

The **Smart Way**

SIEMENS

HVDC PLUS – One Step Ahead

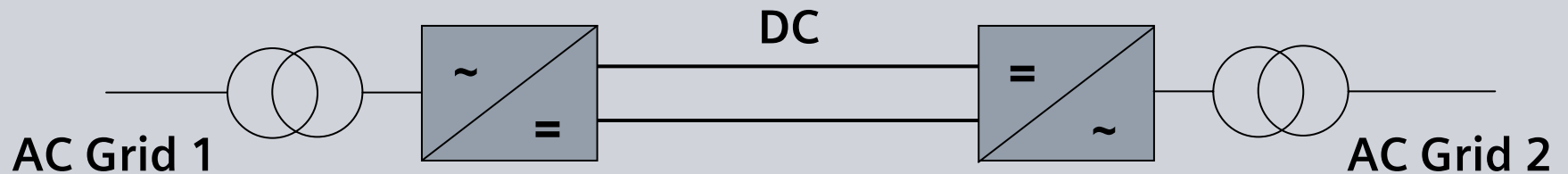
HVDC PLUS –

Technologie, Benefits, Anwendungsfelder

Power Transmission
and Distribution



HVDC Classic – HVDC PLUS



HVDC Classic	HVDC PLUS
Line-commutated current-sourced converter	Self-commutated voltage-sourced converter
Thyristors with turn-on capability only	Semiconductor switches with turn-on and turn-off capability

General Features of VSC Technology

Grid access of weak AC networks

Independent control of active and reactive power

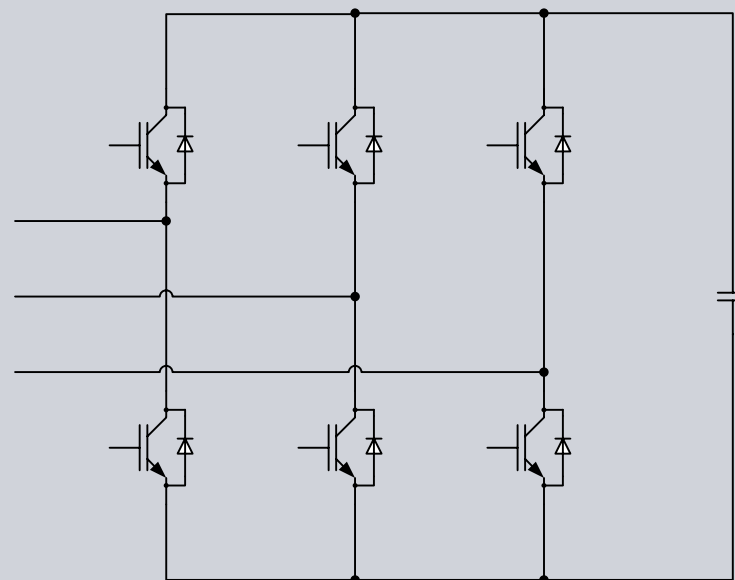
Supply of passive networks and black start capability

High dynamic performance

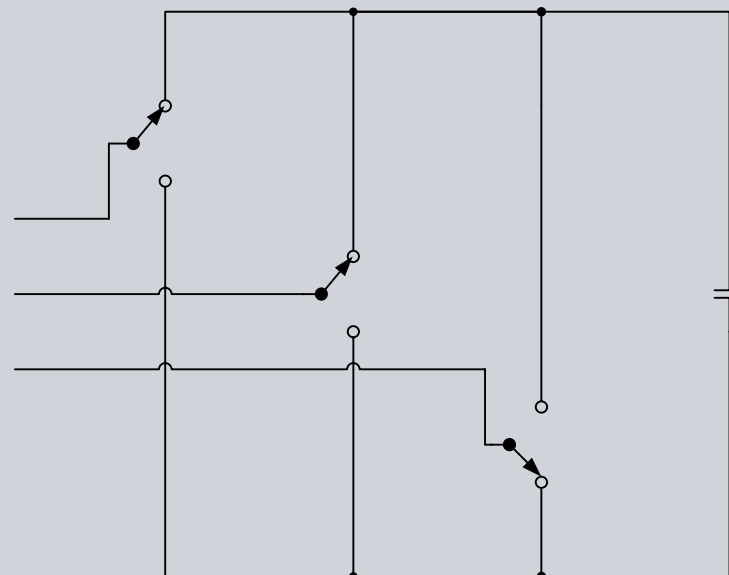
Small space requirements

Additional Features and Benefits of HVDC PLUS

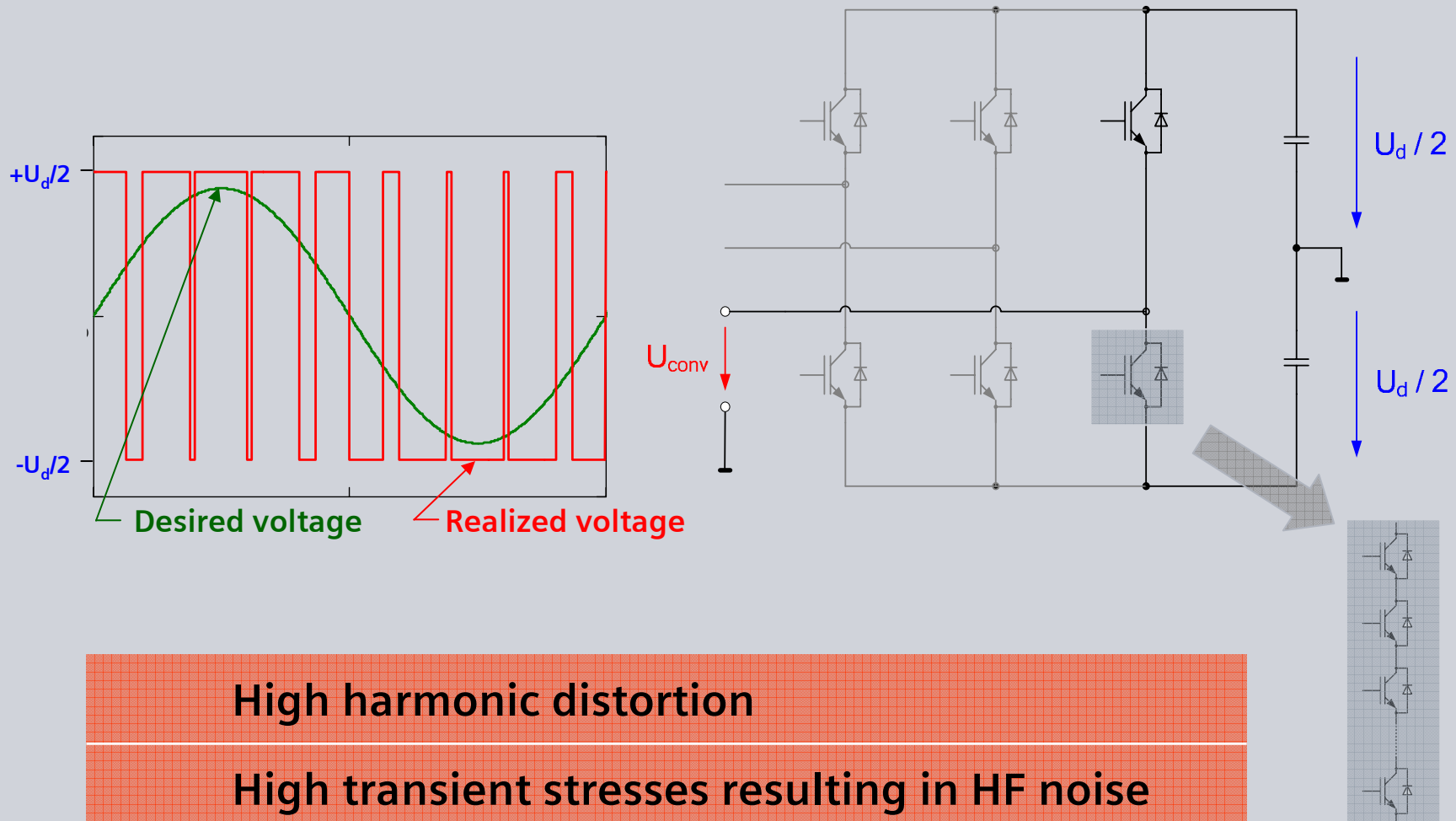
VSC Technology – A look back



VSC Technology – A look back



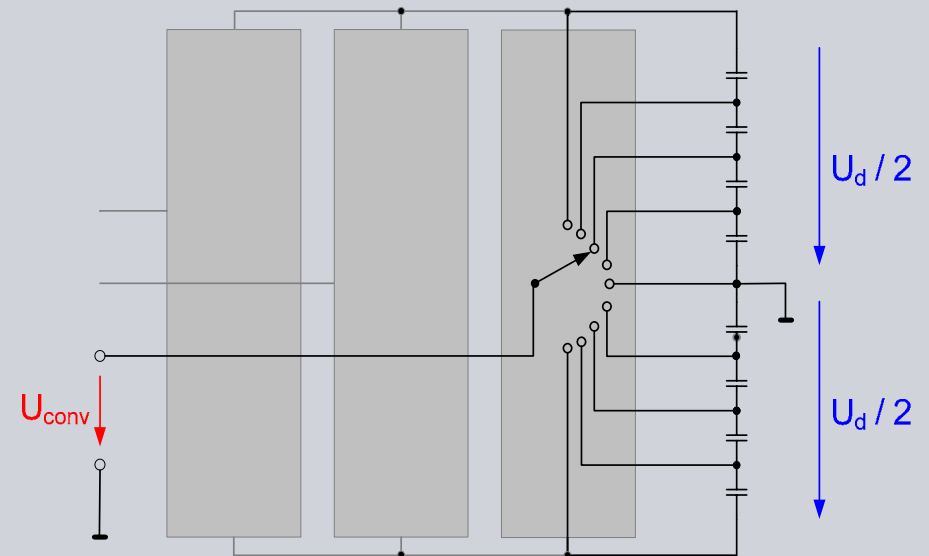
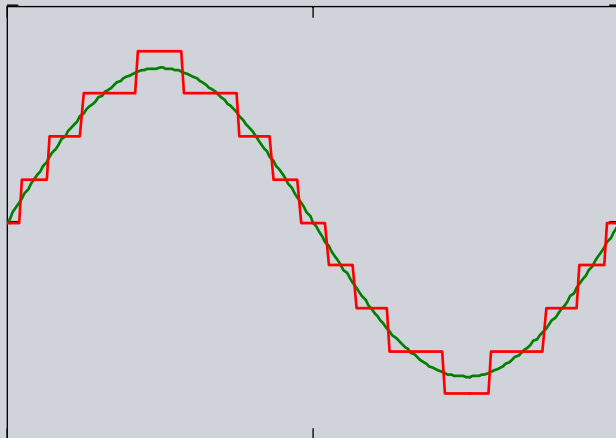
VSC Technology – A look back



High harmonic distortion

High transient stresses resulting in HF noise

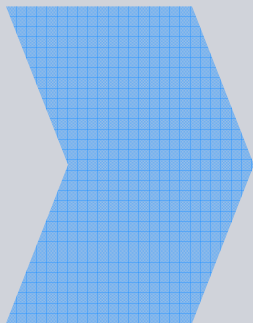
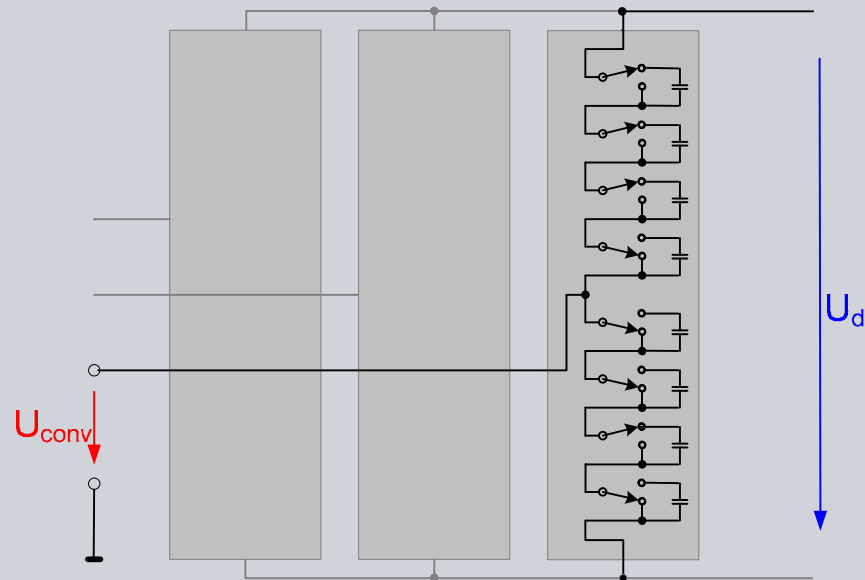
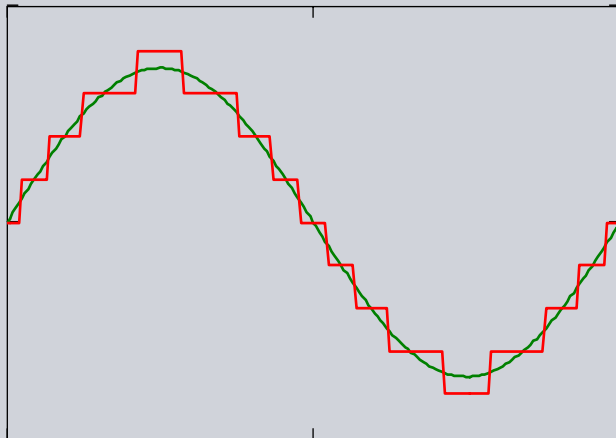
The Multilevel Approach



Small voltage steps

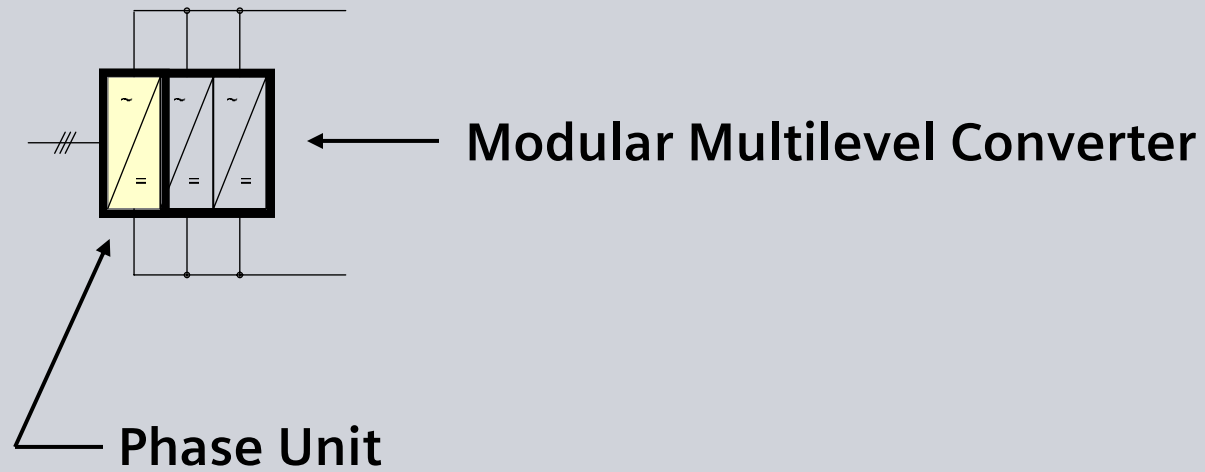
Small steepness of steps

Modular Multilevel Converter - MMC



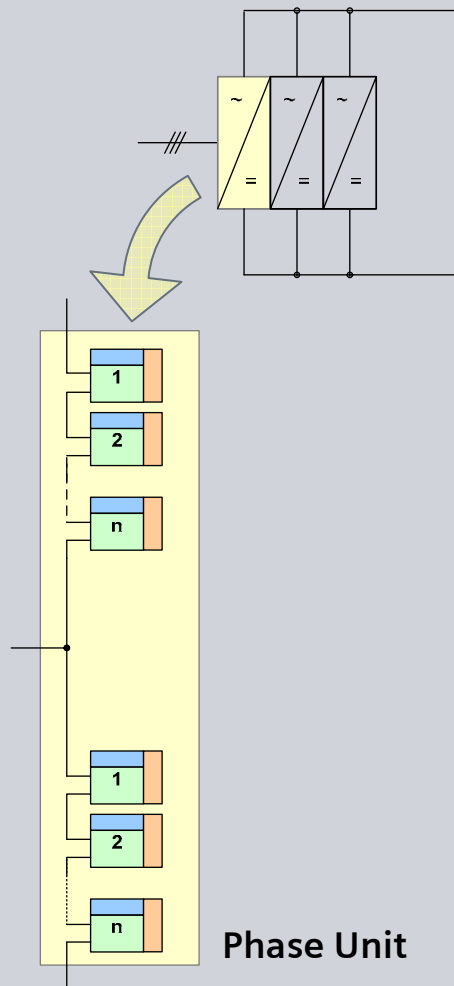
- Low generation of harmonics**
- Low HF noise**
- Low switching losses**

HVDC PLUS with MMC

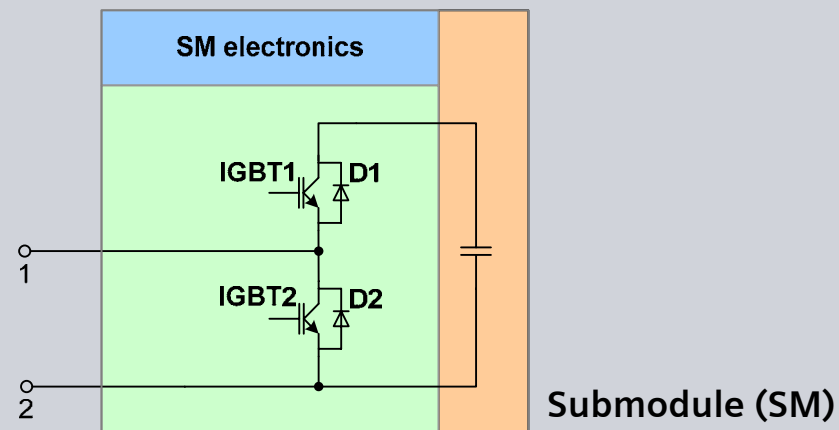
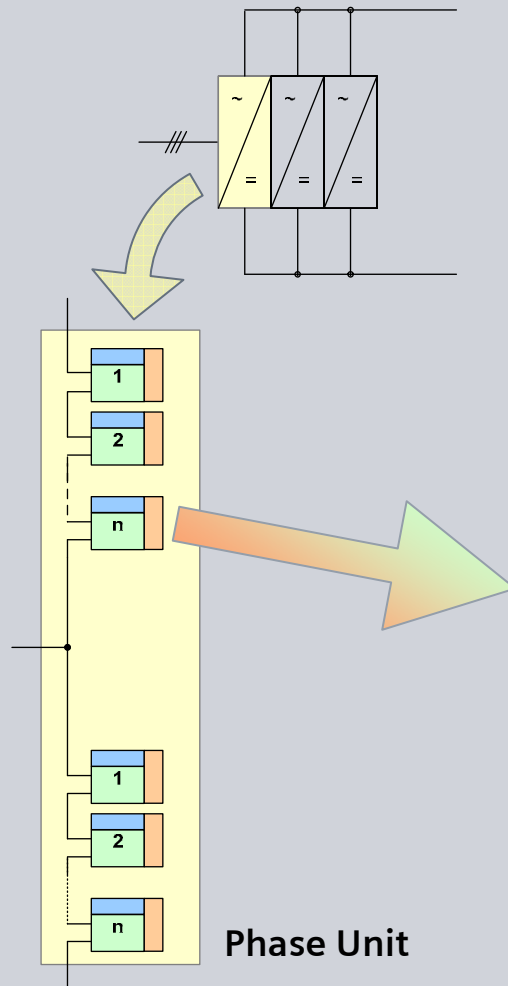


HVDC PLUS with MMC

Modular Multilevel Converter

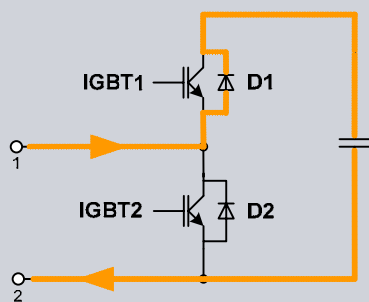


HVDC PLUS with MMC

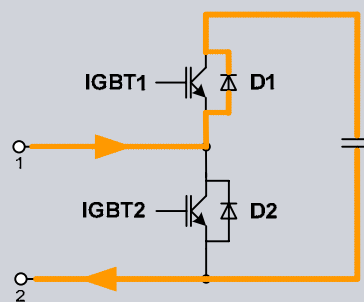


States of Submodules

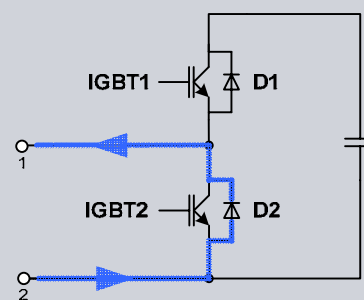
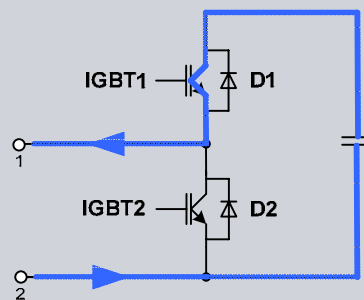
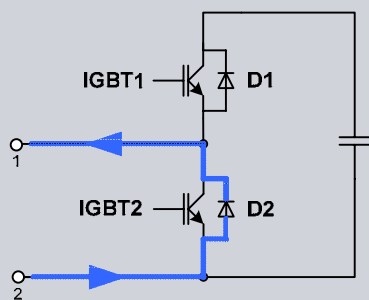
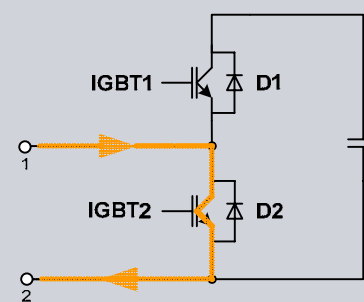
State (0,0)



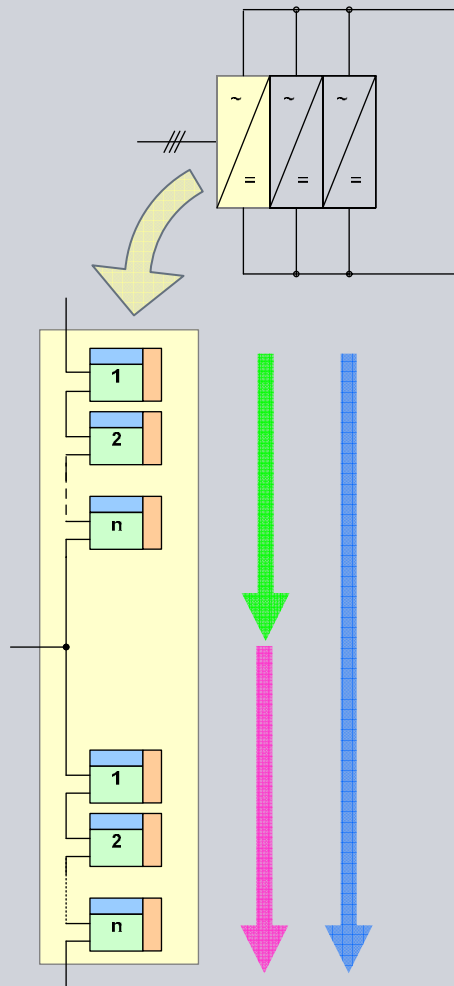
State (1,0)



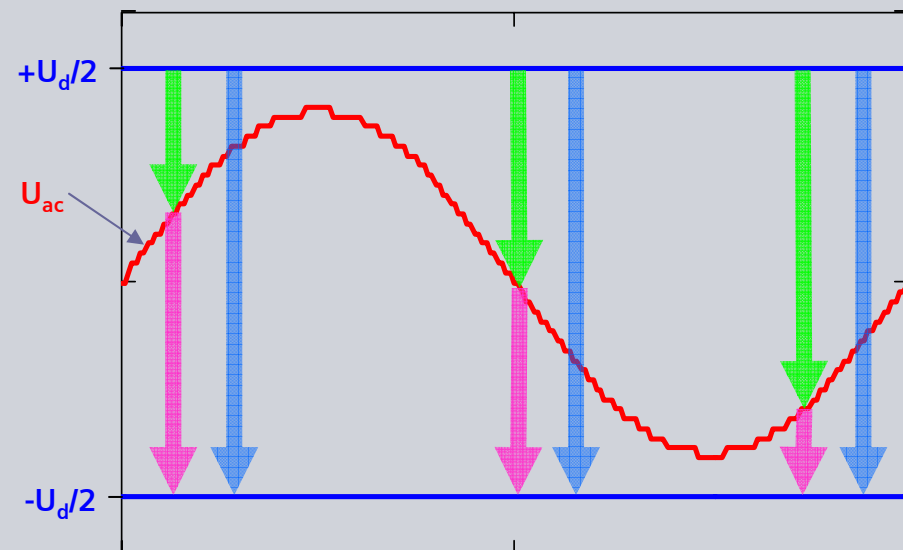
State (0,1)



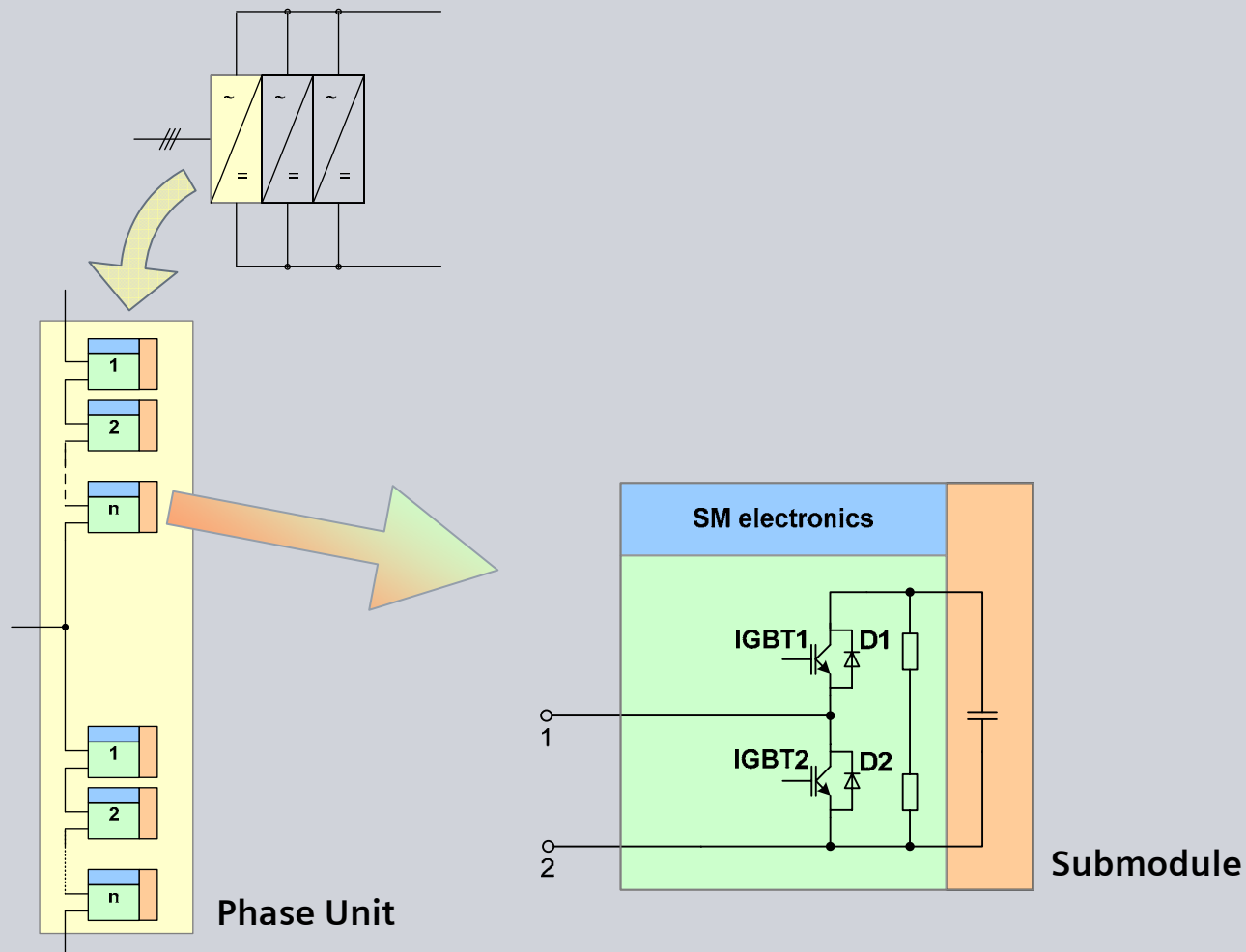
Voltage generation



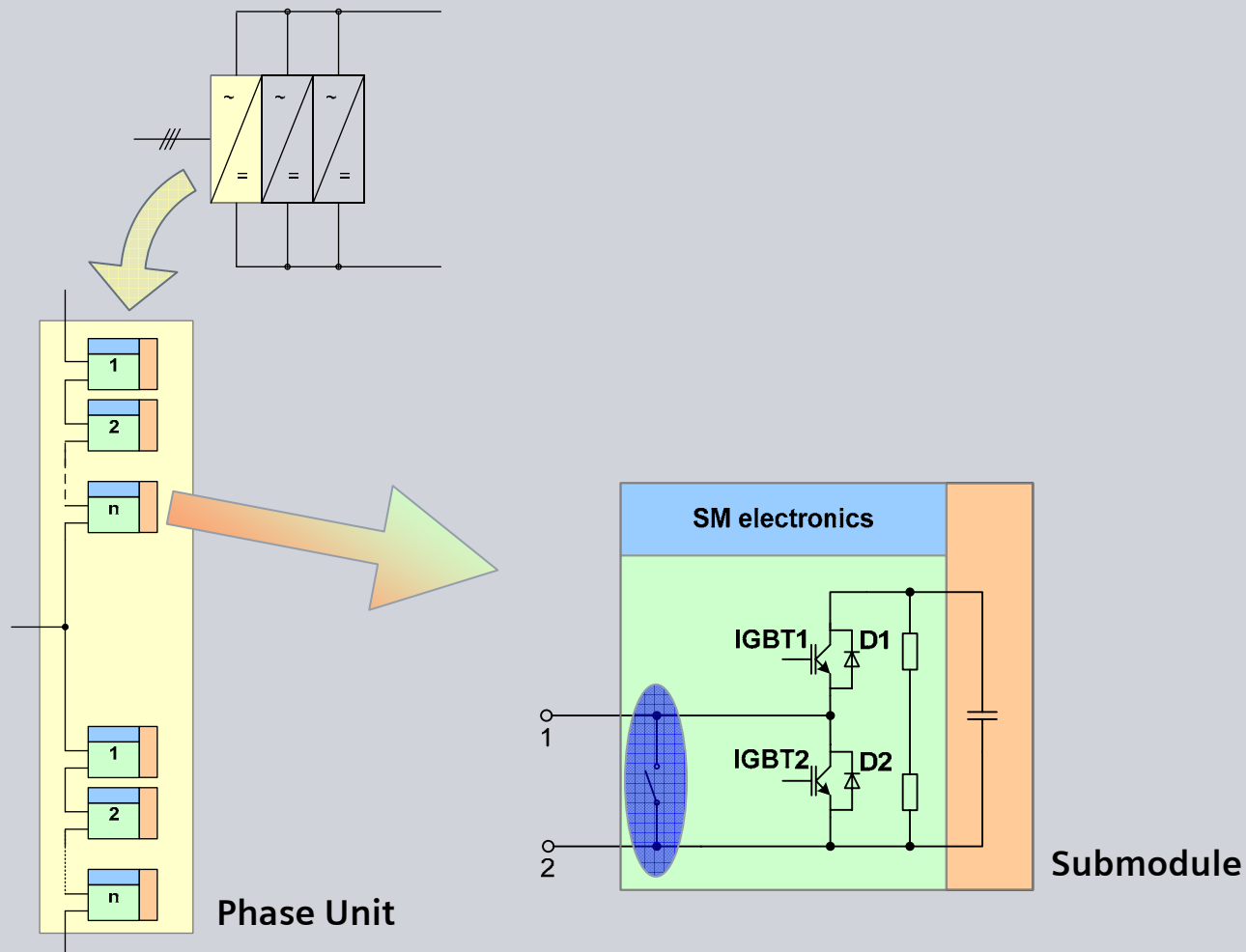
AC and DC voltages controlled by converter leg voltages:



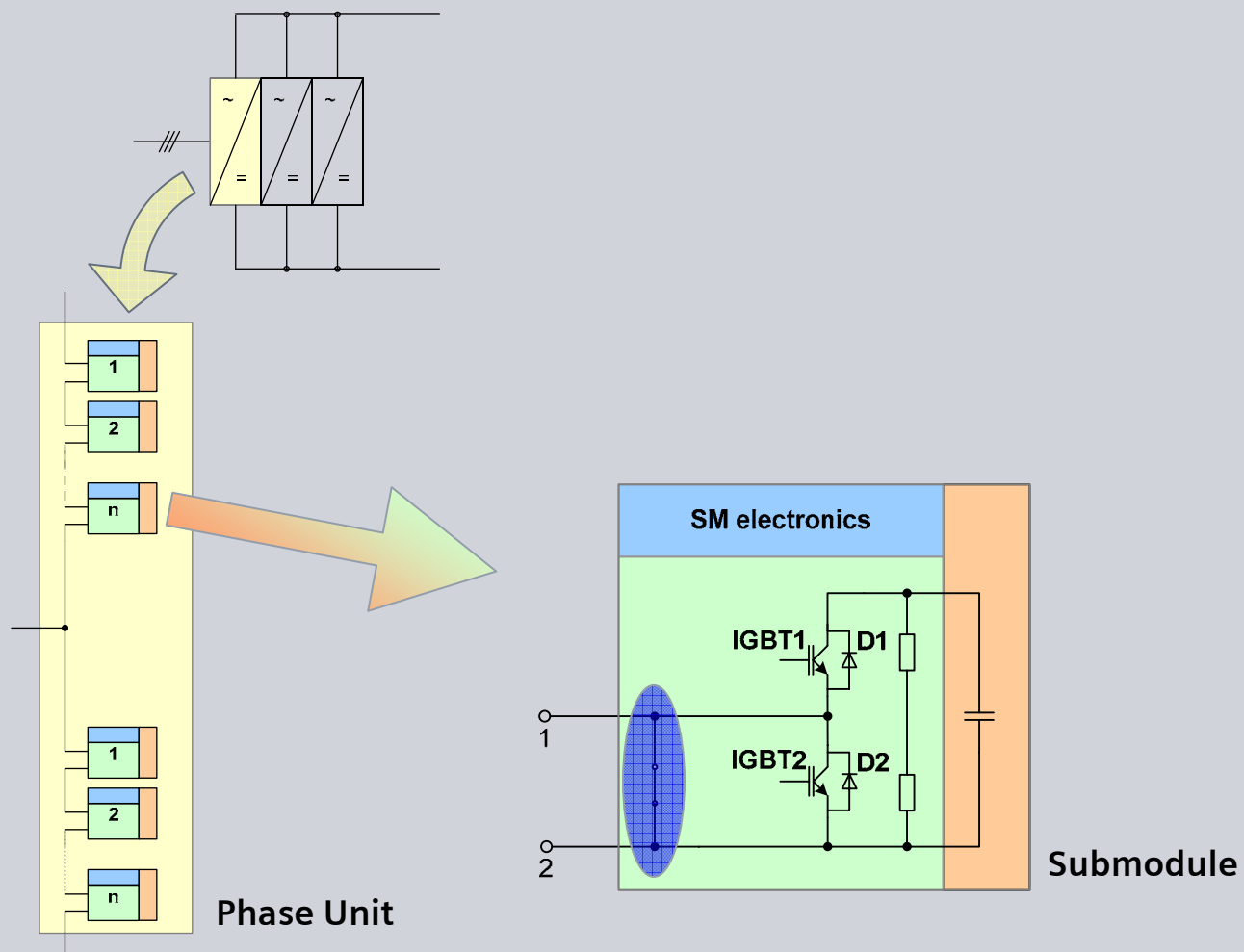
Submodule Design



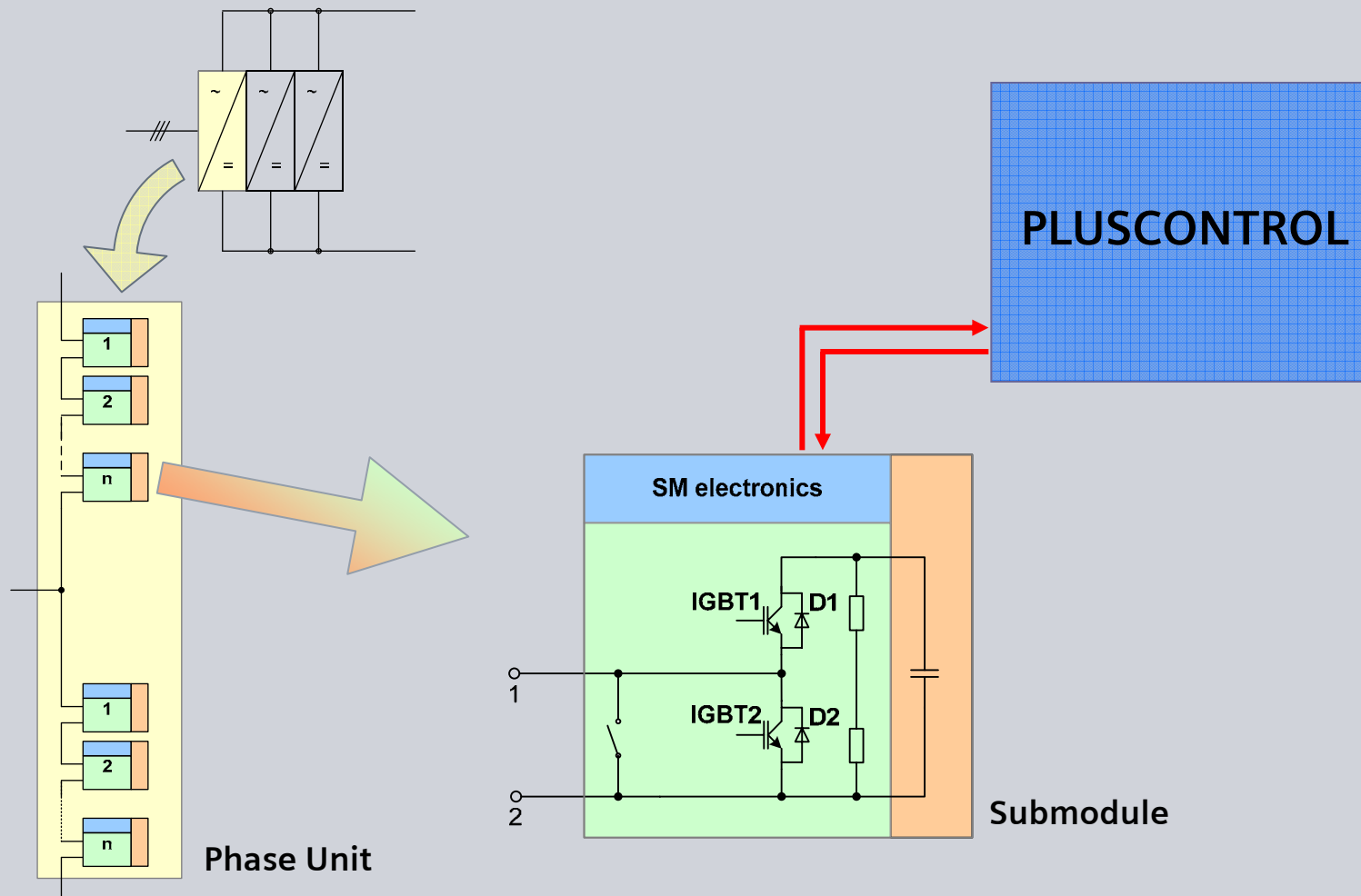
Submodule Design



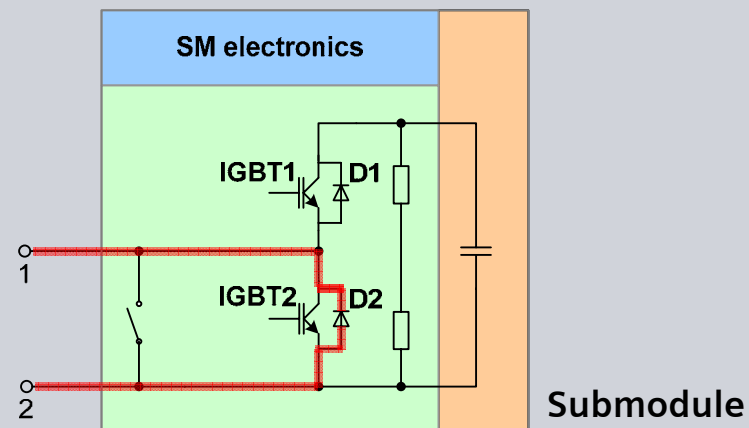
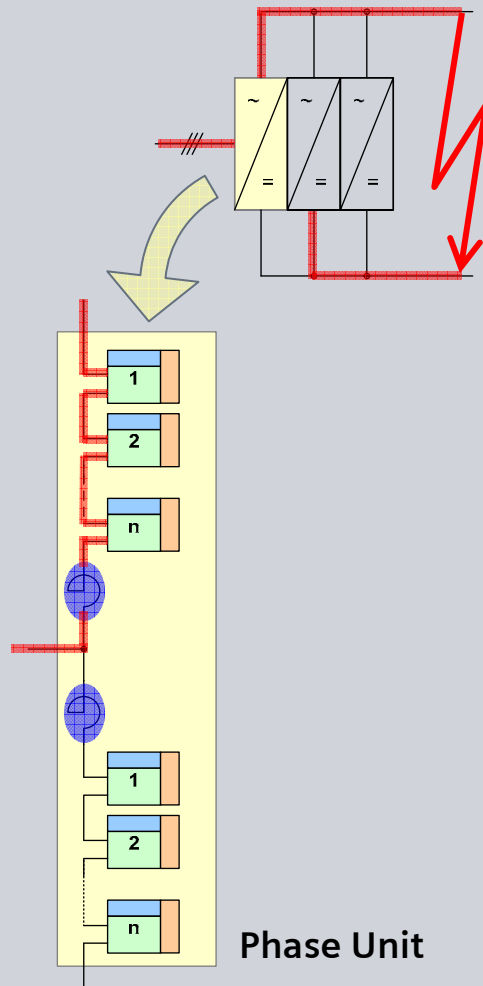
Submodule Design



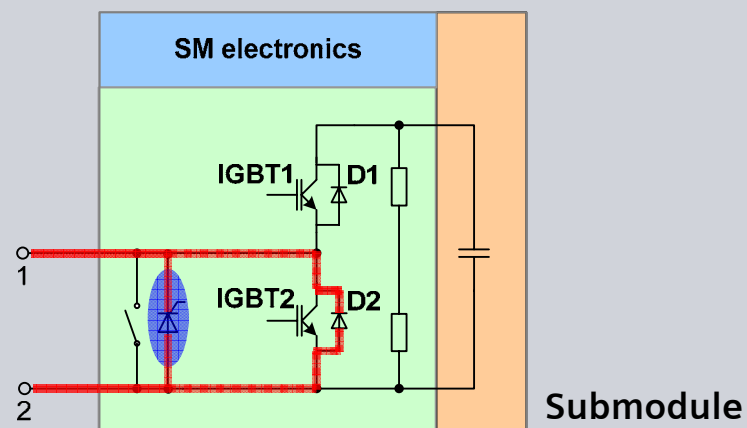
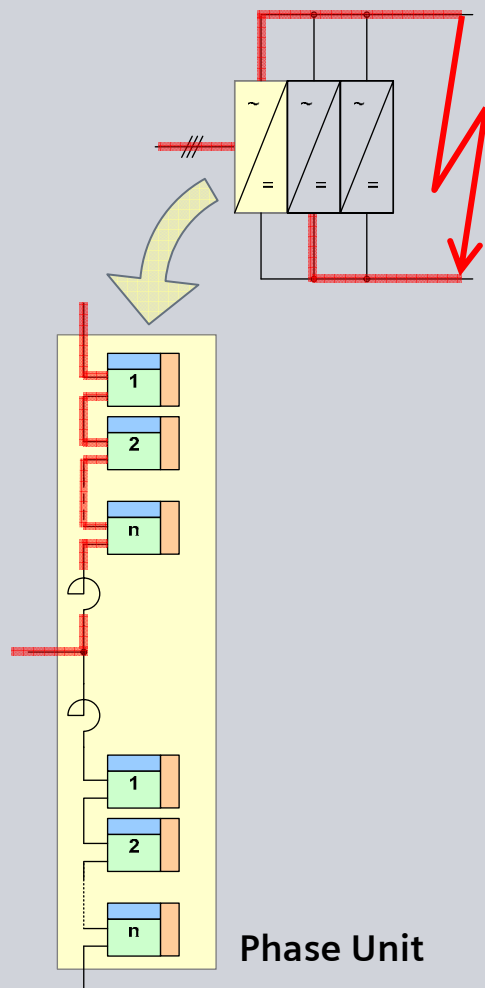
Submodule Design



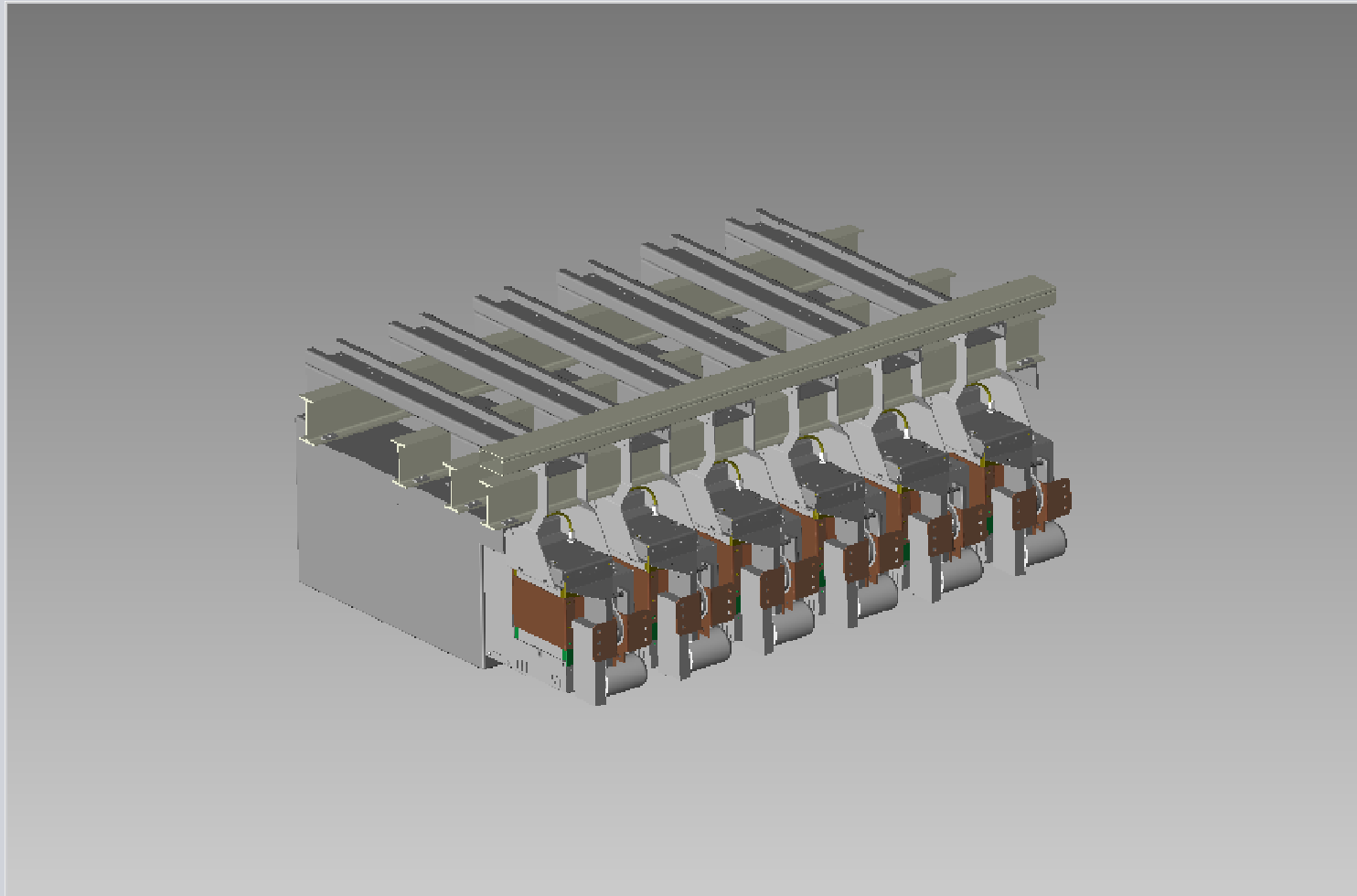
Line-to-Line DC Fault



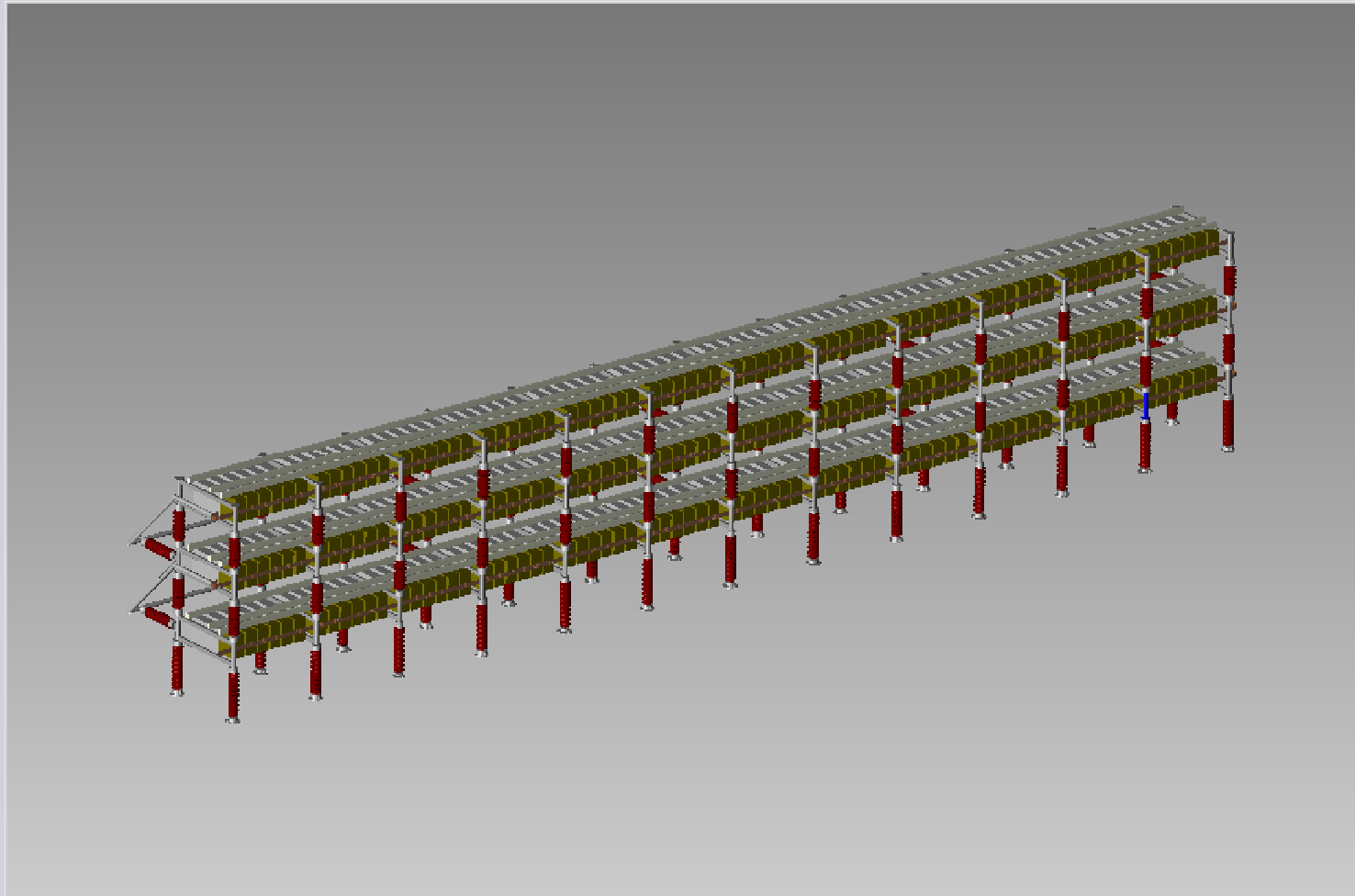
Line-to-Line DC Fault



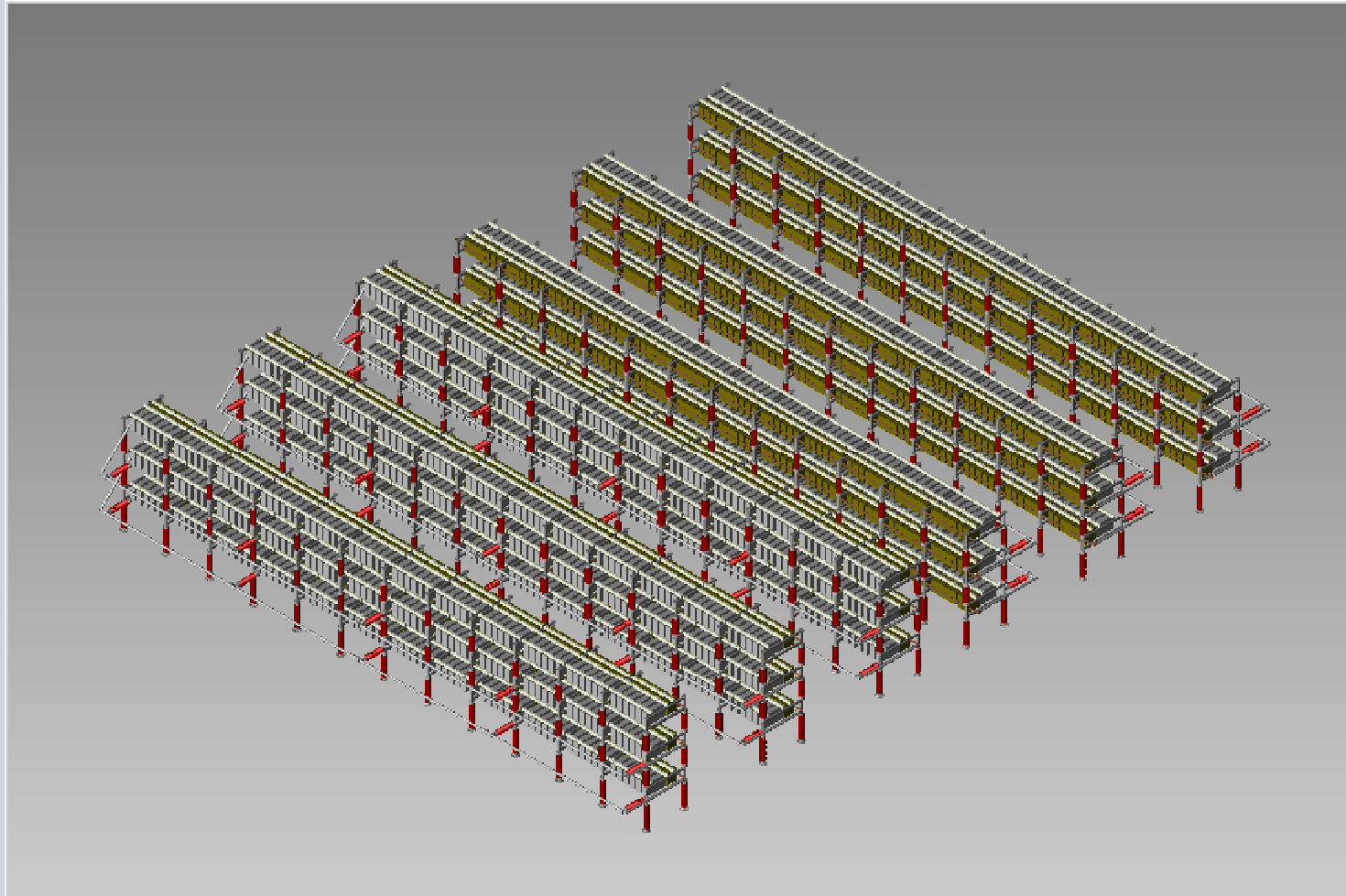
Pre-Assembled Unit



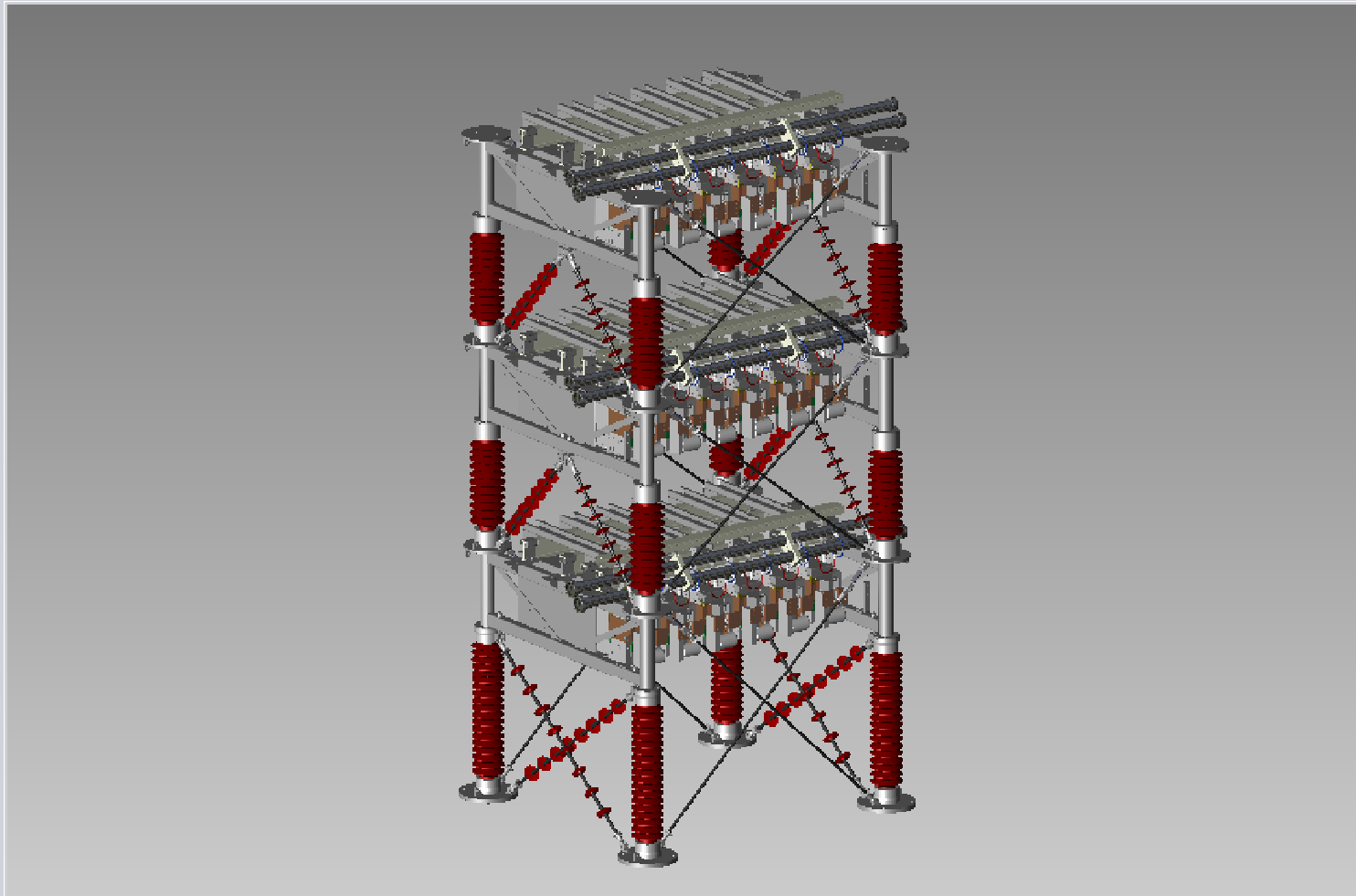
Converter Leg with more than 200 Submodules



Typical Converter Arrangement for 400 MW



Optional Seismic Reinforcements



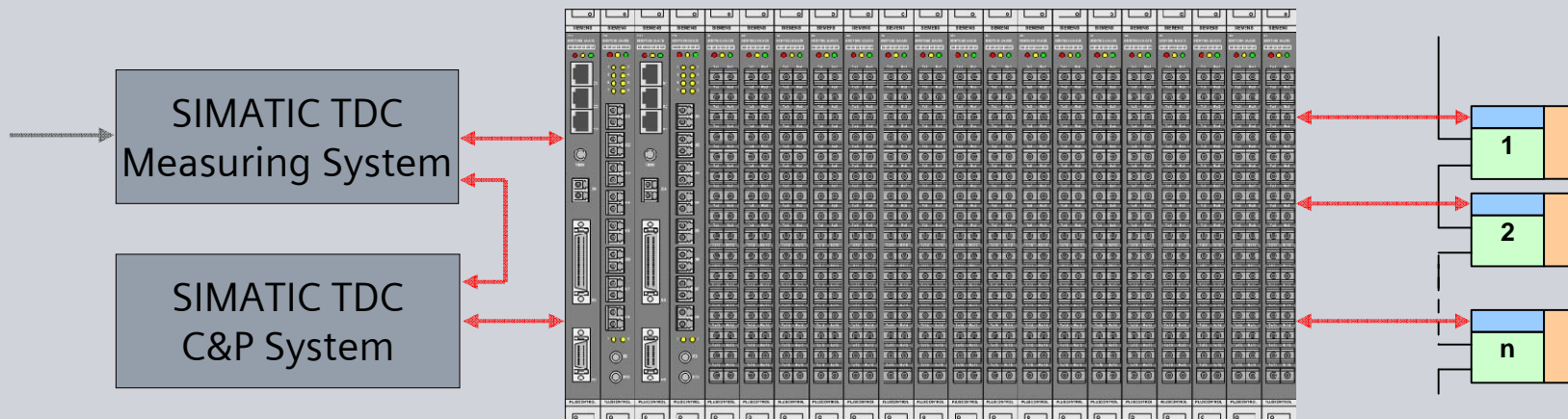
Main Tasks of PLUSCONTROL™

Calculation of required
converter leg voltages

Choice of submodules to
be switched

Control of active and
reactive power

Submodule voltage
balancing control



Main Features of PLUSCONTROL™

Standard 19 inch racks

Highest degree of modularity

Advanced redundancy concept

Hot plug capability of PCBs and fans

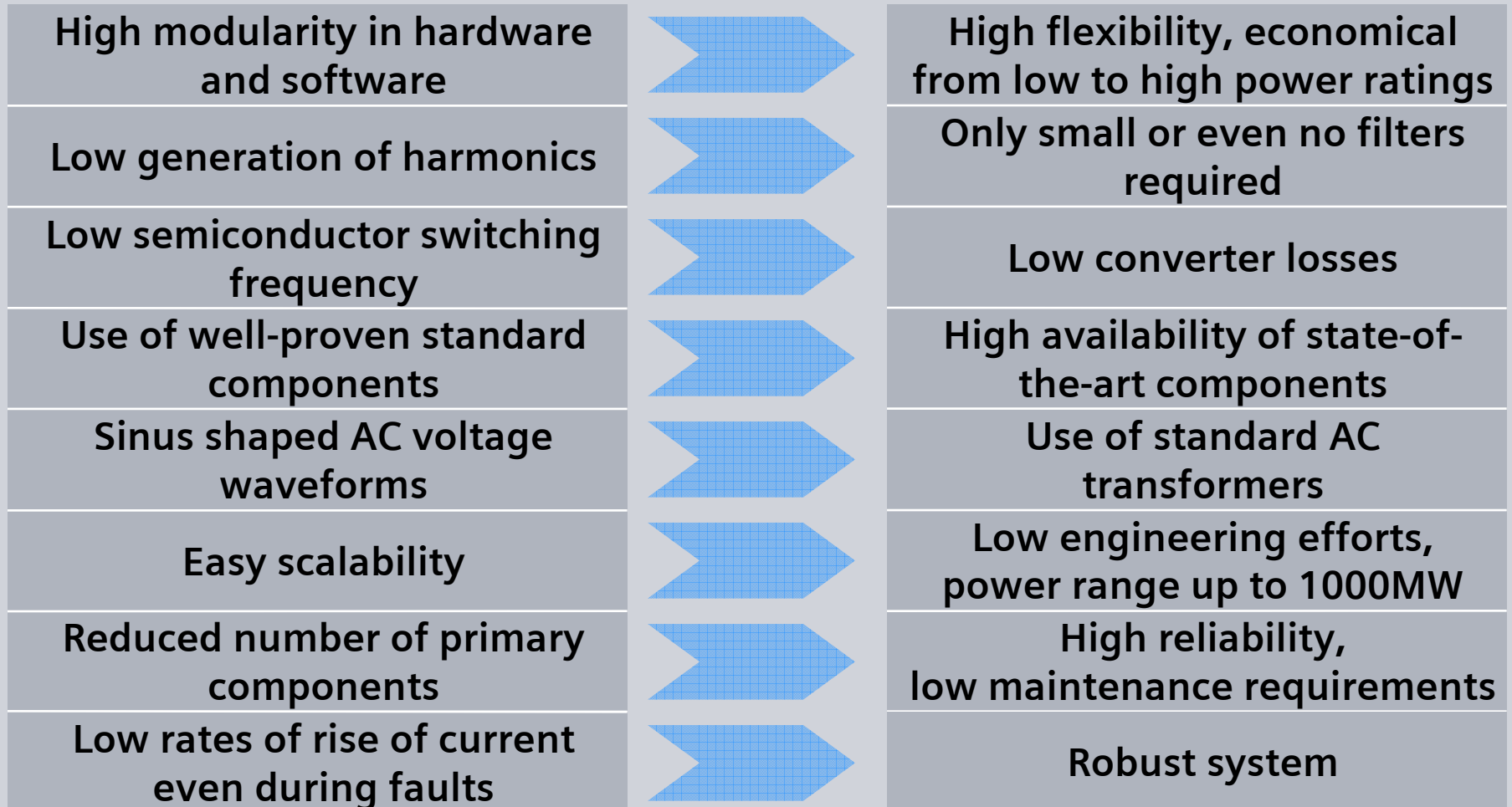
High submodule interfacing capability

High numerical and logical performance

Integration into proven SIMATIC TDC systems

Highly flexible
and
highly reliable
control
system

Properties of MMC topology and benefits



VSC Systems with HVDC PLUS

DC cable transmission

DC overhead line transmission

Back-to-Back systems

Multi-terminal systems

STATCOM operation

Applications of HVDC PLUS

HVDC Systems up to 1000 MW where line-commutated converter have been used in the past

HVDC operation at very weak grids feasible

Grid access for regenerative energy sources, like wind farms

Supply of passive loads

Power supply of megacities

Contribution to reduction
in CO₂ emission

Siemens will be Market-Leader in VSC-based HVDC Technology!

Thank you very much for your attention