Development of Loop Power Flow Controller for Autonomous Demand Area Power System

– Demonstration and Estimation of Distributed Control Using Local Information –

Background

To smooth introduction of distributed generation, we proposed the loop or mesh structure for distribution systems using loop power flow controller (LPC) at the opened switch which can connect the adjoining feeder. LPC can optimize control for distribution systems in the points of reducing voltage rise, voltage fluctuation and loss minimum power flow control, and so on, with acquisition of distribution system status. Adapting to areas that cannot use communication systems, in consideration of power quality for the transition phenomena and limitation of fault area, we also required distributed control using local voltage information for the LPC.

Objectives

The purposes of this paper are to demonstrate basic functions of LPC and to estimate the control method using simulation analysis.

Principal Results

(1) Demonstration of basic functions

We added functions (PQ cont.) of loop power flow and reactive power control by voltage drops of the feeders to the original control [*1] (P cont.). The change of the control method aims to cooperate with voltage controller at substation transformers and improve the voltage stability. The basic functions of PQ control were demonstrated by the Demand Area Power System Hybrid Demonstration Facility (Fig. 1) located at Akagi testing center in CRIEPI.

Power flow control functions: We confirmed the voltage control function that restrains the voltage rise from 4% to under 1% occurrence by power generation and increase of the load. For transition of power generation, the LPC responded within 2 cycles (Solid curve of Fig. 1 upper-left) and restrained the voltage rise compared with the radial distribution system (Broken curve of Fig. 1 upper-left).

Fault area limiting functions: We proposed a basic function to separate the fault section required in loop operation and demonstrated the function of LPC for fault control in the cases with observation V0 [*2] and without (Fig. 1 lower-left).

(2) Efficacy of distributed control

We compared the voltage rise, voltage fluctuation and total line losses for radial distribution system, distributed control with LPC and optimal control with LPC (Fig. 2). The voltage rise and the voltage fluctuation became the same as optimal control. The total line loss was little increased compared with optimal control, but the loss was half of the radial distribution system.

Future Developments

We will consider cooperation with existing facilities such as tap control of distribution substations and SVR control.

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Reference

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*1 : Komae Reserch Lab. Rep. : Development of Loop Power Flow Controller for Demand Area Power System -Autonomous Control in Transition Period-, No. T00045(2001-4)

*2 : Zero phase voltage that was observed in case of line-to-ground fault.

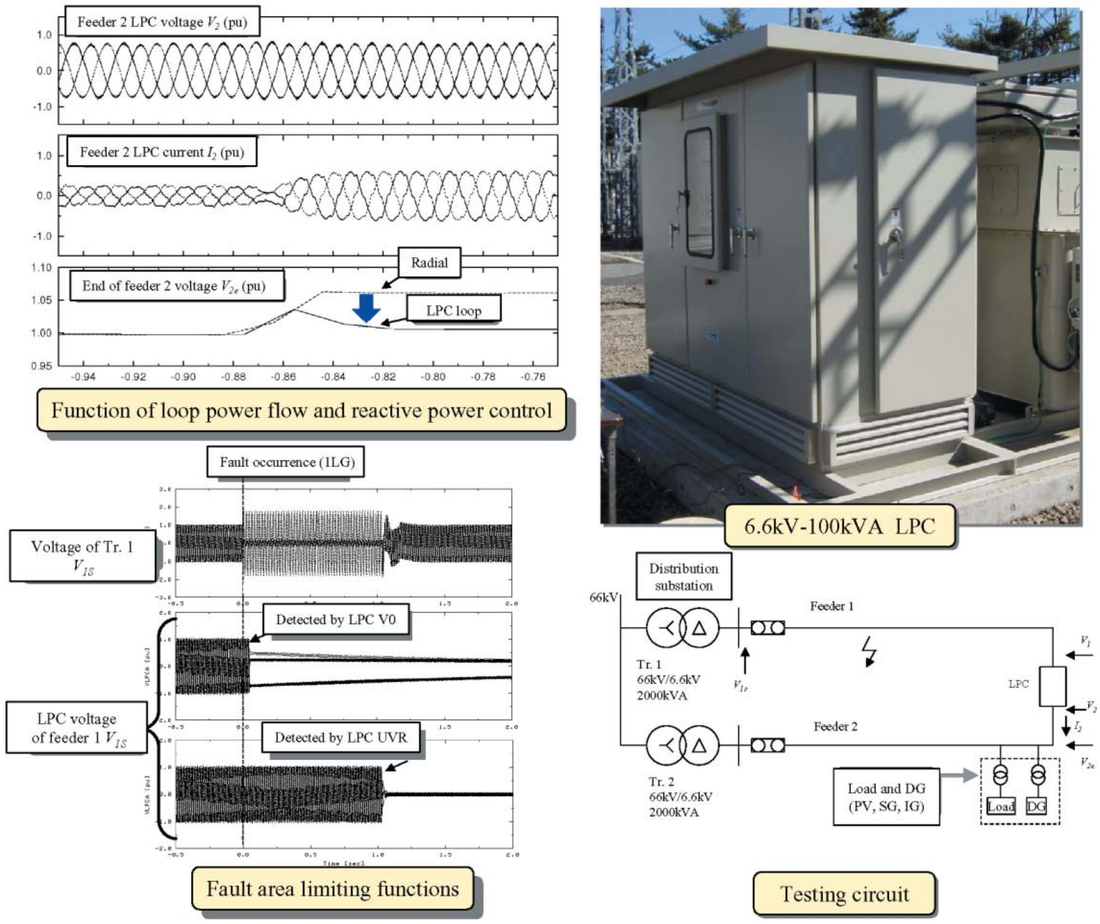
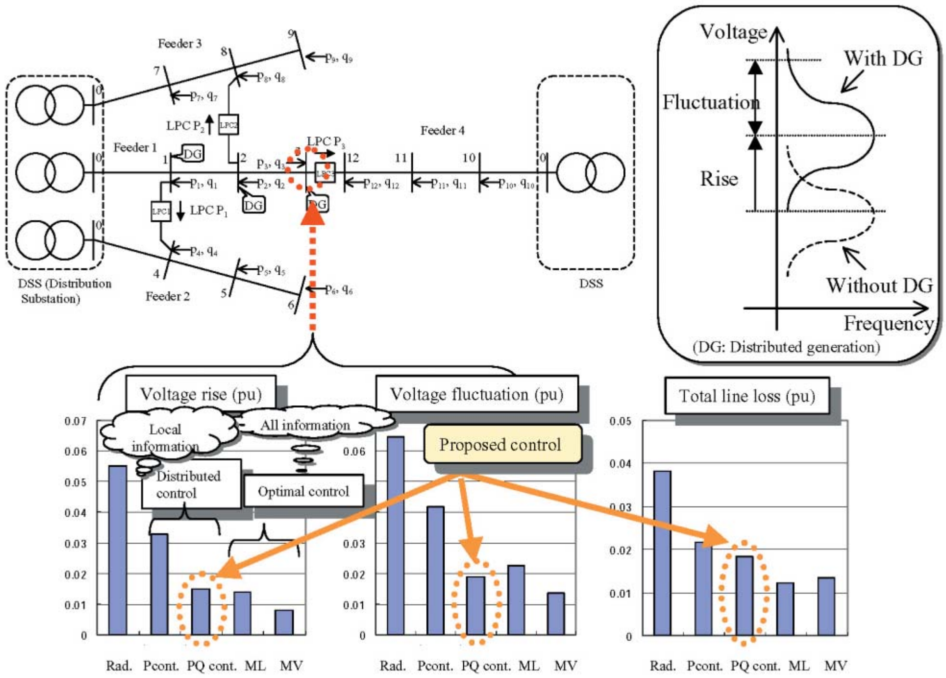


Fig.1 Demonstration of basic functions



(Rad.:Radial distribution system, P cont.: Loop power flow control, PQ cont.: Loop power flow and reactive power control, ML:Optimal control for minimum line loss, MV: Optimal control for minimum voltage error)

Fig.2 Comparison of control method