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Short Review Paper

Control strategies for microgrid operation

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Abstract

The increasing usage of non-conventional and distributed generation increases the ideology of minimum fuel consumption and transmission losses respectively. The problem solved by the distributed generation and nonconventional sources are appreciable at a cost of scarifying the existing supply system reliability. The operation of these sources along with the existing system needs very advance but economical methods simultaneously. The "Microgrid" is one of the methods. The microgrid involves the microsources. These microsources needs advance interface with the existing sources for reliable usage. To control the microgrid operation, both with existing system and stand alone, also called "island", requires various control strategies. This paper proposes the control methods for microgrid operation.

Keywords: Control, Strategies, Microgrid, Operation.

Introduction

The microgrid provides better methods to ensure the optimum usage of distributed generation. This increases the efficiency and reliability of the system and customer satisfaction. The basic structure of the microgrid consist of the microsources, microturbines, invertors local microsources controller (LMC), system optimizer and protection systems. The microsources involves the small capacity (<100KW) generators like biomass generator, diesel generator, wind turbines and photovoltaic modules (solar cells). The dc storage is also used in microgrids (like lithium ion, flywheel etc.) which can be used for supplying power via interfacing it through invertor. The microcontroller is a plug and play controller. This implies that a microsource can be add or removed from main grid without changing the protection and control of the unit. The enable this, the microsources needs to be controlled by LMC's. Further each invertor should respond to change in load whether the system is connected to grid or isolated from the grid i.e. islanded. For this, the real and reactive power controller is required. Also the voltage must be controlled for both the conditions and the most importantly, frequency control.

Real and reactive power control

Microgrid involves various microsources which can be classified into two types which are AC sources (Diesel generator, microturbines, wind generator etc.) and DC sources (Battery, photovoltaic cells etc.). The DC sources needs to invert. The invertor used is a voltage source invertor. The coupling of invertor by grid bus is done by inductor coil. The magnitude of voltage and phase angle is controlled by inverter specification i.e. triggering pulses[1]. The power flow between invertor and grid depends upon the magnitude of the output voltages of invertor (V) and the bus voltage (E). It also depends on the difference between phase angle between these two. The power flow is given by;

$$P = \frac{3EV}{X} \sin\delta \quad (1)$$

$$Q = \frac{3V}{X}.(V - E\cos\delta) \quad (2)$$

$$\delta = \delta_V - \delta_E \quad (3)$$

The power v/s power angle characteristic is shown in Figure-1. The LMC will have an input of V and δ to calculate the P and Q. From (1) and (2), P depends on the power angle and Q depends on the magnitude of convertor voltage V^2.

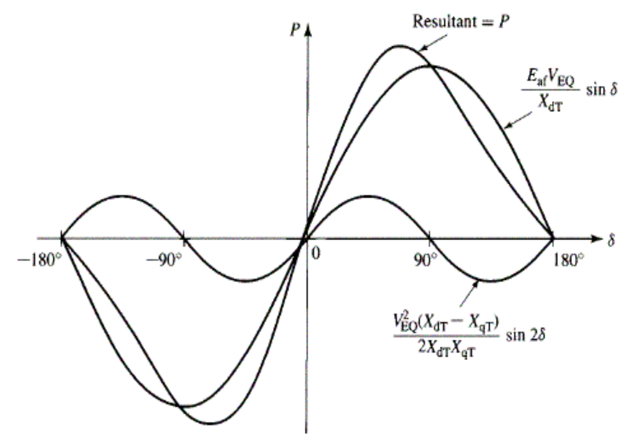

Figure-1: Power angle characteristics.

Voltage control: To achieve local reliability, the voltage regulation needs to be controlled. The value of voltage depends on the value of reactive power in the grid. Simultaneously, voltage control requires insuring that presence of circulating reactive current should be negligible between the sources[3]. This can be depicted via voltage v/s reactive current droop controller. This convertor is used to set the voltage set point on the Q v/s V plot. Under islanding operation, the load needs to be track immediately. For fast tracking of load the voltage regulation is critical and storage problem arises. If microgrid is not operated under the islanding, the load generation imbalance can be provided by the conventional grid and need of storage vanishes[4].

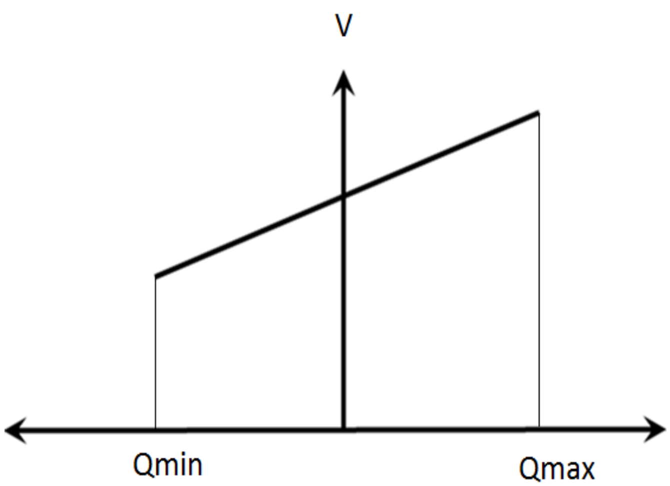

Figure-2: V v/s Q droop.

Frequency control: In islanding operation, the change in set points of power may cause frequency deviation to match the required power. This problem requires complex communication setup to be designed. The easy way to solve this problem is to use power v/s frequency droop function at all the microsoureces. This frequency deviation can be observed under fault, contingencies and outages. Under smooth transfer of operation of grid to island, the systems face the change of phase angle of the voltages and hence, change in power. This change in power results in frequency deviation. This characteristic is shown in Figure-3.

Complete control block diagram

Inverters can provide control and reliability required for plug and play operation. This means new microsources can be added to the without changing the existing system. Microgrid can connect to main grid and isolate itself from grid in rapid and effortless manner.

Active and reactive power can be independently controlled and can meet dynamic needs of the loads[5,6]. Microsource controller techniques rely on the inverter interfaces found in microturbines and storage technologies. Communication among microsources is uneconomical and worthless for basic microgrid operation. Every microsource controller must be able to respond effectively to system changes without requiring data from the loads or other sources. The power electronic controls of current microsources are modified to provide a set of key functions. These control functions include the ability to; i. 1. Regulate power flow on feeders; regulate the voltage at the interface of each microsource; ii. 2. Ensure that each microsource rapidly pickups up its share of the load when the system islands[7].

Control functions the ability of the system to island smoothly and automatically reconnect to the bulk power system is another important operational function.

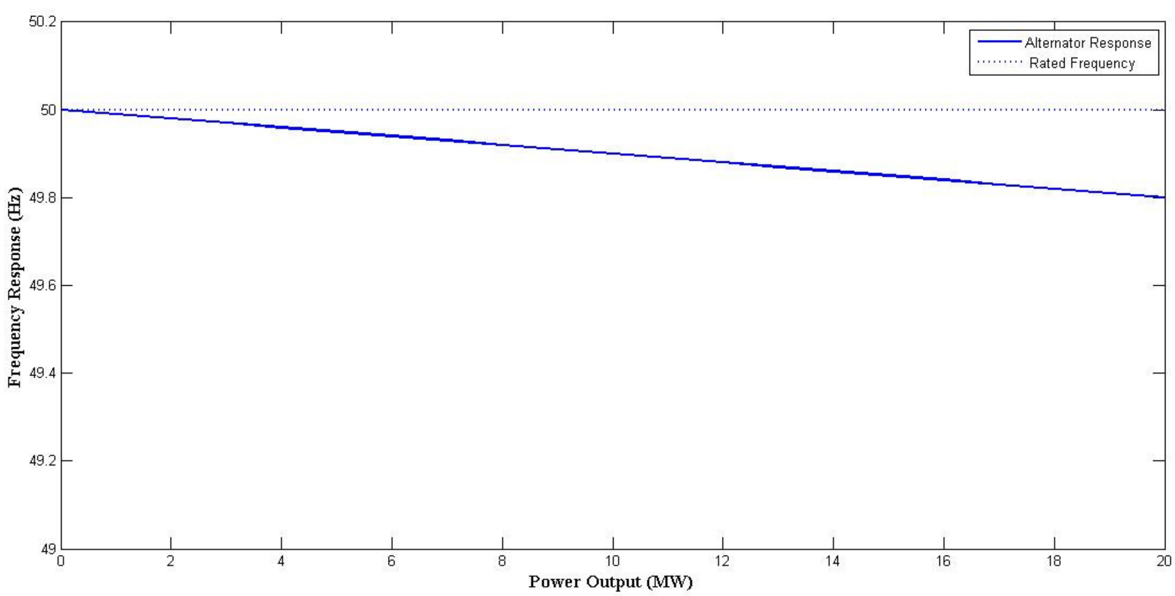

Figure-3: Power v/s Frequency characteristics.

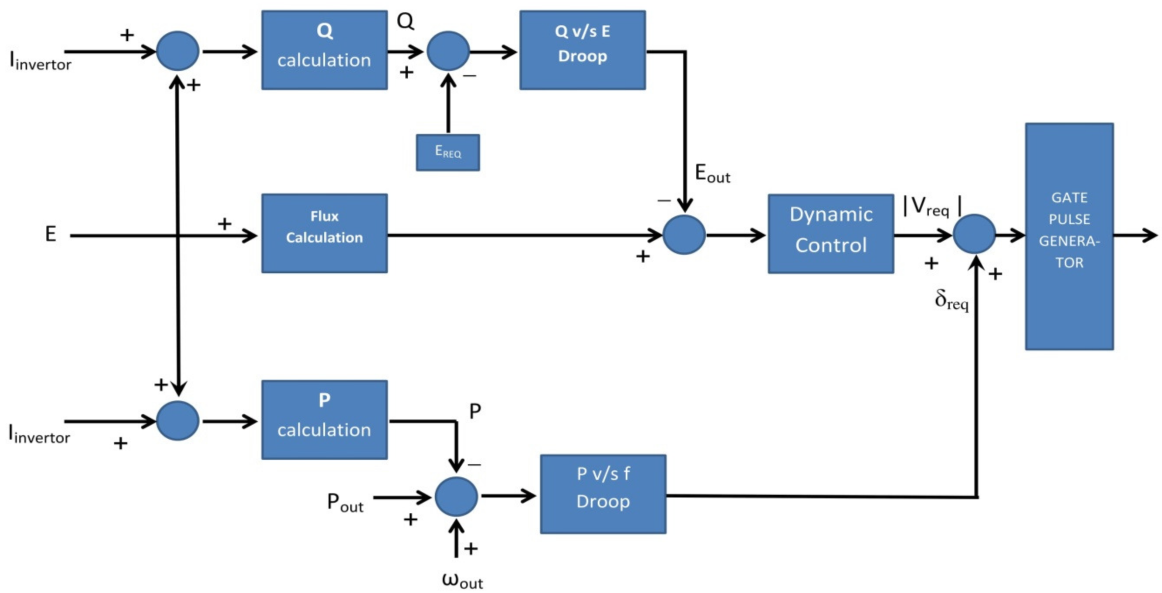

Figure-4: Complete control strategy for microgrid.

Conclusion

The microgrid is getting popularity and progressed well. Various strategies are developing for integration of PV sources, this paper introduces basic conceptual methods and suggested control feedback method instead of communication based method. The basic feedback loops include three loops, power calculation, voltage control and frequency control. As future work this strategies can be implemented on a real time system or simulation based system.

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