Training

HVDC & FACTS at DIgSILENT PowerFactory

This four-day training course offers an overview of high voltage direct current (HVDC) transmission and flexible AC systems (FACTS). Line-switched converters (LCC), modular multilevel converters (MMC), static VAR (SVC) compensators, STATCOMs and thyristor-controlled series capacitors (TCSC) are addressed. Topologies and controls are explained, steady state, harmonic and dynamic behavior. Participants will learn how to model these systems in PowerFactory. Case scenarios of practical use are investigated.

This training aims to enable the participant to understand modern HVDC / FACTS devices, diligently analyze an electrical network that includes HVDC / FACTS and identify the benefits and limitations..

DAY 1   **HVDC systems with LCCs**

Introduction to HVDC
- Overview converter technologies, monopoles, bipoles.
- Basics of line-commutated converters (LCCs).

Exercise: Model of a six-pulse bridge in PowerFactory
- Introduction to the thyristor-based rectifier model, power flow setpoints, load flow analysis, time-domain simulation.

Steady-state analysis of LCC-HVDC
- Steady-state behaviour, reactive power demand and compensation, typical harmonic spectra, harmonic filters.

Exercise: Steady-state model of LCC-HVDC in PowerFactory
– Implementation of an HVDC model, power flow setpoints, load flow analysis, reactive power compensation.

End of the first day

DAY 2   **HVDC systems with LCCs**

Dynamics
- Control schemes for rectifiers and inverters. Implementation in PowerFactory, firing angle and extinction angle control.

Exercise: EMT simulation
- Influence of firing angle on steady-state operating point, reactive power demand, FFT analysis, response to system disturbances

HVDC systems with MMCs

Introduction to MMCs
- Voltage-sourced converter (VSC), modular multi-level converter (MMC), MMC with halfbridge topology, MMC with full-bridge topology, operation principles, modulation techniques, applications, steady-state control strategies, models in PowerFactory

Exercise: Steady-state studies
- Implementation of MMC-HVDC links into AC network models, application: 50 Hz/60 Hz link, embedded link in 50 Hz grid, offshore link; load flow analysis, different control strategies.

End of the second day

DAY 3   **HVDC systems with MMCs**

Dynamic behaviour

- Dynamic control strategies (control for islanded and nonislanded operation), MMC internal controls, protection schemes (blocking mode, DC chopper), behaviour during network faults

11:00 h   **Exercise: Dynamic behaviour, Part1**

- Dynamics under normal operating conditions, response to network disturbances, DC overvoltage mitigation in offshore HVDC links.

Exercise: Dynamic behaviour, Part2

- Behaviour of half- and full-bridge MMC HVDC systems in cases of faults in the DC link

Exercise: Power System Analysis

- Practical use case examples of power system analysis with HVDC systems

End of the first day

DAY 4   **FACTS**

Parallel Compensation with FACTS: Static VAR Compensator/System (SVC / SVS), Static Synchronous Compensator (STATCOM)

- Overview of parallel compensation devices, application use cases, topologies, behaviour, controls, harmonics.

Exercise: SVC

- Implementation of a SVC in an AC grid, load flow analysis, dynamic simulations, harmonic load flow.

Exercise: STATCOM

- Implementation of a STATCOM in an AC grid, load flow analysis, dynamic simulations.

Series Compensation with FACTS: Thyristor-Controlled Series Capacitor (TCSC)

Overview of series compensation devices, application use cases, topologies, behaviour, controls, overvoltage protection with surge arresters.

Exercise: TCSC

- Implementation of a TCSC in an AC grid, dynamic simulations (RMS and EMT).

End of the second day