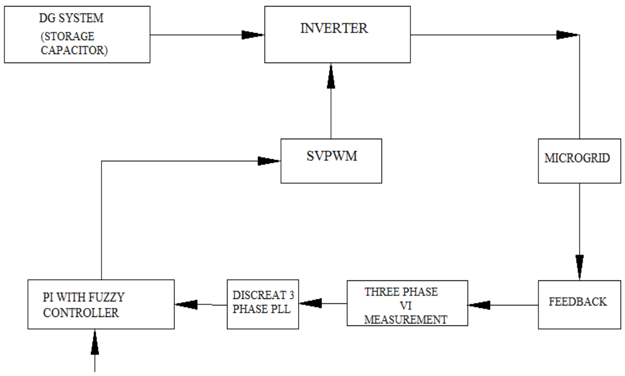

Figure1. Block Diagram Of DG System

Table 1 DG system Data

Parameter	Quality
Rated voltage	6.6kv
Dc generation	0.5MW
DC link capacitance	100000 µF
Line impedance(L1)	0.01+j0.035pu
Line impedance(L2)	0.001+j0.002pu

III. CONTROL STRATEGY OF GRID SIDE CONVERTER

When the DG is disconnected from the grid the power balance is lost which leads to variation of AC voltage magnitude and frequency. The real and reactive power are controlled by set point in the control strategy. The d-axis and q-axis are transformed by using PLL transformation (abc-dq0 transformation). The d-axis are controlled by PI controller and q-axis are controlled by PI controller. The 0 axis are controlled by fuzzy controller. The PI and fuzzy controller are used in the loop use for error signal to synchronize them. The important issue in the islanding is resynchronization technique. In islanding mode the DG system voltage is phase shifted from the grid voltage despite in magnitude and frequency. PI and fuzzy controller design is an optimal procedure of the parameter because manual tuning of these for islanding and grid resynchronization operation is time consuming.

IV. TEST SYSTEM MODEL

A. PI controller and FUZZY controller

The PI controller is used to control the output of the DG system at the rated level. the main advantage of the controller is reliable and simple features. The PI controller not give smooth output power.

The FUZZY controller is used to improve the performance of microgrid in islanding mode of operation. The new control scheme is develop by simple controlling the phase difference. The effect of synchronization performed at different delay models as zero order hold with time delay element.

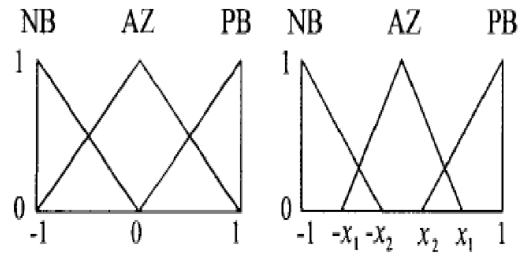

Figure2:fuzzy membership function using three rules

The controller input to the plant the triangular membership function defined for single input three fuzzy rule base system is used the fuzzy member ship are function with three control rules.

B. Dynamic model

The active and reactive power flow between the two AC power sources through the impedance Z=R+jX. The active power is real power is defined as available voltage into actual current. The active power is always positive.

The power is average of actual power and active power these two are present in power system due to resistive / inductive load. The active power as P and reactive power as Q

$$P = \frac{V1}{R^2 + X^2}[R(V1 - V2\cos A) + X\,V2\sin A]$$

$$Q = \frac{V1}{R^2 + X^2}[(-RV2\sin A) + X(V1 - V2\cos A)]$$

If the transmission line is inductive load there is no resistance then the phase angle between the two voltage is

$$P = \frac{V1\,V2}{X^2}[\sin A]$$

$$Q = \frac{V1}{X}[V1 - V2]$$

The exact active and reactive power are proportional to voltage difference and phase angle difference to verify the active scheme of synchronization control of an isolated microgrid.

V. SIMULATION ANALYSIS AND DISCUSSION

e build the new simulation using the MATLAB/simulink software using simpower system toolbox and control system toolbox. the traditional method for measuring use zero crossing signal of two voltages. It is simple and high accuracy but main drawback is long measurement period and weak against harmonics and noises.

In the DG system, the battery storage DG system is connected to grid via inverter to grid. The inverter used in the circuit to convert DC to AC. The VI measurement unit calculates the voltage and current of both grid and DG system. The Phase lock loop will calculate the phase angle, magnitude and frequency. The three phase voltages are transformed to dq0 axis by transformation. The dq0 axis are separated to d-axis, q-axis and 0 are under gone for error calculation. The error calculation is performed by controller circuits. The PI controller loop 1 will perform d-axis calculation and PI controller loop 2 will perform q-axis calculation. Figure 3 shows the pi and fuzzy controller. The fuzzy logic controller will check error calculation for 0 values to set value in 0 states. Then after error calculation the dq0 value are transformed to three phase voltage and after giving a delay time for 0.5 sec. The Clark unit will give equal displacement of phase angle. The SVPWM is used to generate the gate pulse to the inverter unit. The 0.1sec time delay is given to start operation. Once the inverter receive pulse from SVPWM its start operation. The load will start at 0.1sec and up to 0.3 sec the grid share the power to load after 0.3 sec it switchover to islanding mode. The figure 4 shows the DG system model.

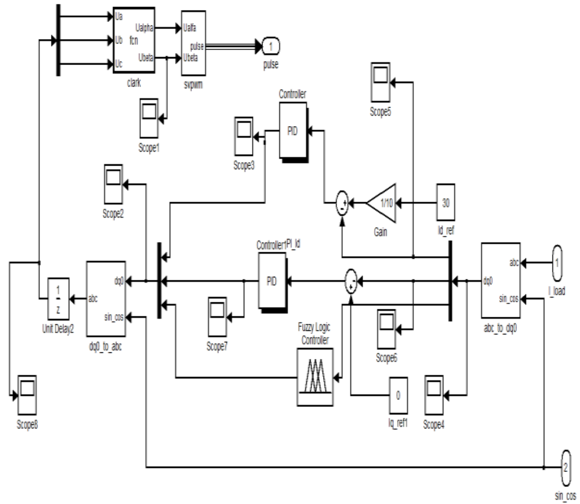

Figure 3 PI and fuzzy controller

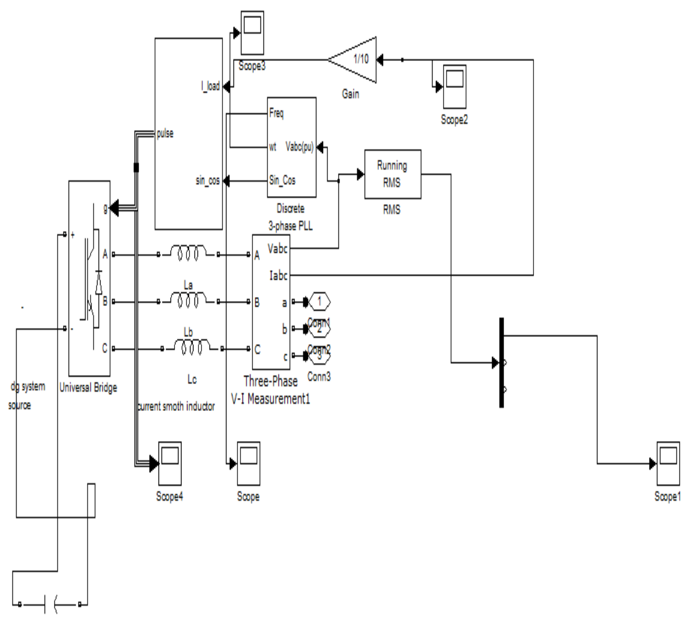

Figure 4 DG system in grid connected mode

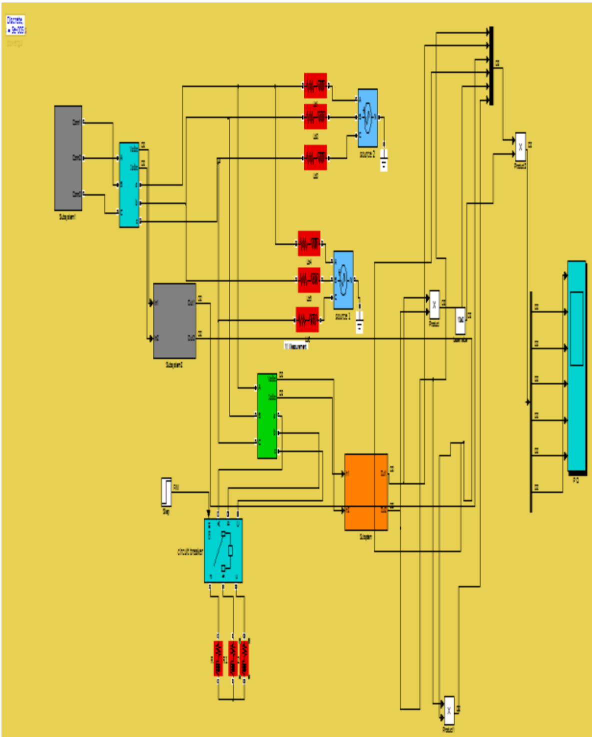

Figure 5 synchronization of microgrid

A. SIMULATION RESULT

The figure 6 shows the output of with fuzzy and PI controller, figure 7 shows without controller. The graph shows active and reactive power output of utility grid and DG system. During 0.1 the grid connected mode is operated and load sharing is happened, after 0.3 the DG system operate in islanding mode of operation.

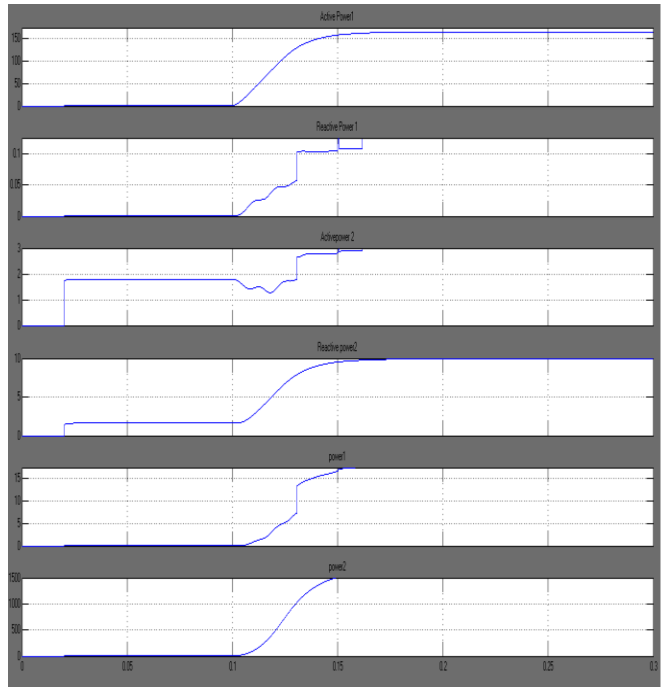

Figure 6 simulation result without controller

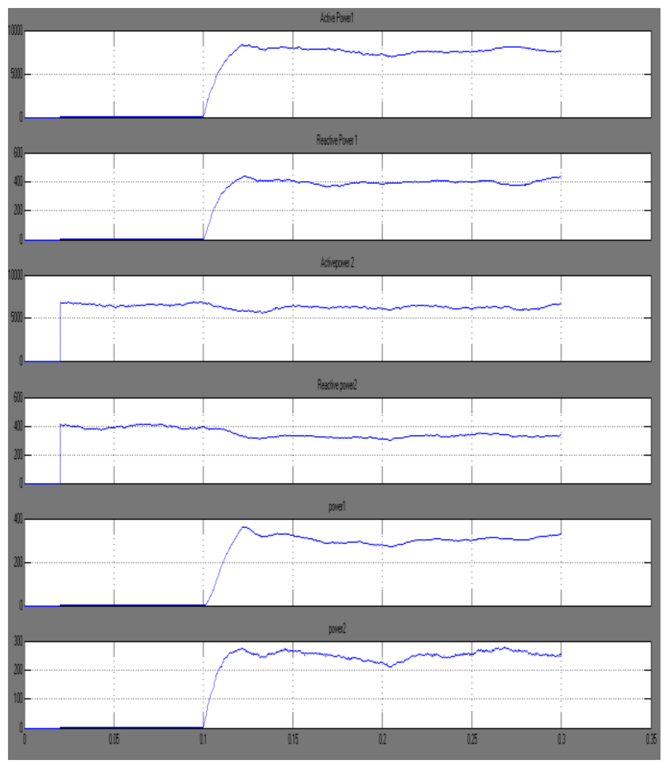

Figure 7 simulation result with controller

VI. CONCLUTION

In this paper a design of pi and fuzzy controller is used for smooth islanding and resynchronization operation. By the simulation result we can conclude that the system response time will be increased. The PI and fuzzy controller are used to control the real and reactive power. The proposed method can be used for different renewable energy system and power system application .

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