LUCAS-NÜLLE

Training System for High-Voltage Direct Current Transmission (HVDC)

Sustainable Energy Transmission for Efficient and Reliable Grids in the Future

SMART MICRO GRID

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High-Voltage DC Power Transmission

Versatile Experiments with State-of-the-Art VSC Technology

High-voltage DC power transmission is a method of transmitting electrical energy by means of high DC voltage. High-voltage technology (HVDC) is designed to exploit direct current as a means to transmit power over long distances since above certain longer distances the high-voltage DC transmission features lower overall power losses than is the case for conventional transmission using three-phase AC power, despite the additional converter losses. High-voltage DC transmission is frequently used for power transmission over comparably short distances if the power transmission cable has been designed with a very high degree of capacitance per unit length. This is typically the case with submarine cables but also underground terrestrial cables.

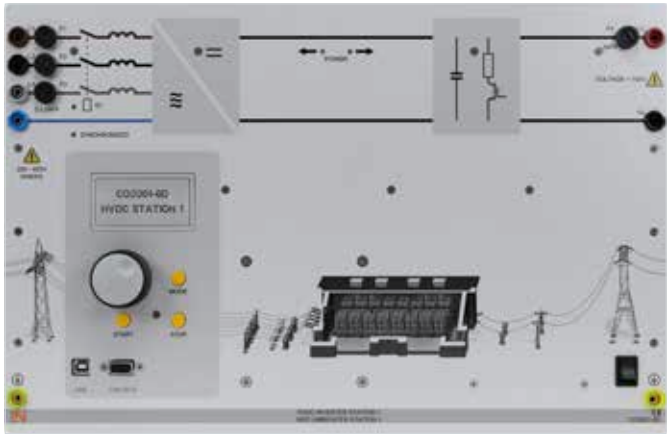
Experiment example "High voltage DC transmission" EDC1

Training content

- Control of intermediate circuit (link) voltage
- Provision of reactive power but with no effect on the flow of active power (STATCOM)
- Manual and automatic synchronisation with the electric power grid
- Control of HVDC reactive power with modification to the flow power
- Individual control of reactive power for both converter stations
- Observation of losses for various lengths of HVDC lines
- Provision of a power network with passive consumers by means of HVDC (black start)
- Coupling of wind turbines
- Investigation of fault ride-through (FRT) behaviour in HVDC systems

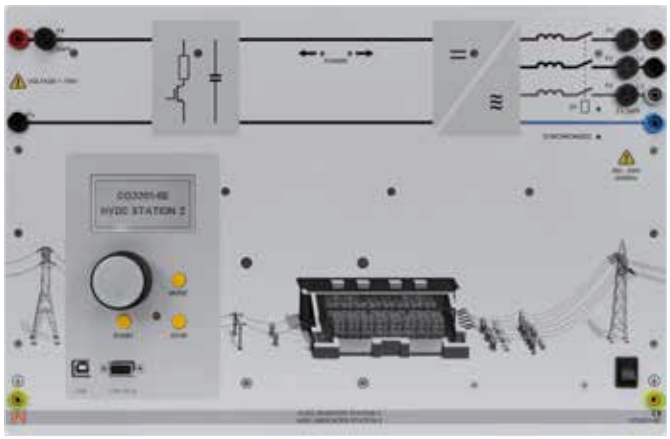
Converter station 1

- STATCOM operation
- Coupling between grids with different frequencies
- Self-sufficient automatic control of reactive and active power, frequency, voltage
- Measurement and display of all system variables
- Transmission of up to 1000 W active power



Converter station 2

- Active power control in both directions
- Connection of synchronous generators, wind power plants and loads
- STATCOM operation
- Coupling between mains with different frequencies
- Self-suffi cient automatic control of reactive and active power, frequency, voltage
- Measurement and display of all system variables
- Manual and automatic synchronisation
- Transmission of up to 1000 W active power



Your benefits

- Imparting knowledge and know-how using a multimedia-based course "Interactive Lab Assistant"
- PC-based evaluation of measurement data
- New technologies of voltage source converter (VSC)
- Integration into the power engineering systems
- State-of-the-art technology including "Fault-ride-through"
- The microcontroller-operated control unit of the converter station permits comfortable operating control and visualisation during the experiments

High-Voltage DC Power Transmission

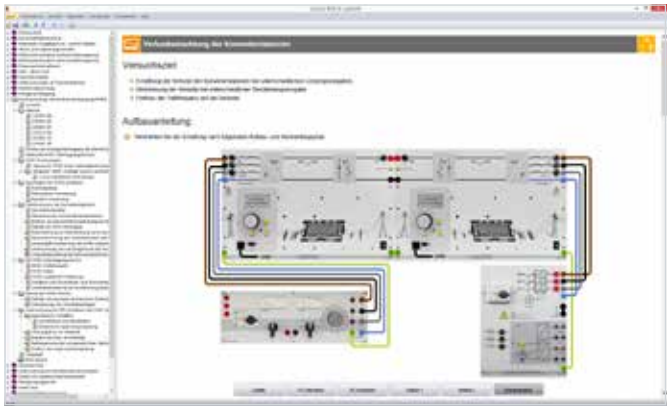
Interactive Training Environment

“Interactive Lab Assistant”

- Multimedia-based step-by-step instruction guide
- Tests of learning progress using question pool with assessment tool

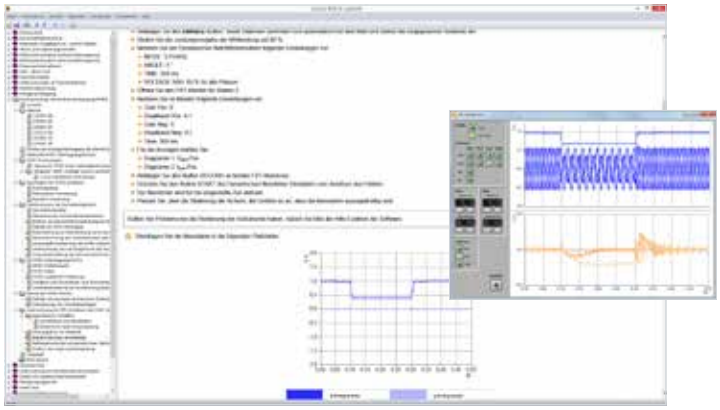
Theory

- Explanation of physical principles by means of easily understandable animations



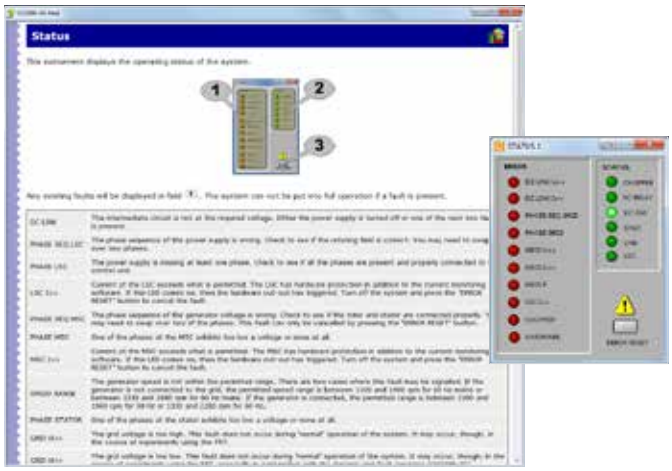
Experiments

- Interactive illustration of experiment set-ups



Measurements and results

- PC-supported evaluation of measurements
- Virtual instruments can be started directly from the experiment instructions
- Measurement results can be copied into the course pages via “drag and drop”

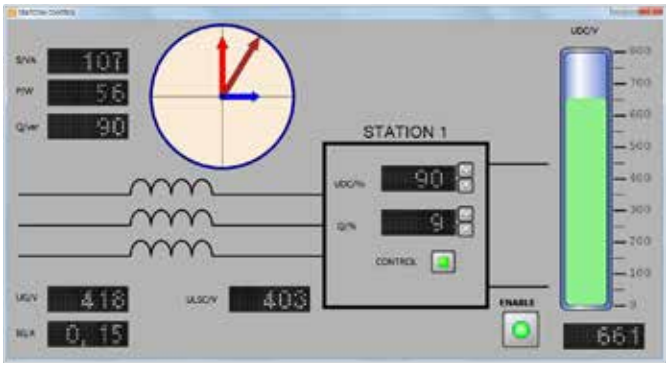


Status display

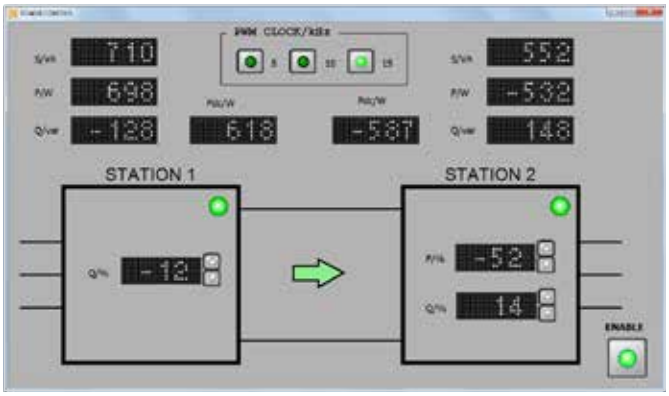
- Status and fault displays for converter stations
- Extensive help function

Various Operating Modes

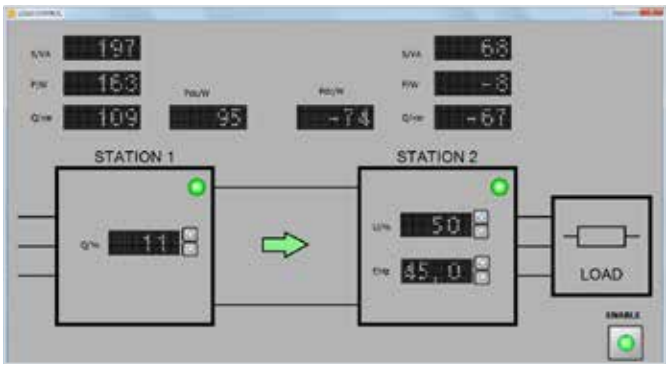
“STATCOM” instrument
- Works even when the transmission line is not operating
- Control of DC link circuit
- Control of reactive power



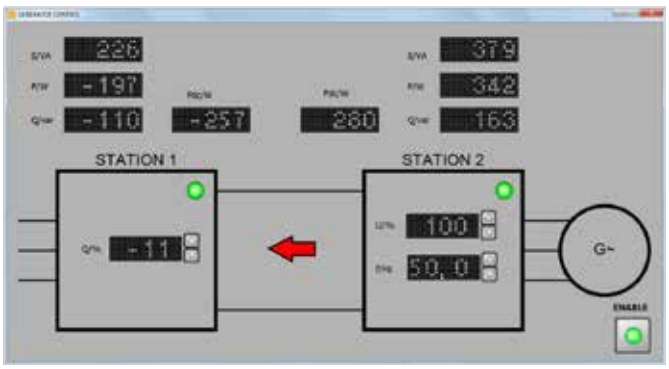
“Power control” instrument
- Control of active power in both direction
- Control of active and reactive power in all 4 quadrants
- Automatic synchronisation



“Load control” instrument
- Supplying a network with passive loads only
- Black starts
- Pre-setting of voltage and frequency on load side
- STATCOM on grid side



“Generator control” instrument
- Coupling of wind power plants without additional generator
- Black starts
- Pre-setting of voltage and frequency on generator side
- STATCOM on grid side

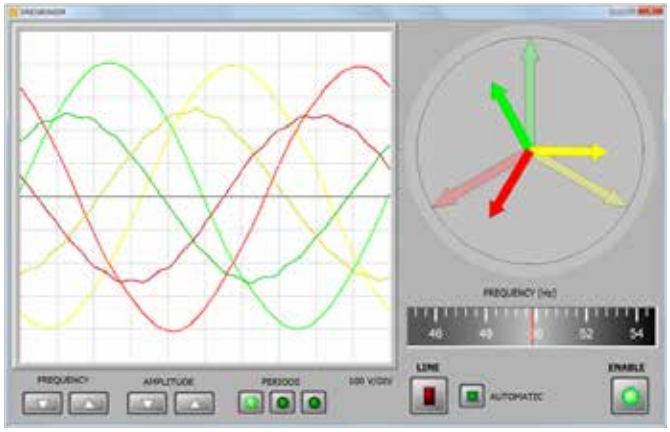


High-Voltage DC Power Transmission

Virtual Instruments

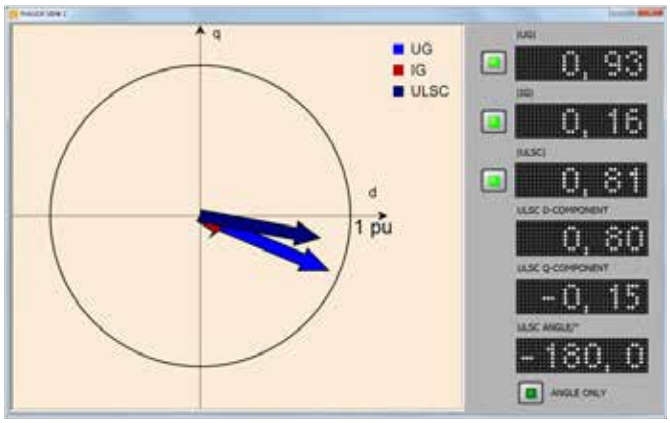
“Synchroniser” instrument

- Automatic and manual synchronisation of converter station with grid
- Three-phase display of grid and converter voltages
- Control of converter output voltage and frequency



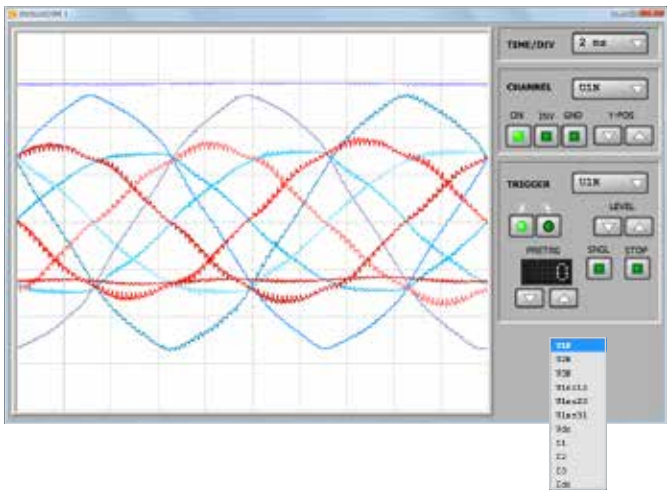
“Phase diagram” instrument

- Display of converter station currents and voltages in a phase diagram
- Display of symmetric components
- Separate instruments for every converter station



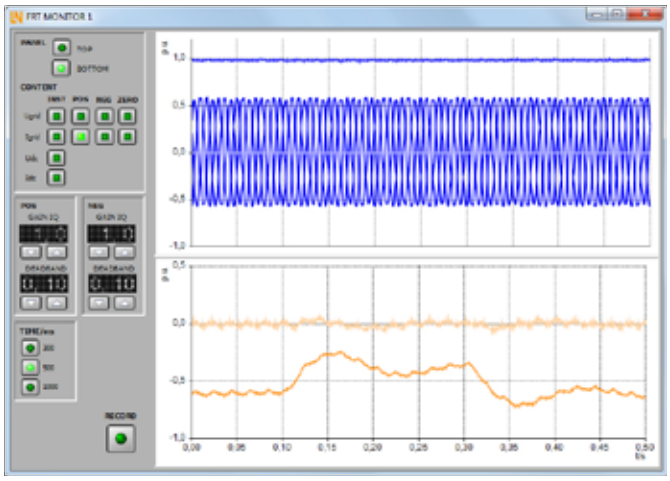
“Oscilloscopes” instrument

- Display of all signals from converter stations
  - Grid voltages
  - Grid currents
  - DC voltage
  - DC current



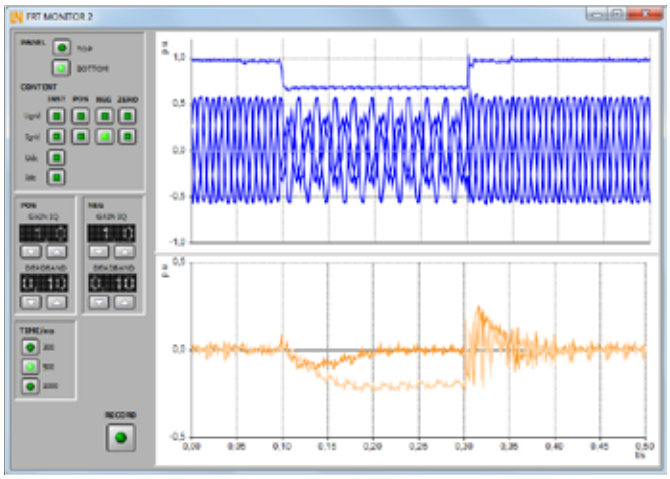
"FRT Monitor" instrument for Station 1

- Setting of "grid codes"
- Display of symmetric components
- Display of instantaneous values
- Simultaneous measurements from both stations



"FRT Monitor" instrument for Station 2

- Setting of "grid codes"
- Display of symmetric components
- Display of instantaneous values
- Simultaneous measurements from both stations
- Investigations with wind power plant connected



SCADA control

- Monitoring of converter stations in a smart grid
- Control of converter stations via SCADA
- Supplying a smart grid with active and reactive power

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