OPAL-RT TECHNOLOGIES

Success Story

Nagoya Institute of Technology uses an OPAL-RT simulator to develop the novel control method of SVR using solar radiation sensor

Nagoya Institute of Technology (NITECH) works on the research of stability of distribution systems when many photovoltaic generations are introduced. NITECH proposes effective voltage control by Step Voltage Regulator (SVR) to reduce the capacity of Static Var Compensator (SVC) using solar radiation information with real time simulator. Dr. AOKI's team is one of very active laboratory in the field of Power system research in Japan. Their research will be applied in the field of future distribution systems with many photovoltaic generations as a good solution for voltage control systems.

1. Challenge

With the increasing number of Photovoltaic generators (PV) connected to distribution system (DS), several concerns such as rise and sudden changes of voltage on distribution line are growing in Japan. Static Var Compensator (SVC) is the effective device to control rapid voltage change. However, since the cost of SVC with large capacity is expensive, it is important to reduce the capacity of SVC in order to increase the introduction of SVC into power systems.

The novel control method of SVR using solar radiation information to reduce the capacity of SVC is proposed. The effectiveness of the proposed method is confirmed by numerical simulation with a real time simulator.

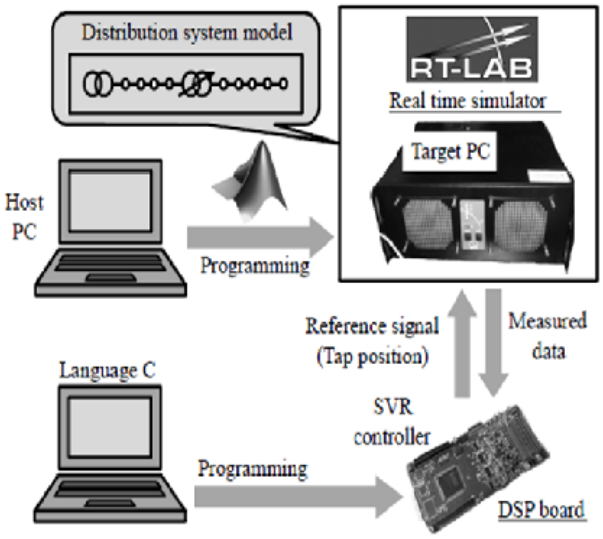
2. Solution

The novel control method of SVR using solar radiation sensor

SVR has time delay for operation. This delay of operation may cause voltage deviation when output of a large amount of PVs change rapidly. In order to prevent this problem, more information is necessary such as voltage at remote node obtained by exchanging information with voltage sensor (VS). The novel control method of SVR using solar radiation sensor, VS and communication is proposed. To prevent voltage deviation caused by time delay of SVR, the proposed SVR presumes voltage variation in the future by means of solar radiation which is obtained by solar radiation sensor located at SVR. Voltage variation by PV can be calculated by voltage sensitivity against solar radiation.

Using a Hardware-In-the-Loop simulation (HIL) with RT-LAB and ARTEMiS

In order to confirm the effectiveness of proposed method, a Hardware-In-the-Loop simulation (HIL) is used. In this HIL setup, a real-time simulation of a distribution system including an SVR is performed on the real time simulator (RT-LABTM). The simulator is connected by analog and digital inputs and outputs to a Digital Signal Processor (DSP) board used to implement a proposed controller in the SVR. The DS model is developed graphically in MATLAB/SimulinkTM and with SimPowerSystems™ on the Host-PC, then the model is compiled with RT-LAB™ software and ARTEMiS real-time plug-in for



SimPowerSystems, and the code is uploaded into the Target-PC. The RT-LAB™ allows parallel computation of such a complex model on multiple processors to ensure the calculation completed within the required time-step, as well as multiple sampling rates for the systems with different dynamics. On the other hand, the controller of the SVR is programmed with programming language C and implemented on a DSP board. The Target-PC performs simulation in real-time and the SVR controller receives measured data in DS from the Target-PC and calculates and sends the reference signal (tap position of SVR) to the Target-PC.

3. Achievement

Current SVR manages voltage properly with no PVs. However, since SVR has a time delay, SVR may not be able to manage voltage properly when large amount of PVs are connected to the distribution system due to rapid voltage fluctuation. Therefore, it is necessary to improve the control method of SVR. Furthermore, improving delay of SVR means that SVR mitigates burden of SVC to control voltage and the capacity of SVC can become smaller. This leads to reduction of the cost and prompts the introduction of SVC into distribution systems. In the proposed method, SVR communicates with voltage sensors and monitors solar radiation. Proposed SVR predicts voltage variation by PV and changes its tap position in advance before the output of PV changes, so SVR can compensate rapid voltage change and reduce the capacity of SVC. The effectiveness of the proposed controller of SVR is confirmed by real time simulation with DSP board.