Research on switching control strategy of micro grid with load

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Abstract. Smooth switching between grid connected and isolated island operation mode is the precondition of safe and stable operation.For photovoltaic system, the PQ control is adopted in the grid/island mode, and the energy storage system, the grid connected mode is controlled by PQ, and the V/F control is adopted in the island mode. The control strategy based on the following state, control mode switching process of micro grid, transient fluctuations can effectively reduce the voltage and frequency of the switching process, reduce the impact on the power grid, using PSCAD/EMTDC to establish scenery storage microgrid master-slave control model.

1. Introduction

The distributed generation technology based on renewable energy is concerned,it will be the future development trend of power system[1, 2, 3].In the distributed generation system,storage system,load and integrated protection device of micro grid has become a hot research topic,.Microgrid is divided into grid connected and isolated island operation[7],the smooth switching between the two modes of micro grid is very important.At present, many researches have been carried out on the smooth switching control of micro grid at home and abroad.In paper[8],the control method of three-phase inverter is proposed,and the control method of double loop feedback control is adopted to improve the quality of the load voltage during the switching process.The [9] control strategy by switching bi-directional inverter, energy storage control device is controlled by the V/f to PQ control switch, in order to reach the island state of micro grid voltage and frequency stability.This paper studies the master-slave control of micro grid system, in order to reduce the switching process of micro grid bus voltage and frequency of transient vibration, the controller state follow smooth switching control strategy based on, and a micro grid model was built in PSCAD software, verify the correctness and effectiveness of the proposed method.

2. Micro grid structure

In this paper, the wind and wind power grid structure is shown in Figure 1, the distributed power supply through the inverter to access the 0.38kV bus, and then through the transformer to access the 10.5kV distribution network, three power supply for the micro grid load.Micro grid by the public switch K1 action to achieve the grid and the island of the switch. When K1 is closed, the operation of the grid is connected, when the K1 is turned on, the isolated island operation state.

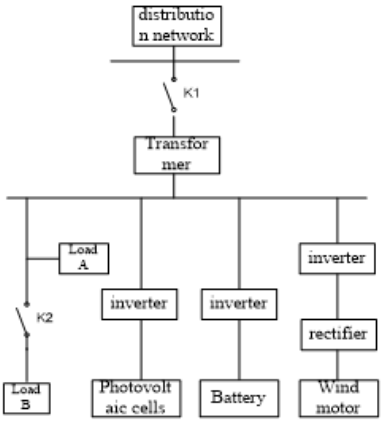


Fig.1 Basic structure of wind and PV micro grid

3. Microgrid control model

3.1 Micro power structure

The photovoltaic micro power supply adopts the double stage grid connected system.Inverter with dual loop control structure, the inner loop controller for current control, the control strategy is the same in different modes; the outer loop controller is the inner reference signal, control of the inverter output constant power grid operation control, islanding the constant voltage and frequency signal.Battery micro power supply as the main power supply, when the island using V/f control to maintain the micro grid voltage and frequency stability. Battery micro power supply by the battery, two-way DC/DC converter, DC/AC converter, etc..

3.2 PQ control principle

In any mode, the PQ control is adopted in the inverter, as shown in Figure 2. The inner loop is the current control and the outer loop is the power control. The outer loop provides the current reference value for the inner loop. In order to eliminate the influence of the change of the d axis and the q axis, the current cross coupling compensation is added in the control of the current inner loop, and the current decoupling control is realized.

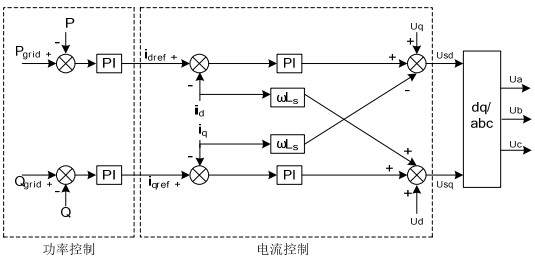


Fig.2 PQ control principle of photovoltaic inverter

The power of the inverter fed AC network is:

$$\begin{cases} P_{grid} = u_d i_d + u_q i_q \\ Q_{grid} = u_q i_d - u_d i_q \end{cases} \tag{1}$$

Current control time domain expression:

$$\begin{cases} u_{sd} = \left(k_{pi} + \frac{k_{ii}}{s}\right)(i_{dref} - i_d) - \omega L_s i_q + u_d \\ u_{sq} = \left(k_{pi} + \frac{k_{ii}}{s}\right)(i_{qref} - i_q) + \omega L_s i_d + u_q \end{cases} \tag{2}$$

The inner loop current controller is adjusted by PI to realize the adjustment of the current without adjustment, the output signal is transformed to the back of the park, the two phase voltage control vector is obtained, and the control signal of the output three-phase inverter is controlled by the SPWM modulation.

3.3 V/f control principle

Under the island mode, the main control inverter of micro grid has the function of voltage and frequency regulation, and the output power is adjusted according to the load demand, the structure

diagram is shown in figure 3.

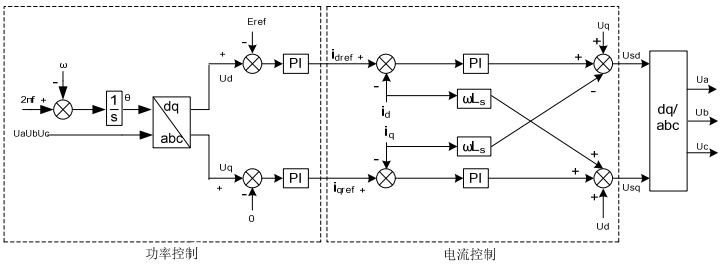


Fig.3 Structure block diagram of V/F controller

The output voltage of the current loop controller is:

$$\begin{cases} u_{sd} = (k_{pi} + \frac{k_{ii}}{s})(i_{dref} - i_d) - \omega L_s i_q + u_d = (k_{pi} + \frac{k_{ii}}{s})\left[(k_{pi} + \frac{k_{ii}}{s})(u_d - E_{ref}) - i_d\right] - \omega L_s i_q + u_d \\ u_{sq} = (k_{pi} + \frac{k_{ii}}{s})(i_{qref} - i_q) + \omega L_s i_d + u_q = (k_{pi} + \frac{k_{ii}}{s})\left[(k_{pi} + \frac{k_{ii}}{s})(u_q - 0) - i_q\right] + \omega L_s i_d + u_q \end{cases} \quad (3)$$

4. State following method based on controller

Micro grid and island controller are different, the system structure is shown in Figure 4, K1 and K2 as the logic switch.

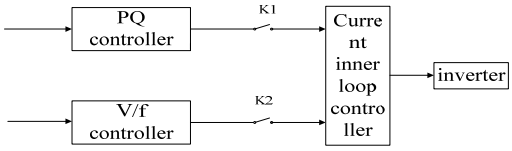


Fig.4 Battery inverter control mode switching

When connected to the grid, K1 closed K2 off, the battery inverter using PQ control; island, K1 off K2 closed, switch to V/f control, changing the control mode of the inverter. In this way, the switching time can produce transient wave. When the PQ controller is running, the V/f Island controller is running, the output of the controller is not equal to the output of the controller because the output of the 2 controllers is not equal. Therefore, in order to avoid the occurrence of the voltage and frequency of the micro grid, this paper uses the method of state following method based on the controller , as shown in the figure.

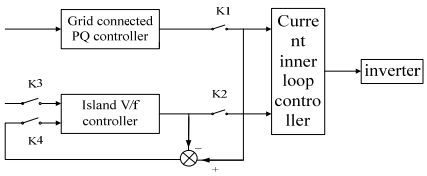


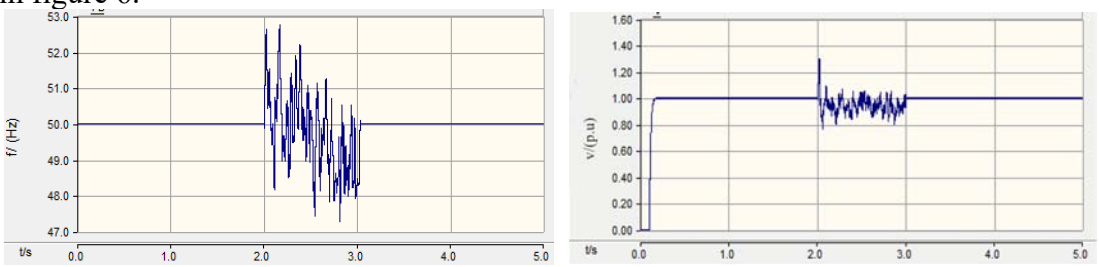
Fig.5 Switch diagram based on the state of the controller

When the network switches K1, K4, K2, K3 open, closed, running battery PQ controller, the V/f controller according to the output of the PQ controller design for a negative feedback as its input, the PI non differential regulation V/f controller with PQ controller output; islanding, switch K2, K3 K1, K4 open, closed. V/f control battery using V/f controller, the PQ controller to follow the exit before the state, the controller output before and after switching smoothly, effectively reduce the transient oscillation.

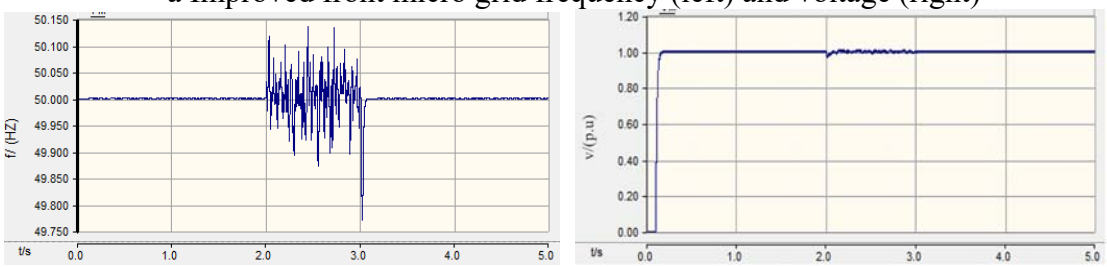
5. Simulation model

On the PSCAD to build a micro grid model, in the mode switch, the photovoltaic and wind output are kept unchanged. Micro grid operation 5s, when the 2s Island run, when the 3s grid operation, the traditional operation strategy and the state to follow the control strategy of the simulation as

shown in figure 6.



a Improved front micro grid frequency (left) and voltage (right)



b Improved micro grid frequency (left) and voltage (right)

Fig.6The curves of voltage and frequency of micro grid before and after improvement

Before and after the improvement of power battery output curve of micro grid is shown in Figure 7, it is shown that the improved control method, the output power fluctuation is relatively large, but the use of the method of smooth switching controller state to follow after the battery output power changes significantly smaller, show that the method can reduce the impact of power fluctuation on the micro grid, the blue line the figure for the active power and reactive power for the green line.

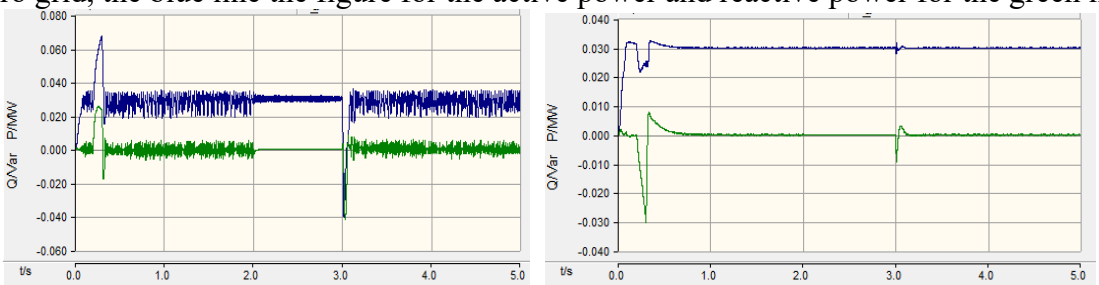


Fig.7Improved front (left) rear (right) micro grid battery active and reactive waveforms

6. Conclusion

The scenery storage microgrid model established by PSCAD, the smooth switching state following control method based on, can effectively reduce the impact of fluctuations and power fluctuation of voltage and frequency of micro grid mode switching process of micro grid, realize smooth switching, improves the stability of the micro grid voltage and frequency.

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