HYOSUNG CORPORATION

Study Committee B4

DC SYSTEMS AND POWER ELECTRONICS

Paper ID_10323

HVDC Controller with Model-Based Design and Verification through HILS

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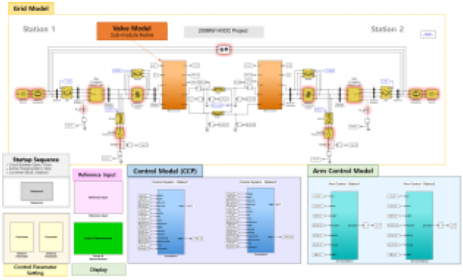
Motivation

- The 20MW HVDC Pilot Project was completed in 2017 and the 200MW VSC HVDC is being developed by improving capacity and speed.
- Reduces mistakes in the development process and facilitates validation through model-based design and automatic code generation.

Method/Approach

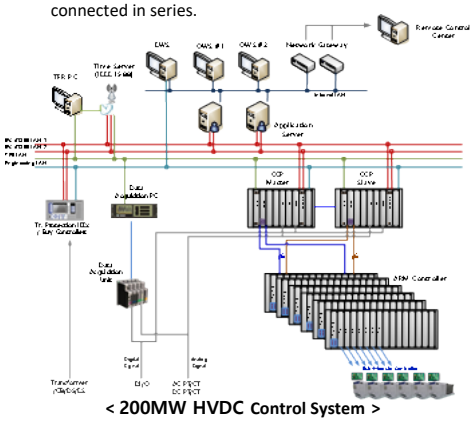
- The system and valve were modelled using Simscape Electrical and only the converter controller has been implemented in the automatic code generation method.
- To verify the model, after identifying that the model using the Simulink Library produces the same result as by EMT simulation, a model using the Xilink Library is added and results are compared.



< 200MW HVDC model >

Objects of investigation

- The 200MW HVDC is installed at the Yangju 154kV substation in Korea and has a MMC structure, hundreds of Half-Bridge SMs (Sub-Modules) are connected in series.

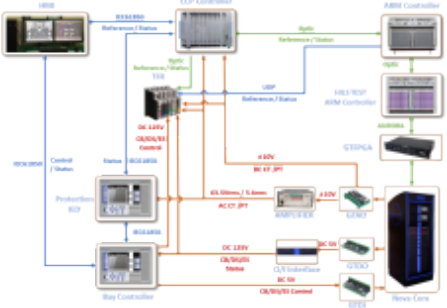


< 200MW HVDC Control System >

- The control and protection system plays the role of controlling and protecting the entire system including the converter and various indoor/outdoor devices.
- The converter control and protection (CCP) and the Arm controller, which controls switching of SMs.

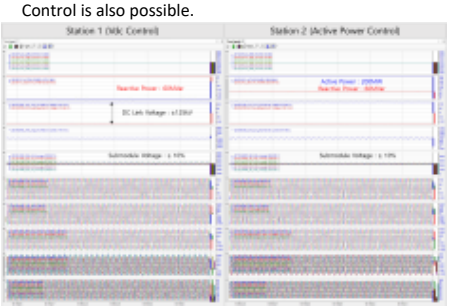
Experimental setup & test results

- To verify the implemented control algorithm, Hardware in the Loop System was performed and the response of the converter and the system is simulated by Real Time Simulator.
- 200MW HVDC HILS consists of the same product and structure to be installed on-site.



< Configuration of 200MW HVDC RTDS HILS>

- 200MW HVDC is a system that can control up to 200MW of active power and 60MVar of reactive power.
- Each sub-module voltage moves within the range of ±10% of the rating and DC Link rating is ±120kV up to ±125kV.
- Station1 performed Vdc Control and Reactive Power Control and Station2 performed Active Power Control and Reactive Power Control. Vdc Control and Active Power Control can be changed by station and Vac Control is also possible.



< Results of HILS>

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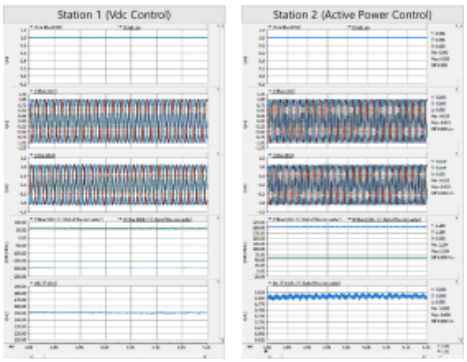
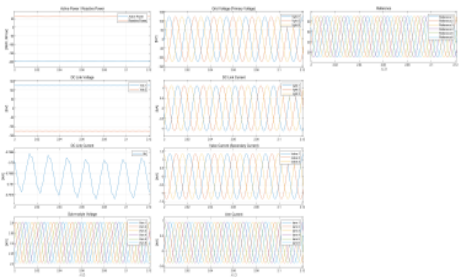
continued

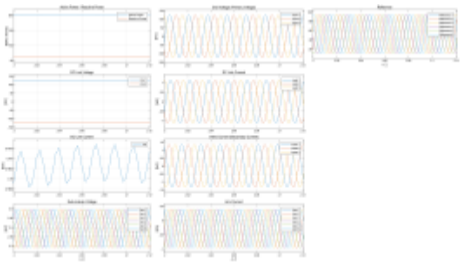
- When the controller gains of the PSCAD, Simulink, and HILS systems were set identically and the results were compared, almost the same results were confirmed in the rated range operation, precision, and response time.



< Results of EMT Simulation >



< Results of Simulink Simulation (Station1 : Vdc Control) >



< Results of Simulink Simulation (Station2 : Active Power Control) >

Conclusion

- Since the model simulated through automatic code generation can be directly applied to the controller, mistakes that may occur in the existing development process can be eliminated and individual models can be easily tested.
- The part that can be applied automatic code generation is limited to the control algorithm so software developers are required for communication and peripheral function implementations, and the optimal design of the model must be considered in consideration of limited hardware resources.
- By using Real Time Digital Simulator, the Yangju grid system and valve were modelled and the performance was verified by interworking with the actual control system including the controller to which automatic code generation was applied.
- Confirm the applicability of automatic code generation to the actual HVDC controller and it could operate stably in the rated operation of the 200MW HVDC system.