Demonstration Test of Fast Separation and Islanding Prevention Methods on Fault Section in ADAPS

Background

It is expected that penetration of the distributed power generation (DG) mainly expands in the utility distribution system. The large penetration of DG may cause some serious problems such as deterioration of power quality, degradation of protection and safety and so on. CRIEPI is now carrying out the study of "Autonomous Demand Area Power System (ADAPS)"*1 as a new system technique which promotes smooth introduction and utilization of DG with restraining such problems using power electronics and communication technologies. Concerning problems on protection and safety, there is a case that the distribution line fault cannot be removed by occurrence of islanding phenomena with DG. From this point of view, we proposed an autonomous protection measure in which fault detection, separation of the fault section and fault removing including islanding prevention with forwarding disconnection technique are carried out with a section of distribution line. It is necessary for establishment of a procedure to urgently demonstrate the validity of the control measures and some back-up measures for islanding prevention etc. when control system is not sufficient.

Objectives

To demonstrate the proposed measures for separation of fault section and fault removing. In addition, to demonstrate backup measures for islanding prevention when the forwarding disconnection is limited to part of DG.

Principal results

1. Demonstration and evaluation of the measures for separation of fault section and for fault removing

The proposed measures for separation of fault section and for fault removing are demonstrated with the high voltage ground fault test carried out in the ADAPS hybrid experimental facility of CRIEPI. The proposed measure is composed of sectional switches with sensor and the operation control sub-system. The Mobile Agent and Ethernet techniques are adopted for communication measure (Fig.1).

As the results of demonstration test, the following are cleared. Urgent control mode is properly broken in normal control mode of control system. By the urgent mode, the event step from accident occurrence to stop of islanding after separation of fault section is completed within 1.0 second required on the Japanese electric code. (Fig.2)

2. Islanding prevention method when the forwarding disconnection is limited to part of distributed power generation.

After stoppage of DG by forwarding disconnection, islanding may occur due to balance condition between load consumption and power supply of remaining DG.

(1) The possibility of islanding increases if the whole generation power is larger than load consumption (Fig.3-a). DG not having forwarding disconnection should stop the operation by detecting the islanding phenomena. For the detection, the time of forwarding disconnection should be set longer than islanding detection time of the DG not having forwarding disconnection. The frequency change rate detection measure is effective for the islanding detection especially (Fig.3-b).

(2) When LPC exists in the islanding section, Reactive power injection measure of the LPC is effective for islanding prevention. Remarkable frequency change occurs by the injection of reactive power more than 30% of DG capacity. Each DG can stop the operation by detecting the frequency change.

Future developments

Method for uninterruptible power supply and method for system recovery will be demonstrated. Summarizing those results, specifications of the protection control system for ADAPS will be established.

Main researchers;

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References

Hiromu Kobayashi, 2005 "Demonstration Test of Fast Separation and Islanding Prevention Methods on Fault Section in ADAPS", CRIEPI Technical Report R04026 (in Japanese)

Tetsuo Otani, 2005 "A SCADA based-on Mobile Agents and Ethernet for Demand Area Power System - Processing Time of Supervisory Control on Distribution Lines and Consideration of Its Application to Fields -", CRIEPI Technical Report R04004 (in Japanese)

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*1 : Loop shaped distribution line is adopted for basic system configuration. Loop power controllers (LPC), controlling line power flow and voltage actively, are installed at each looping point. Supply and demand interface (SDI) is installed in each customer. The SDI controls DG autonomously taking account of energy saving and load leveling, based on information from both utility side and customer side. A central operation control system is installed for the purpose of unifying whole system. Operation control sub-system is also installed in each section for the purpose of rapid and reliable operation in case of line fault. As a communication method for co-operation between all devices, the Mobile Agent and the Ethernet network are being investigated. Those measures may be able to cope with frequent changes of system configuration and of system management control functions including fault operation flexibly with low cost.

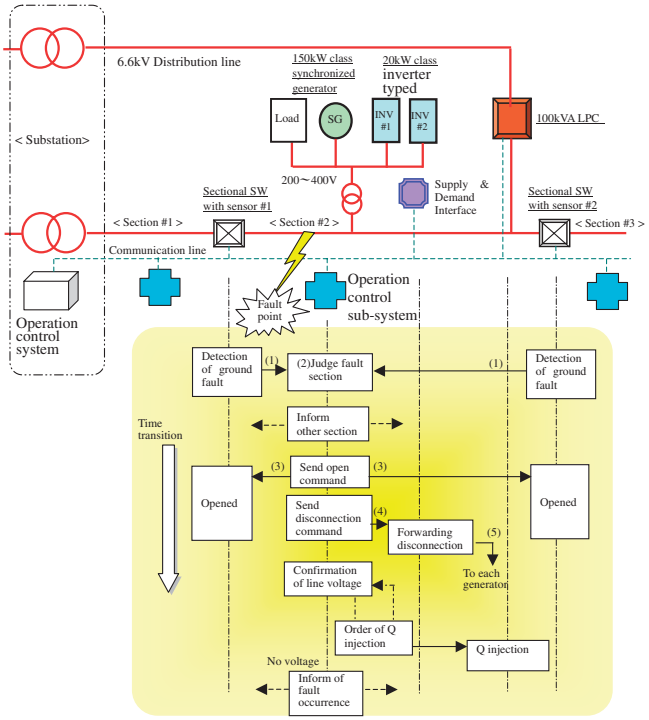


Fig.1 Demonstration circuit and proposal measure

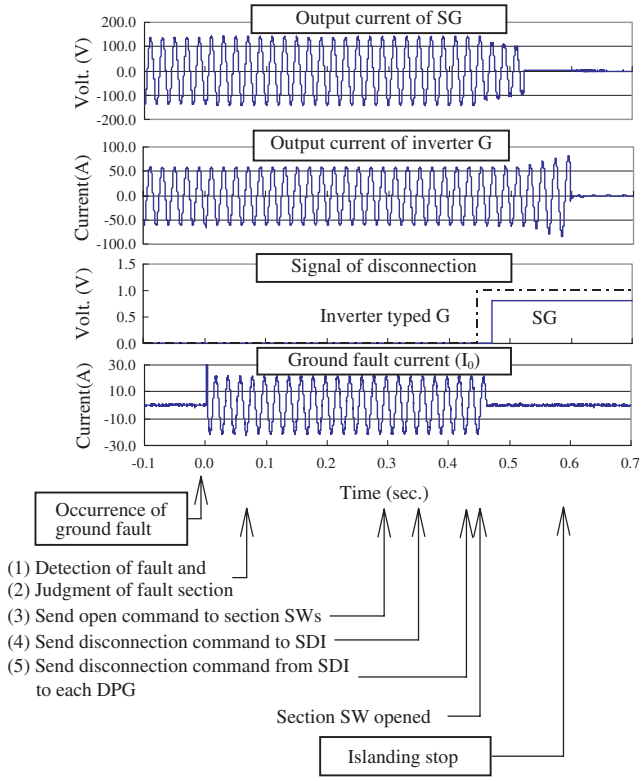
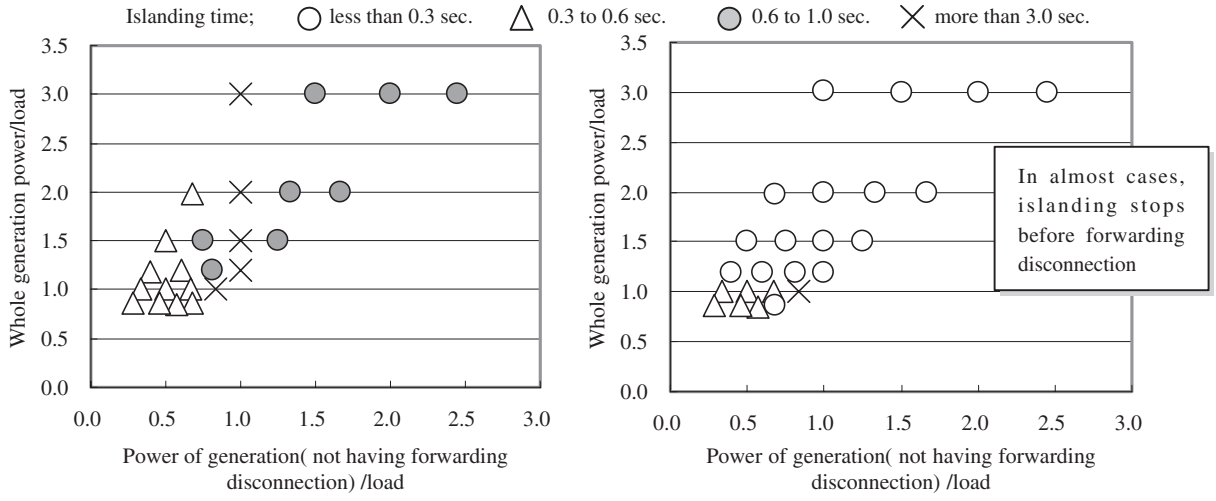


Fig.2 Demonstration results in ground fault



(a) Proposed measure; not applied

(b) Application of frequency change rate measure applied and time coordinated

Fig.3 Simulation results in case that the number of DG having forwarding disconnection is limited

- Parallel operation of synchronized generator and inverter typed generator (Total power output; 300kW)
- Forwarding disconnection; applied synchronized generator only
- Forwarding disconnection time; 0.3 sec. after distribution line separation from the grid