



09.11.22, GOLDEN, USA, 6TH INTERNATIONAL WORKSHOP ON GRID SIMULATOR TESTING OF WIND TURBINE POWER TRAINS AND OTHER RENEWABLE TECHNOLOGIES

Voltage and current control of Power Electronics AC and DC Grid Simulators

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Agenda

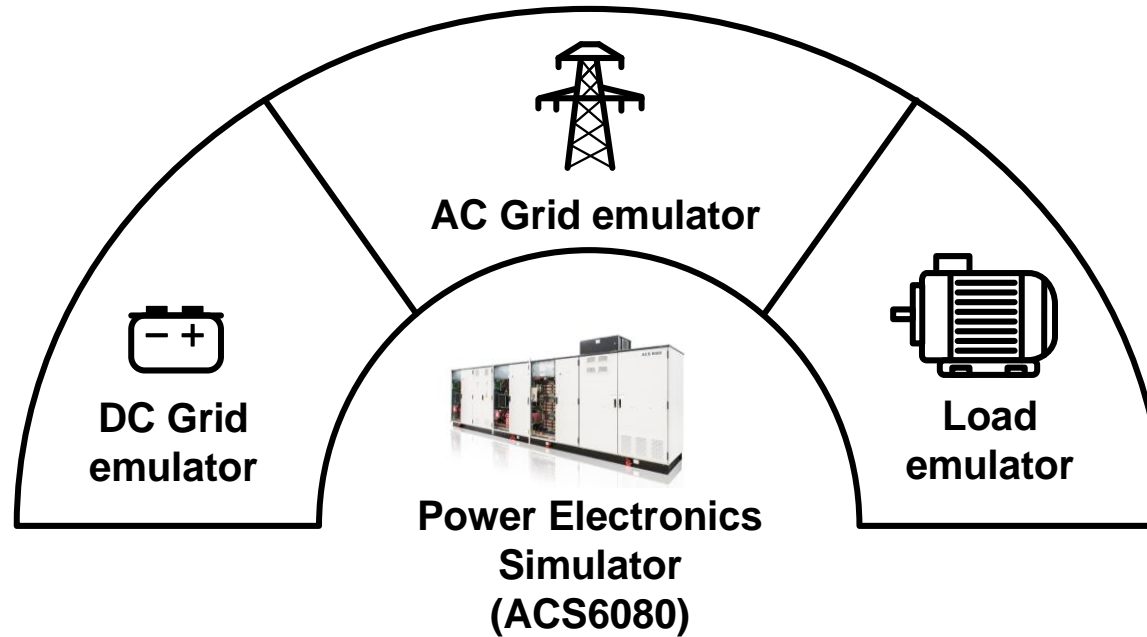
- Introduction
- Power Electronics AC Grid Simulator's control modes
- Power Electronics DC Grid Simulator's control modes
- Conclusions

Power Electronics AC and DC Grid Simulators

Various applications

- controllable multi-phase AC voltage source (grid emulation, generator emulation),
- certification of grid-tied power converters.

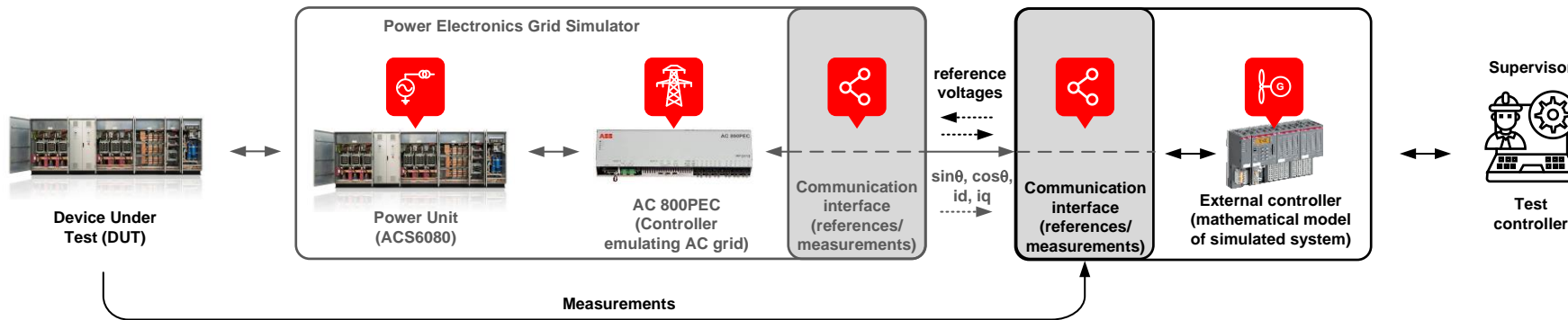
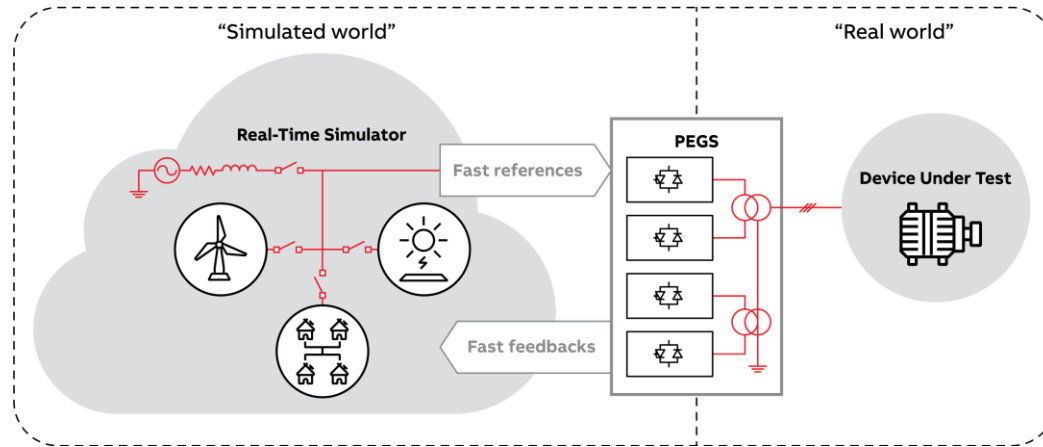
- controllable DC voltage source (grid emulation, emulation of other applications e.g. battery),
- battery charging modes.



- controllable three-phase AC current source,
- emulation of asymmetrical loads.

Power Hardware in the Loop new opportunities

Features providing voltage and current control modes

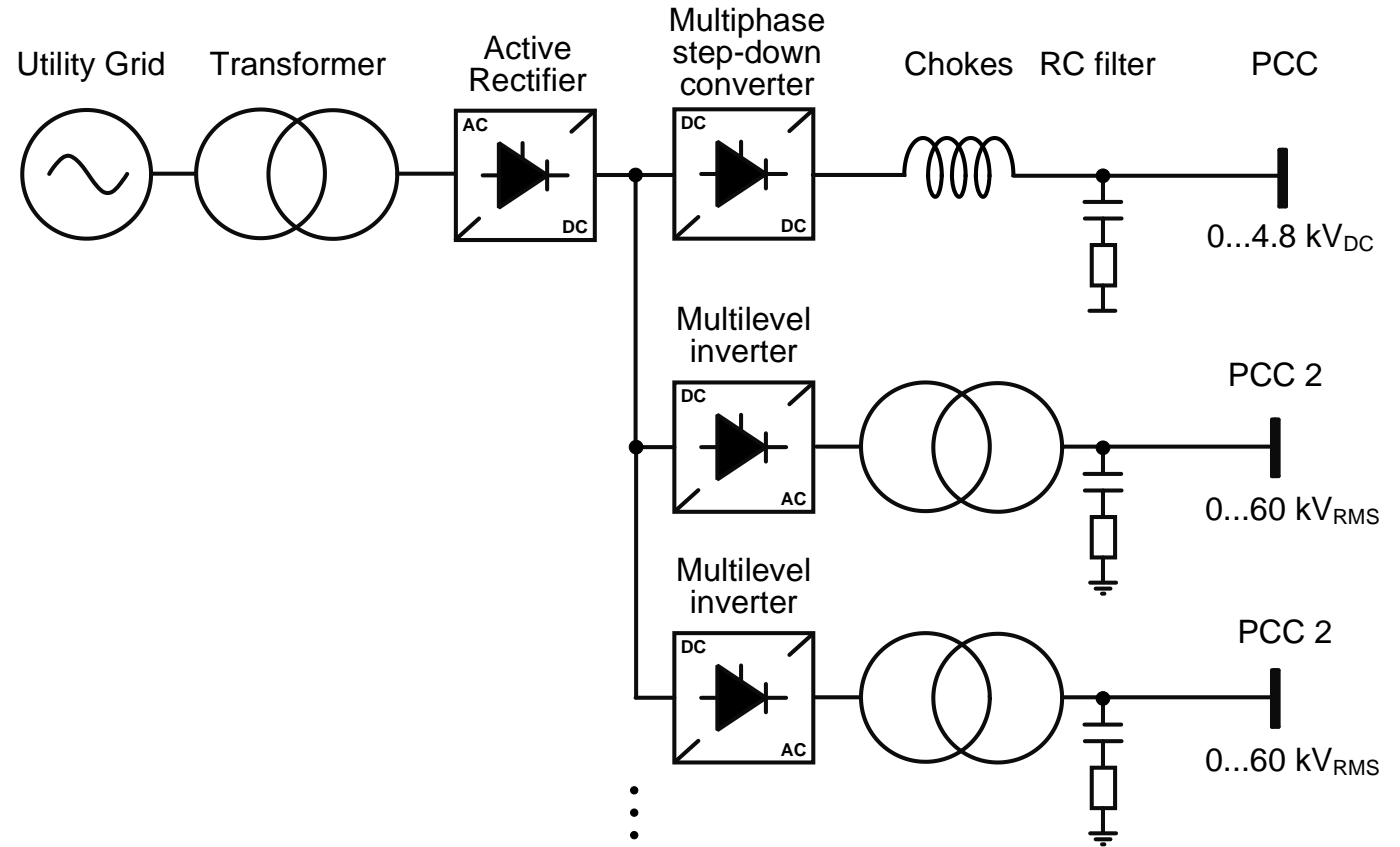
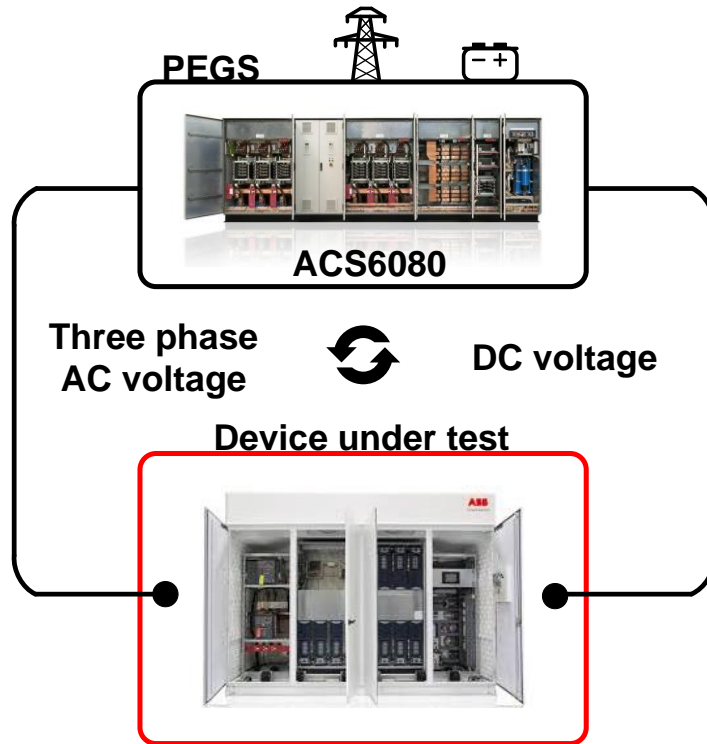


Features providing new opportunities of Power Hardware in the Loop (pHIL) simulations:

1. Control modes implemented in ABB's controller integrated with PEGS:
 - voltage control,
 - current control.
2. Fast communication:
 - Fast reference chain,
 - Fast measurement chain.

Universal test bench with modular scheme and increased power capability

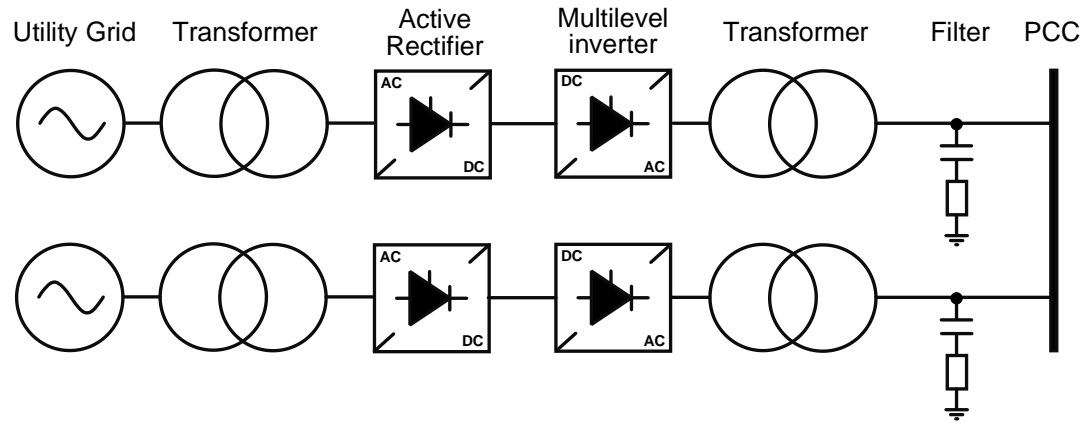
Modular HW design: parallel or series configuration



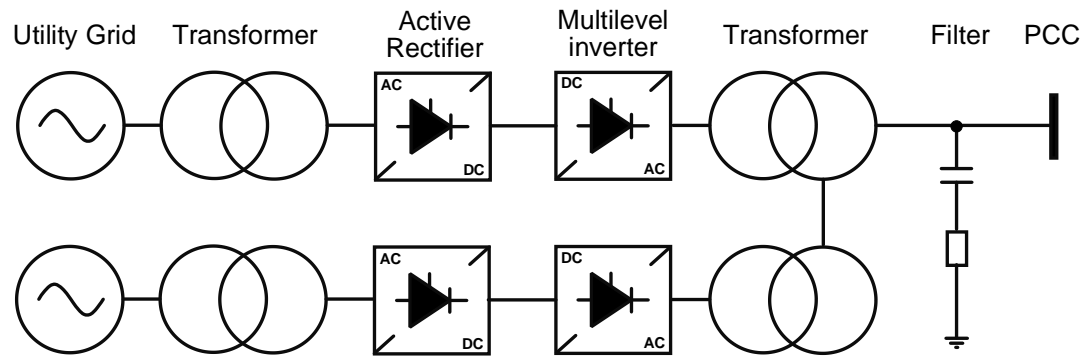
Power Electronics AC Grid Simulator

Multidrive operation

Parallel configuration:

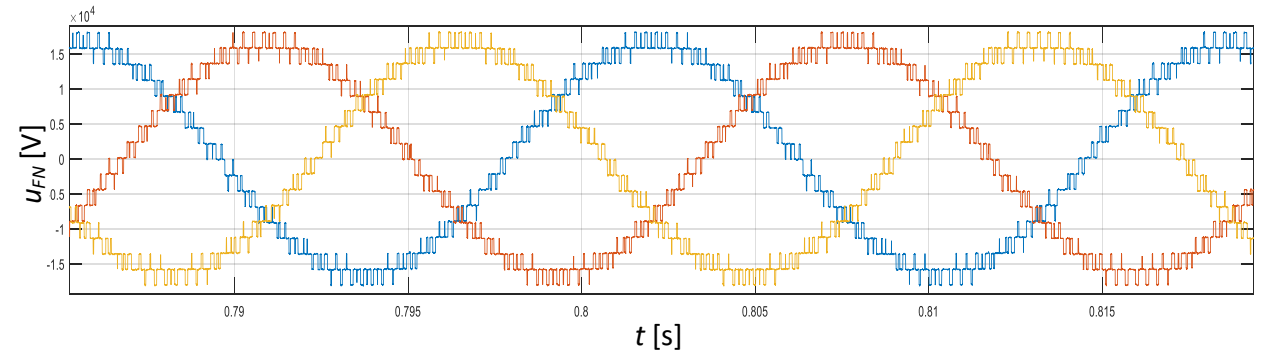


Series configuration:



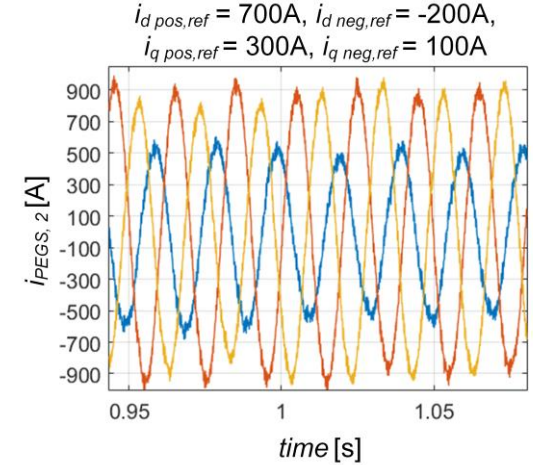
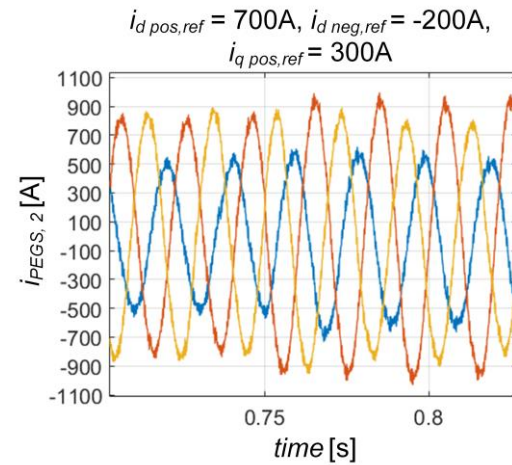
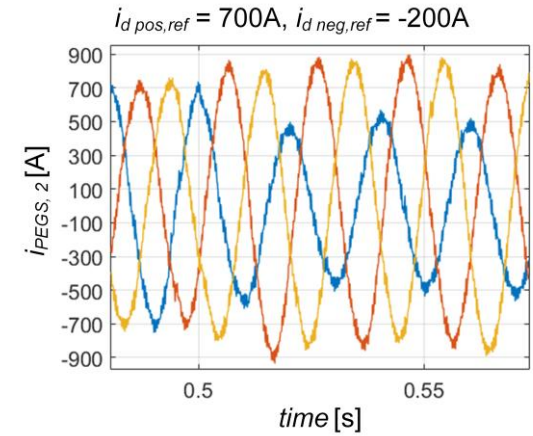
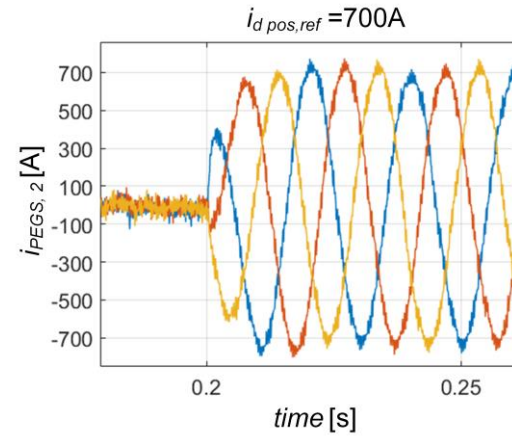
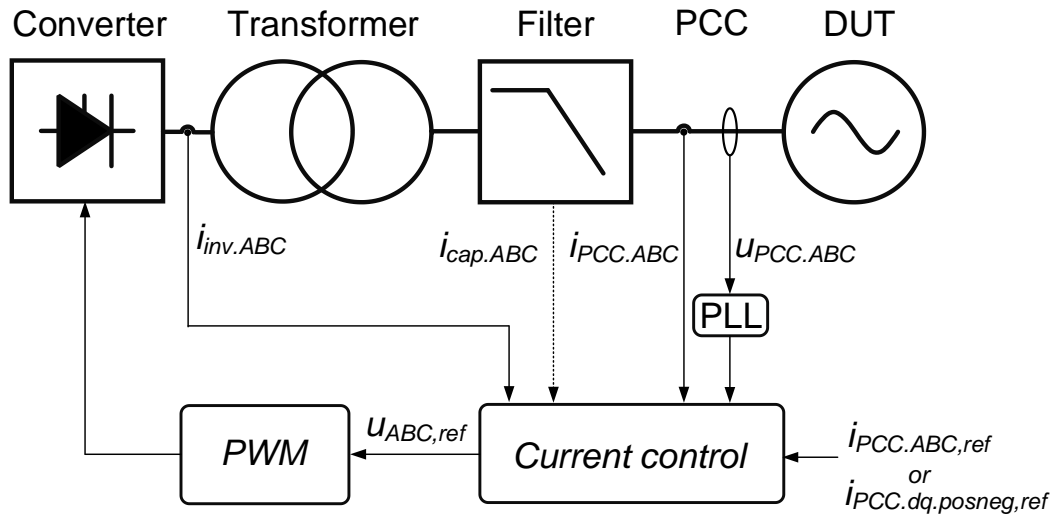
General characteristic:

1. Synchronization of voltage.
2. Control modes:
 - grid-forming,
 - grid-following.
3. References:
 - voltages (polar coordinate system, instantaneous values)
 - currents (dq pos, dq neg, or instantaneous values).



Power Electronics AC Grid Simulator

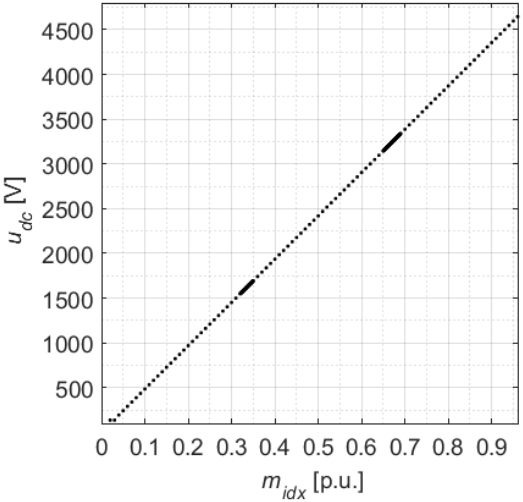
Current control of Grid Simulator



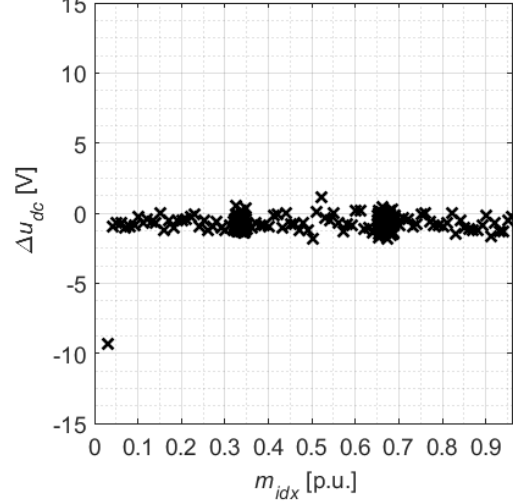
Power Electronics DC Simulator

Open-loop voltage control

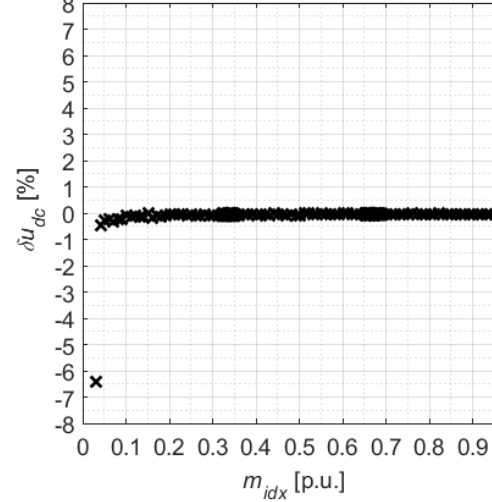
Control characteristic $u_{dc\ out} = f(m_{idx})$



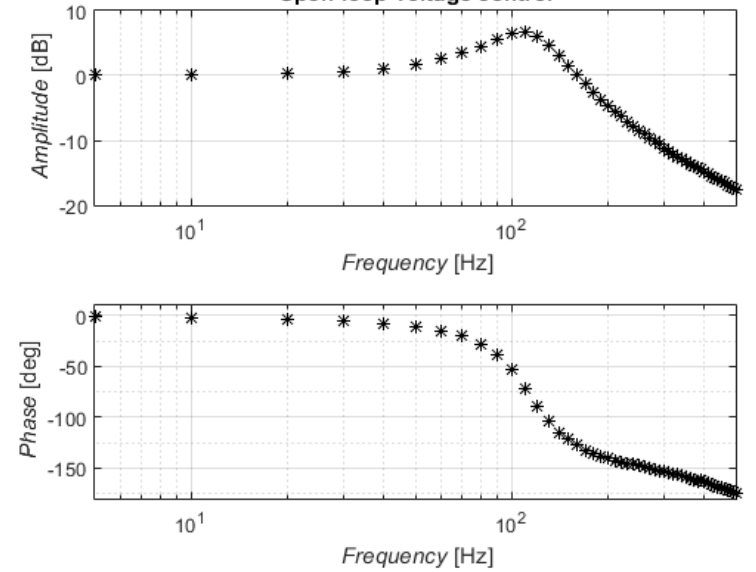
Absolute error $\Delta u_{dc} = f(m_{idx})$



Relative error $\delta u_{dc} = f(m_{idx})$



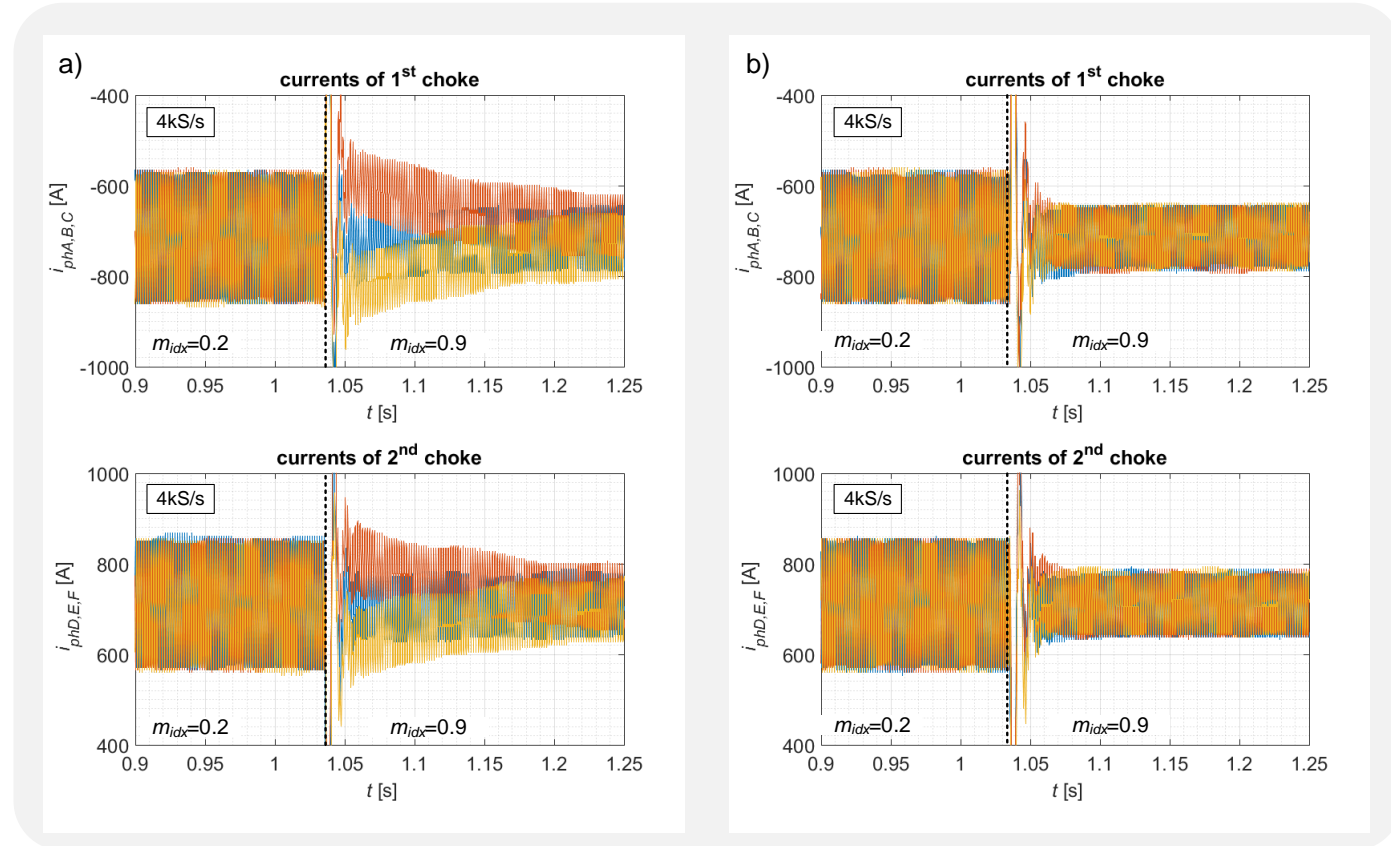
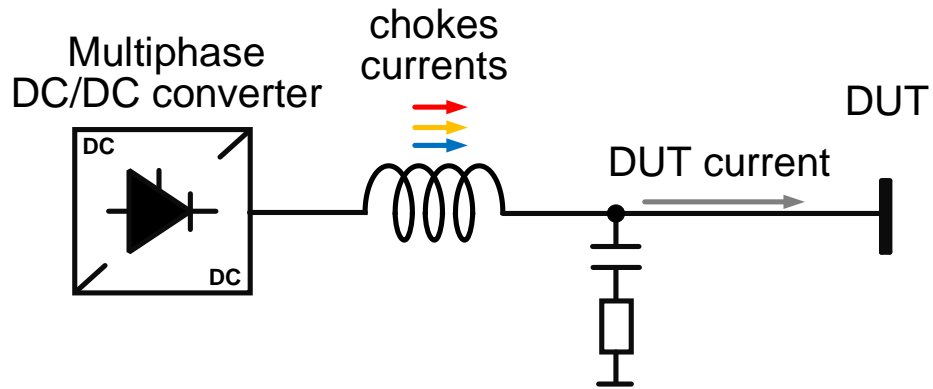
Open-loop voltage control



Power Electronics DC Simulator

Equal power sharing between power electronics converter phases

Higher dynamic of the system and robustness against parameters uncertainties.



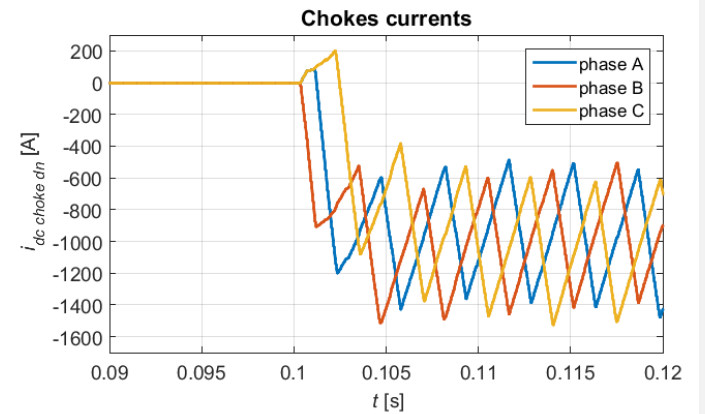
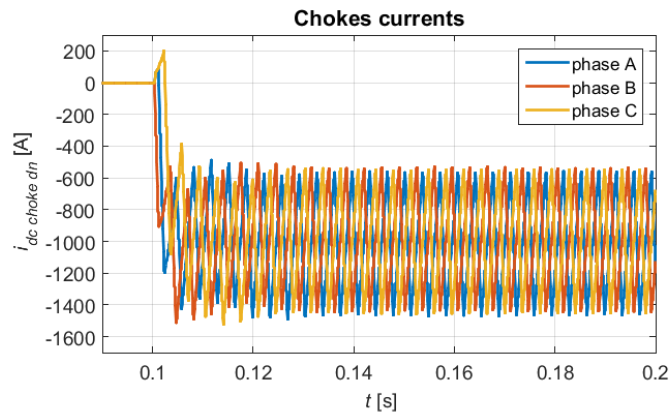
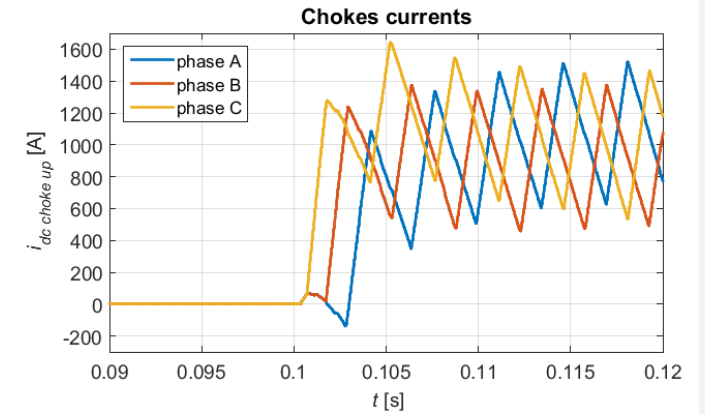
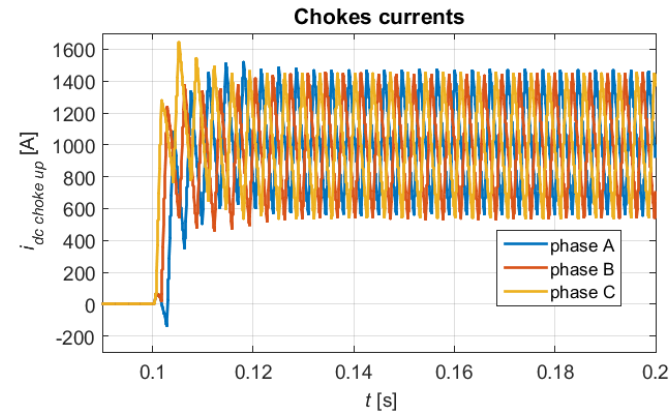
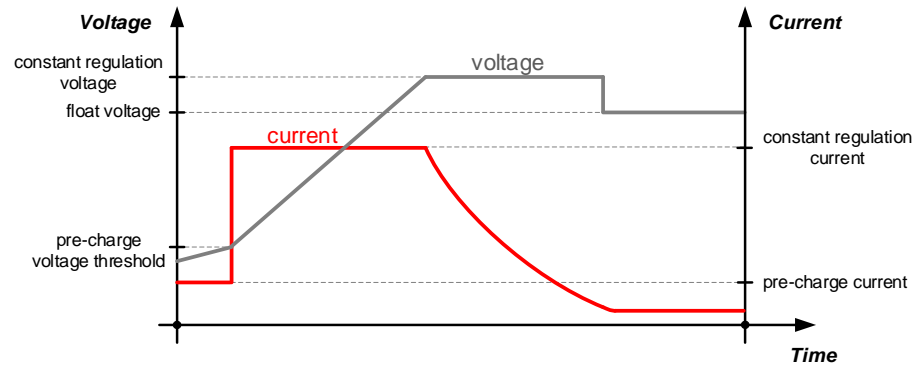
Converter phase currents during a step of modulation index: feature **disabled** (a), feature's continuous mode **enabled** (b)

Power Electronics DC Simulator

Closed-loop control modes

Battery charging modes:

- current control,
- voltage control.



Power Electronics AC and DC Grid Simulator Simulators

Conclusions

1. ABB's PowerLink with reduced communication latency provides new opportunities of Power Hardware in the Loop simulations.
2. Communication link between two PEC controllers allows to synchronize voltages of two Power Electronics Grid Simulators.
3. Setup based on series or parallel operating PEGSs provides increased power capability and perfect voltage quality.
4. Current control mode allows emulation of symmetrical and asymmetrical loads.
5. Power Electronics DC Grid Simulator due to interleaved modulation scheme provides high voltage quality.
6. Power Electronics DC Grid Simulator is equipped with voltage and current closed-loop control modes.

ABB