Advanced Real Time Simulation Platform for Control and Protection Studies of LSIS 80kV 60MW Jeju HVDC System

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ABSTRACT

This paper describes the physical configuration and features of the advanced control and protection devices, and operation control and monitoring system that are connected to a real time simulator for LS Industrial System 80kV 60 MW Jeju HVDC Pilot Project. Highlight of simulation result are provided to demonstrate the control and protection functionality.

Keyword: HVDC, control and protection, operation control and monitoring, real time digital simulation

1. Introduction

Increased attention has been paid lately to the design of high voltage direct current (HVDC) power transmission system and led to extensive research in areas such as for the control and protection (CNP) design and operation control and monitoring (OCM) system. The CNP modeling and OCM developing schemes for HVDC system often encounters many technical difficulties, for example, the complexity in modeling of HVDC converters and controls, reliability and flexibility in developing human-machine interface (HMI).

Studies for advanced CNP design have been carried out by LS Industrial System (LSIS) for 80kV 60MW Jeju HVDC simulation project. The main objective of this paper is to represent the development strategy of the LSIS HVDC simulator for Geumak-Hallim HVDC transmission system. This simulation system consists of a real time digital simulator (RTDS) and a set of HVDC CNP panel. The OCM system is built by using supervisory control and data acquisition for process automation system (SCADA-PAS) of LSIS. Both CNP and OCM are made exactly identical to actual system in order to describe accurately its analog and digital behavior. The configuration and the function of simulation system are described in figure 1. Various simulation studies are conducted using the proposed system and highlight simulation results are described.

2. Model Development of HVDC Simulator

2.1 Control and Protection Development Approach

RTDS has advantages of expandability, conducting multiple studies simultaneously, interactive run time interface, multiple software installations, improved firing algorithm and network solution [1]. RTDS also provides an effective measure for the design of HVDC system configuration and engineering commissioning of control and protection devices [2].

The RTDS system for LSIS HVDC simulation consists of 3 racks that are physically attached in two cubicles. Each rack contain a giga transceiver workstation interface (GTWIF) whose function is to handle communication between the RTDS system with host computer and several giga processor card (GPC) whose function is to solve the overall network solution and auxiliary components [3]. Several types of RTDS I/O modules are used in order to connect the HVDC control and protection devices to the RTDS system. The RTDS simulation software includes RTDS operating system, RTDS compiler, RSCAD, RTDS power system and control system library [4]. HVDC control and protection devices of the real time simulation system were designed based on the real application of the relevant and important functions of 80kV 60MW Geumak-Hallim HVDC transmission system [5].

The control and protection devices attached in 8 cubicles with this arrangement:

a. DC control A and B, 2 panel
b. DC protection A and B, 2 panel
c. Field I/O A, B and A/B, 3 panel
d. Measurement panel, 1 panel

in which the redundancy functionality is included. DC control cubicles consist of station control system (SCS) and pole control system (PCS) racks. The DC protection only consists of one pole protection system (PPS) rack.

Each of rack consists of several boards that have specific function. Control and protection unit (CPU) board is designed in terms of the control hardware and software that carries out all station control, pole control and protection-related functions. Next is system (SYS) board that handles the system diagnostic information collection and transmission function. The other boards are fieldbus media converter (FMC) board, memory (MEM) board, LAN communication board, and transient fault recorder (TFR) board.

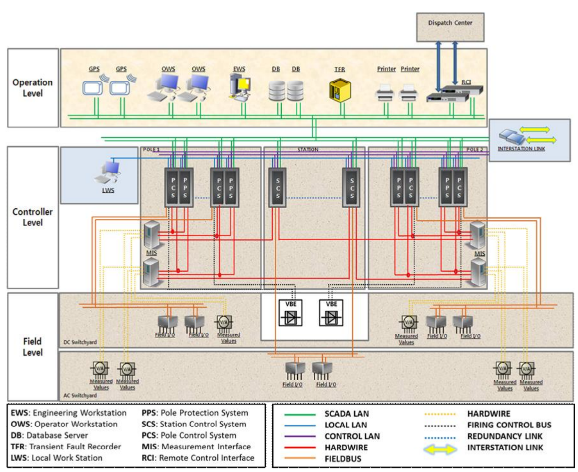

Figure 1. HVDC control and protection system.

Workstation is provided in each station for HVDC operation control and monitoring by using HMI. The new integrated HMI adopted by LSIS HVDC, the operation Control and Monitoring (OCM) system, employs the most advanced software concept with regard to system reliability and flexibility as well as user-centered aspect. The OCM system integrates a large number of features in HVDC supervisory system especially for LSIS 80kV 60 MW Jeju HVDC Pilot Project. The principle functional overview of the OCM system is shown in the Figure 2. The system is built up around three main parts: OWS, OPAS Logic Editor, and server. These parts communicate over the LAN using standard data exchange mechanisms and query languages.

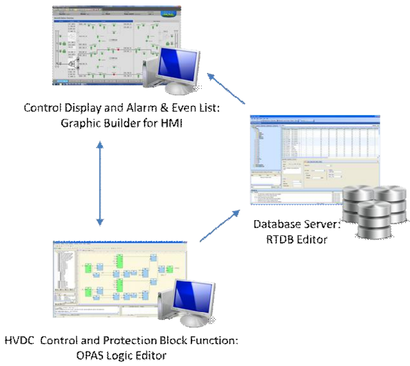

Figure 2. OCM system principle functional overview.

2.2 Control and Protection Simulation Studies

The HVDC CNP platform was connected to RTDS in closed loop mode to represent Geumak-Hallim HVDC CNP system. The HVDC converter and all DC main circuit components were modeled in the RTDS. Figure 3 represent the control and protection algorithm of HVDC system for Geumak-Hallim 80kV 60MW HVDC. To verify the consistency between simulation system and the practical control and protection system, several tests are carried out, including converter block/deblock, power ramp, reactive power control, station and pole control mode etc. It can be seen from the highlight test result that the operative characteristic of HVDC control and protection platform simulated with RTDS are consistent with the practical behavior of the real HVDC system.

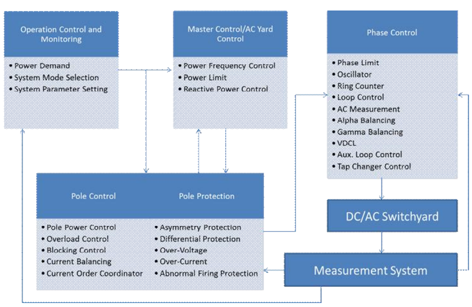

Figure 3. HVDC control and protection algorithm diagram

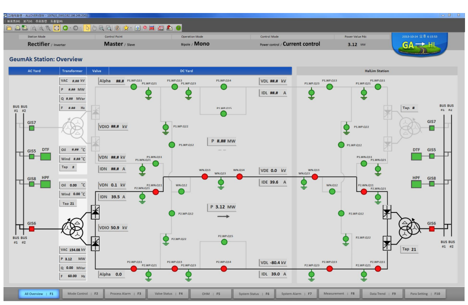

Figure 4. System overview page interface

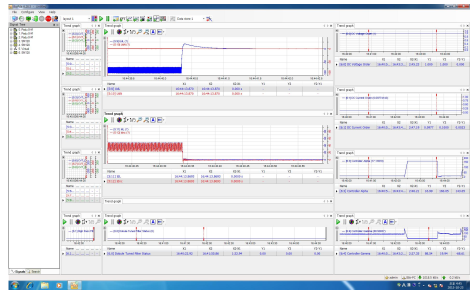

Figure 5. Transient fault recorder monitoring during block/deblock test.

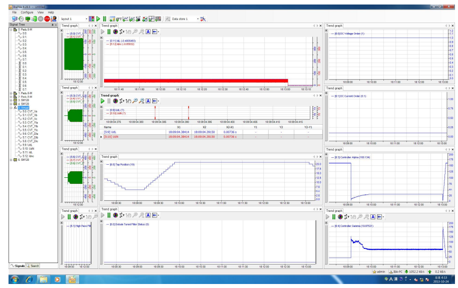

Figure6. Transient fault recorder monitoring during tap changer test.

Actual simulation result can provide more information about DC power, DC current, DC current reference, DC voltage, firing angle, extinction angle, control signals and detailed AC system information.

3. Conclusion

In this paper, an advanced real time simulation system which consists of an RTDS and HVDC control and protection platform is introduced. The objectives of this simulator development are both for research purposes, operator training in a real time operation system environment, as well as to represent the LSIS HVDC technical development strategy. Several simulations have been conducted to demonstrate the typical control and protection application function and selected simulation result have been provided.

This paper was part of Jeju 80kV 60 MW HVDC System Pilot Project of LS Industrial System Company.

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