Congreso Conmemorativo IEEE

"Evolución a Nuevos Sistemas de Transmisión de Alta Confiabilidad"

Ing. Aleksandar Stevanovic

Compensador Síncrono Estático STATCOM

SIEMENS

125 años Innovando para México

SVC PLUS®
The advanced STATCOM

Septiembre 2022 IEEE

Aleksandar Stevanovic

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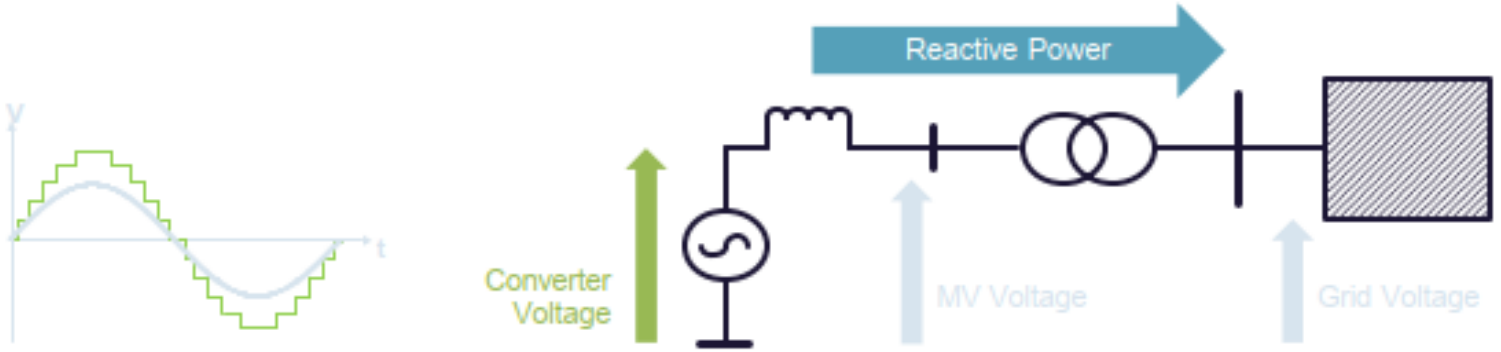
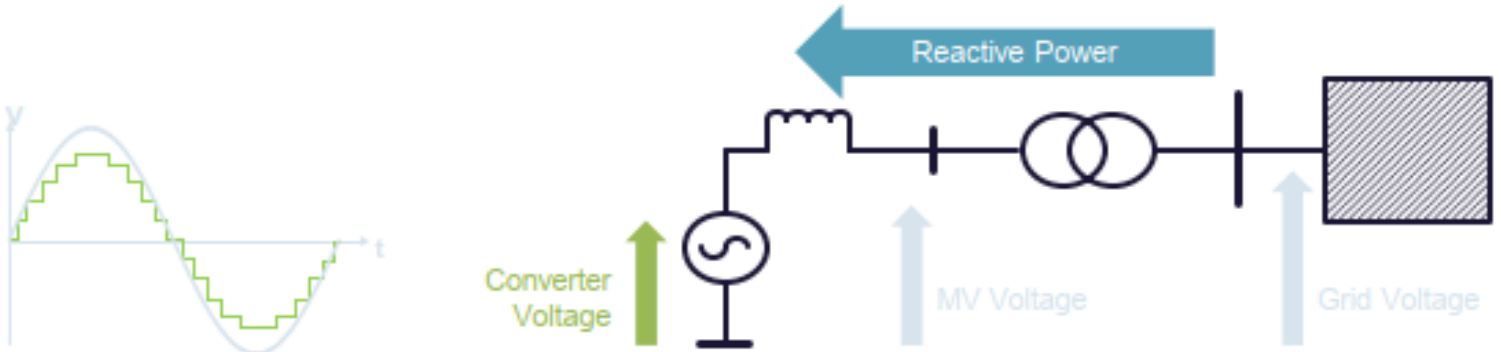
SVC PLUS
Operating Principle – STATCOM

Capacitive



Inductive



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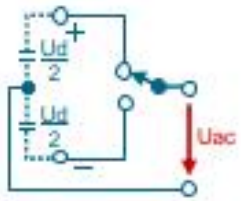
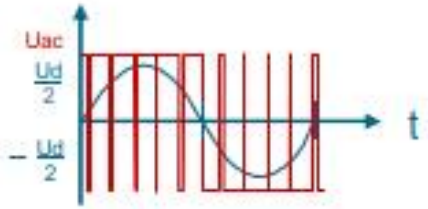
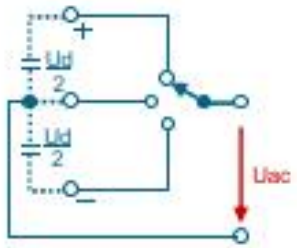
The Evolution of VSC Technology

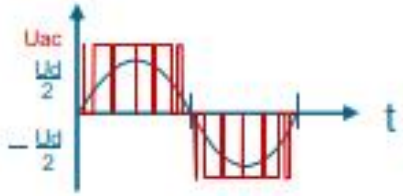
Two-Level



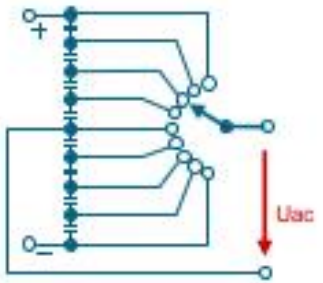


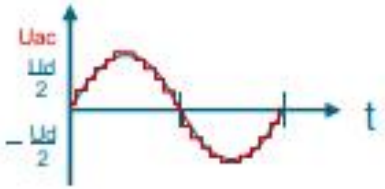
Three-Level





Multilevel





GTO /IGCT

IGBT in PP

IGBT Module

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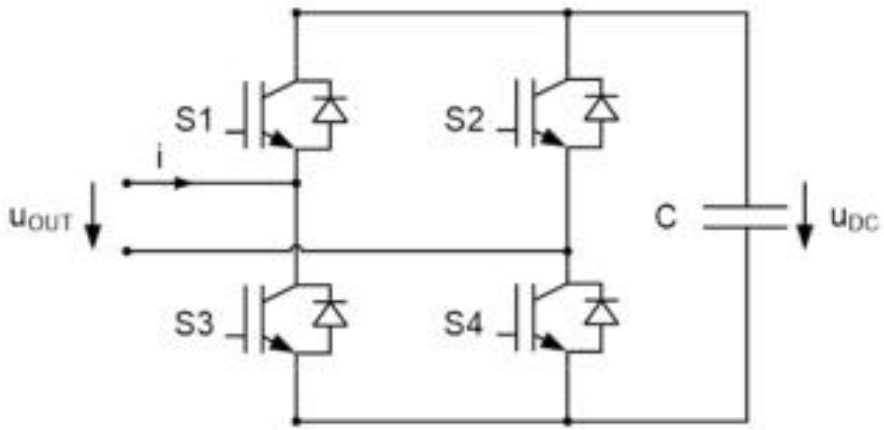
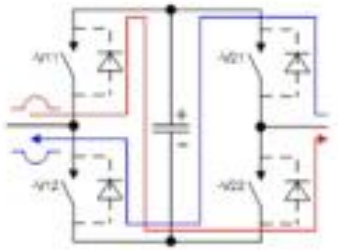
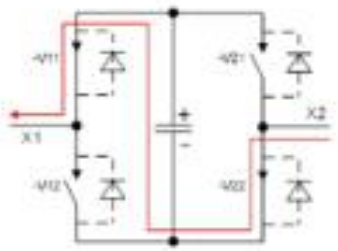
SVC PLUS – principle of operation



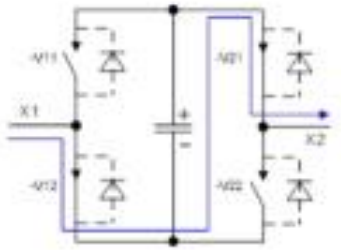
- H-bridge configuration consist of 4 IGBTS with free-wheeling diodes
- Each bridge has a capacitor for energy storage
- Each sub-module can output either u_{DC}, 0 V or – u_{DC}



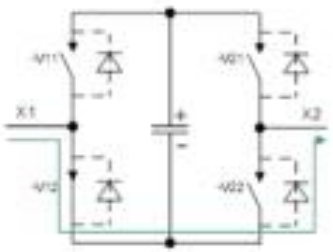
1) loading of DC capacitor via diodes and charging resistors (undrawn) during on-sequence or converter blocking



2) +VC to X1 and –VC to X2



3) -VC to X1 and +VC to X2



4) possible bypass of DC capacitor after 3) using one IGBT and one free-wheeling diode

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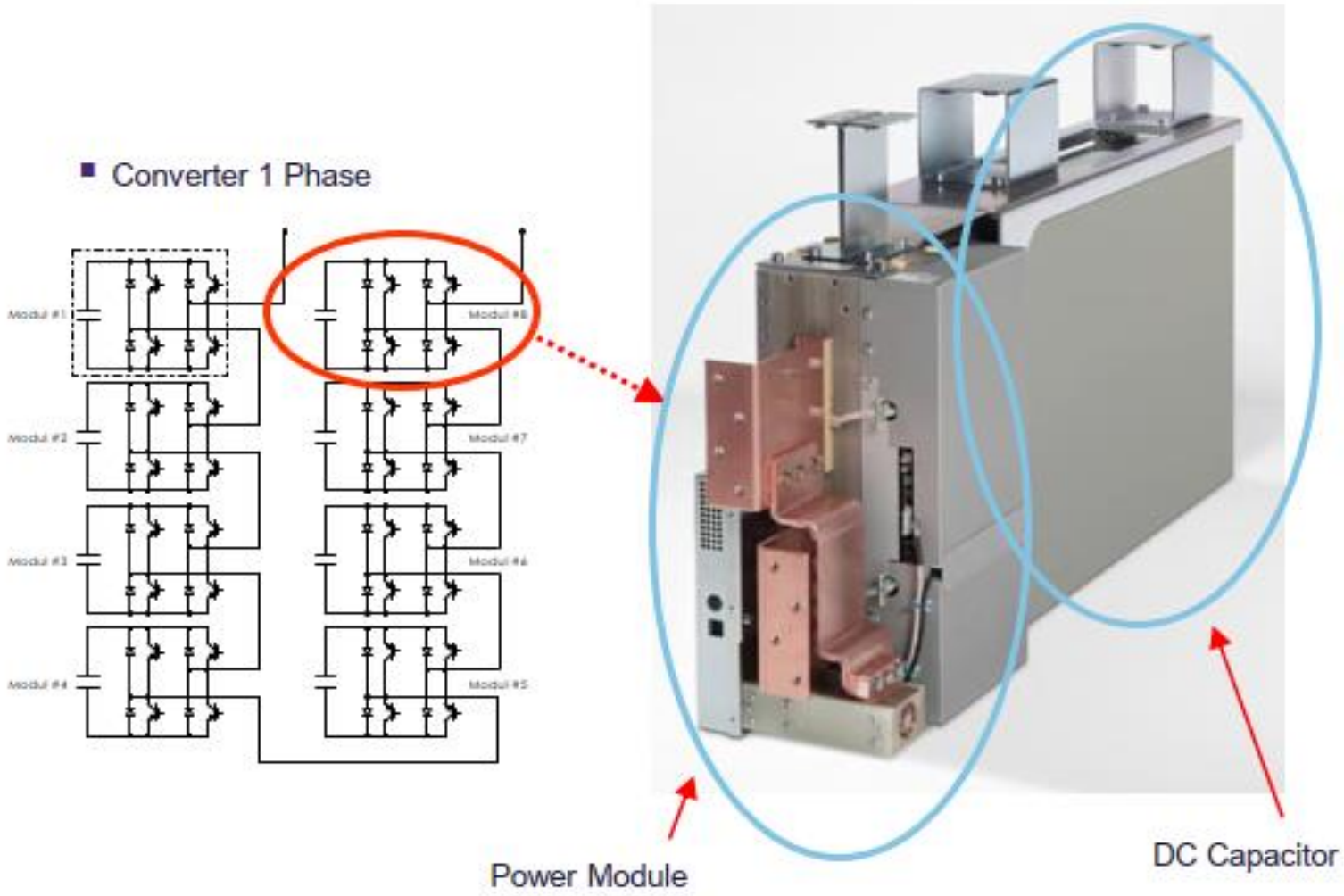
SVC PLUS – principle of operation



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SVC PLUS – principle of operation

Modular Multilevel Converter

IGBT Module

SubModule

Converter

SVC PLUS

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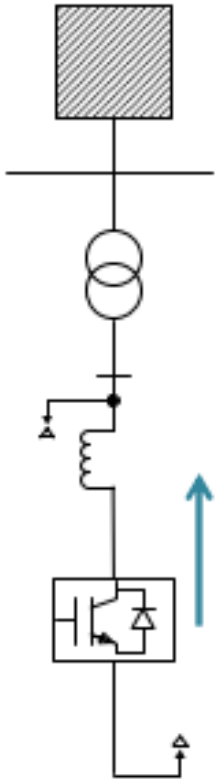
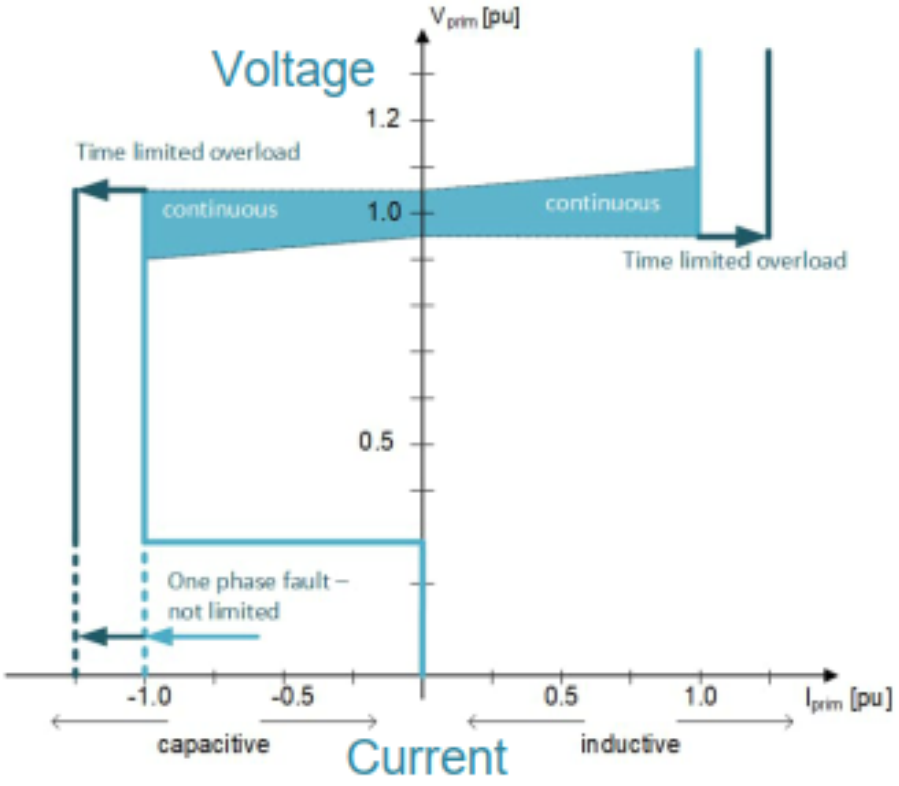
SVC PLUS – principle of operation



Voltage
limited by number of submodules

Current
limited by IGBTs capability

MVA = Voltage x Current



SVC PLUS is the most standardized solution for parallel compensation you can get on the market with purely software based control algorithms ready for future adaptions

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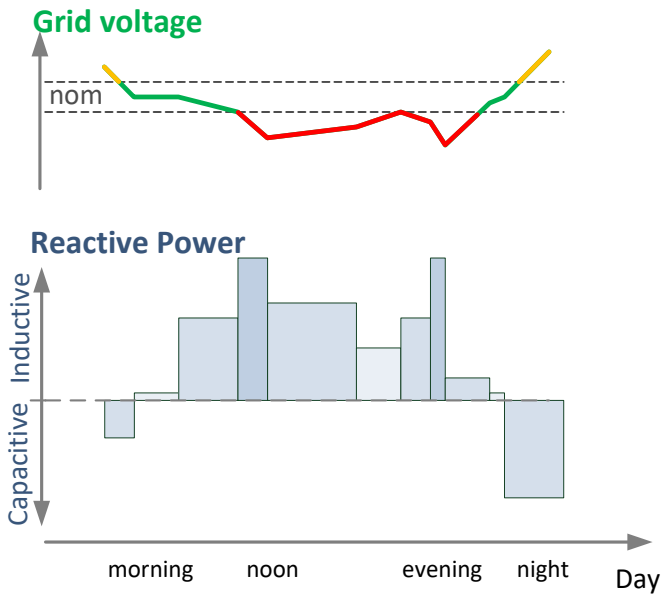
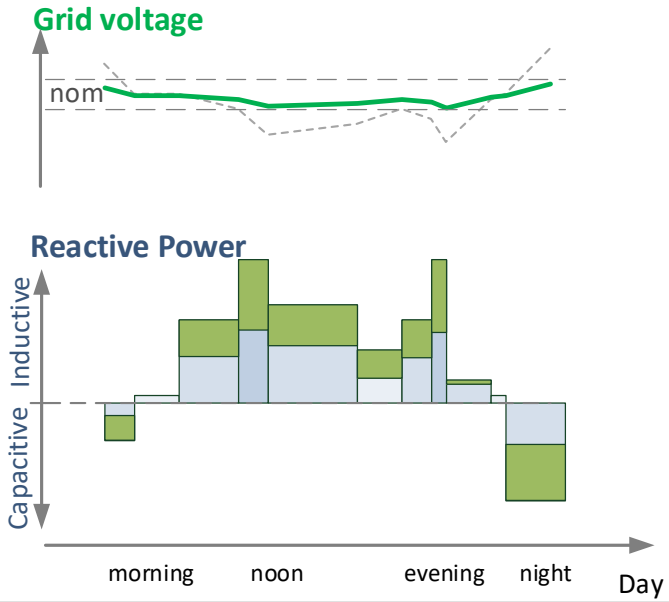
Lack of reactive power means voltage violations in steady state condition



Without reactive power compensation



With reactive power compensation

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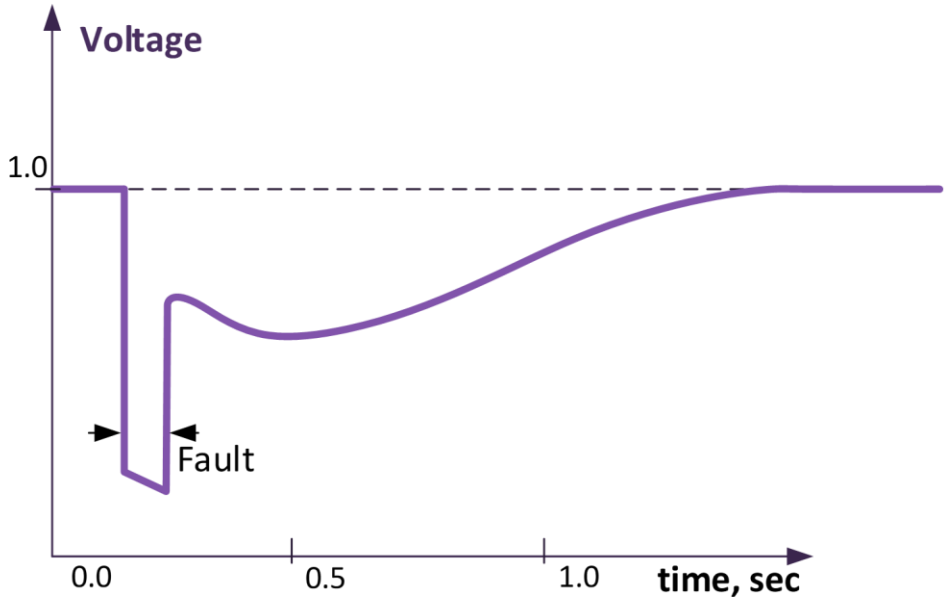
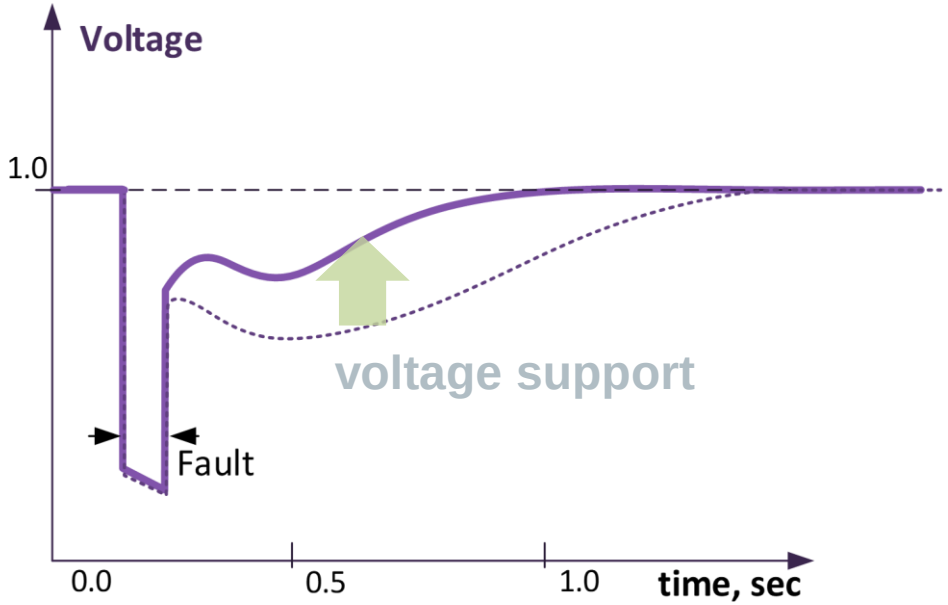
… and after dynamic events in the network





Without reactive power compensation

With reactive power compensation

Need to provide fast-acting voltage support

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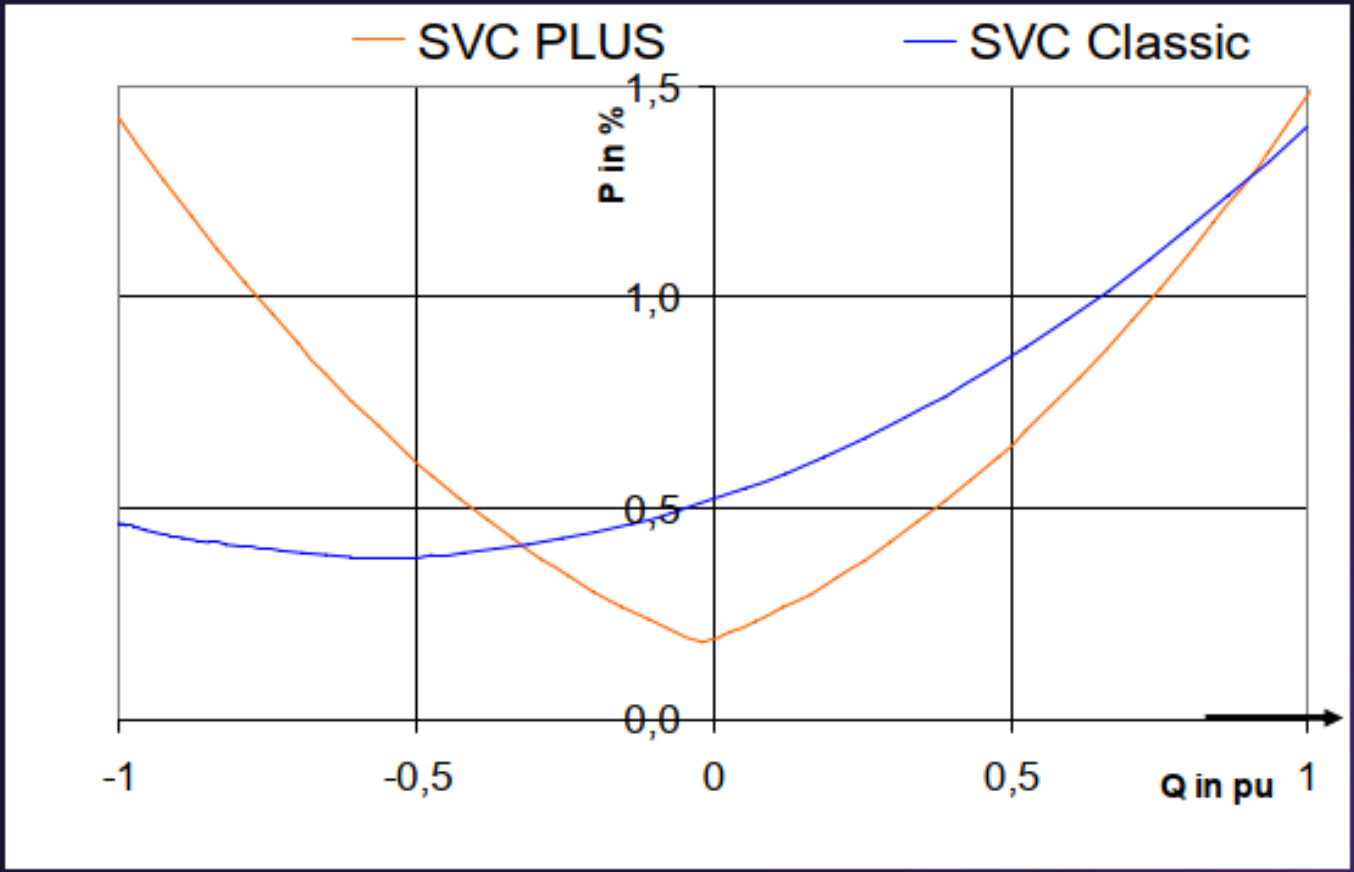
SVC Plus - Low losses



Loss evaluation for fully operational system

ready to react on system disturbances without any delay

safety standards with key interlockking systems

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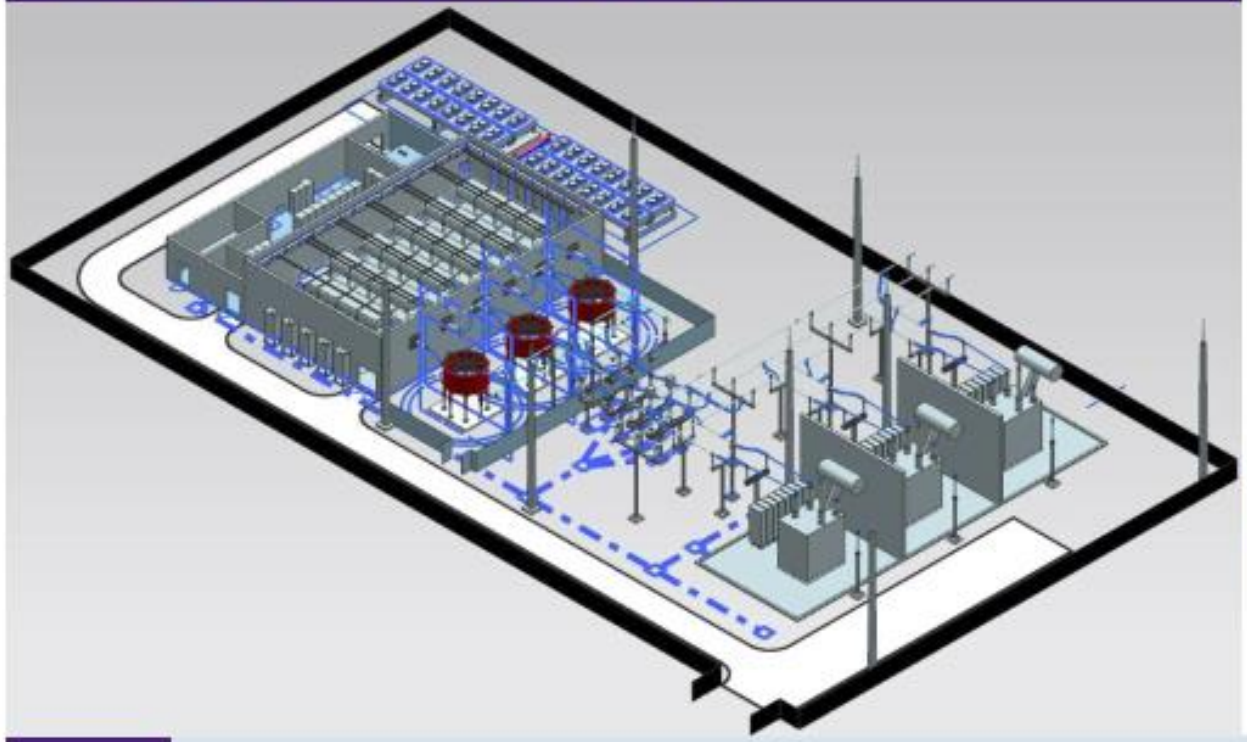
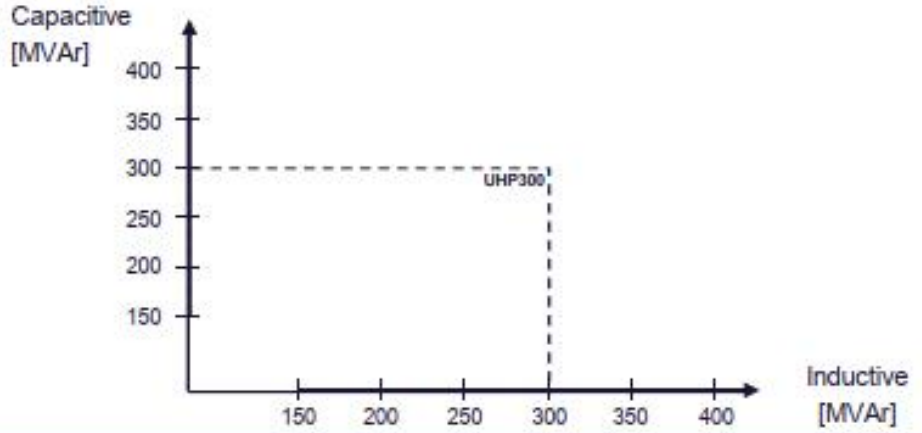
SVC PLUS – high stadardization
One branch – 300MVAr

SVC PLUS UHP300 (±300MVAr)



SVC PLUS UHP: Typical Operating Ranges



SVC PLUS Configuration (Reference Design)

UHP300	±300 MVar	4.5kV IGBT	L70m x W43m x H6,8m

Key Data

Temp. Range	-30/+45°C (*)	System Voltage	400kV (reference)	SVC Rated Voltage	≤ 123kV
Altitude	≤ 1000m (*)	Op. Range	±300MVar	SVC Ins. Level (BIL)	1050 kVp
Standard	IEEE 1031-2000	Op. Voltage	0.9 to 1.10 pu (reference)	Seismic Level: Moderate	(IEEE 693) (*)

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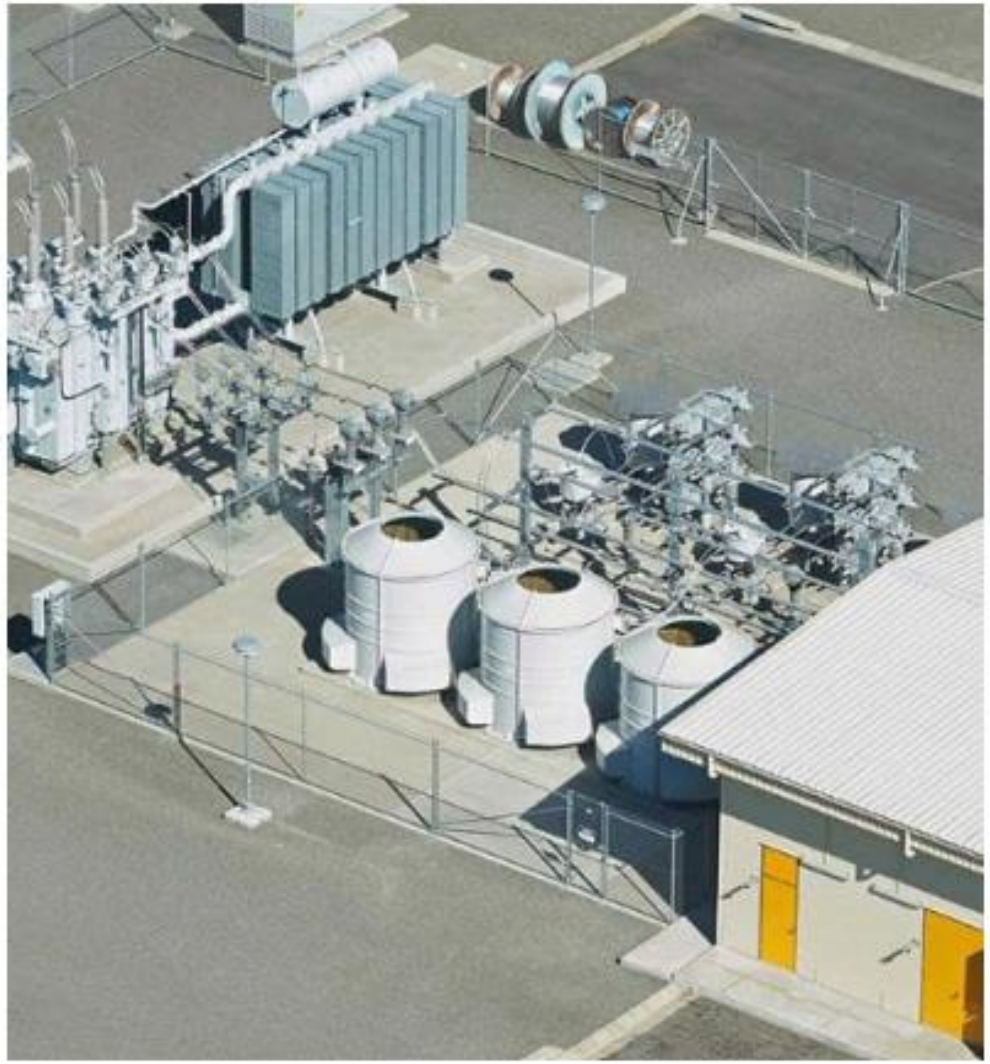
Parallel Compensation
SVC PLUS



- Connection to the high-voltage grid
- Fast provision of continuously adjustable capacitive and inductive reactive power depending on the main voltage
- Current characteristic
- Symmetrical operating range
- Filtering of harmonics not necessary
- Change in reactive power output within 30 - 35ms
- Low losses at 0Mvar

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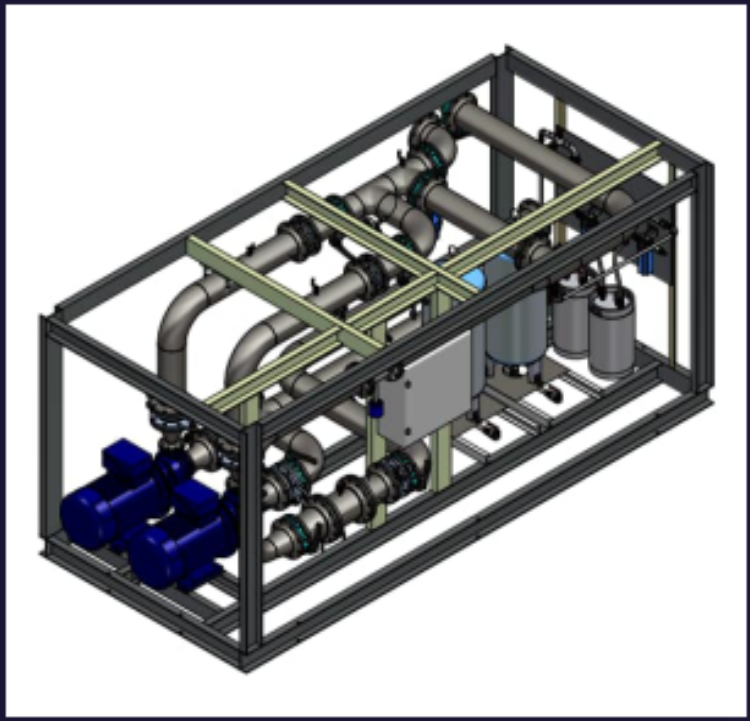
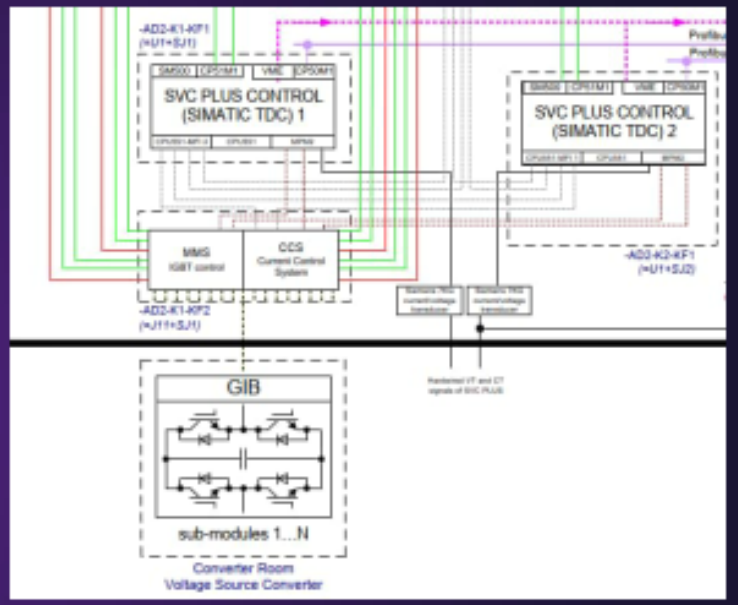
SVC PLUS – Availability



- Redundant control system
- Redundant cooling system pumps
- Redundant submodules
- Low scheduled maintenance requirements

Bumpless switchover from redundant
control system 1 to redundant control system 2



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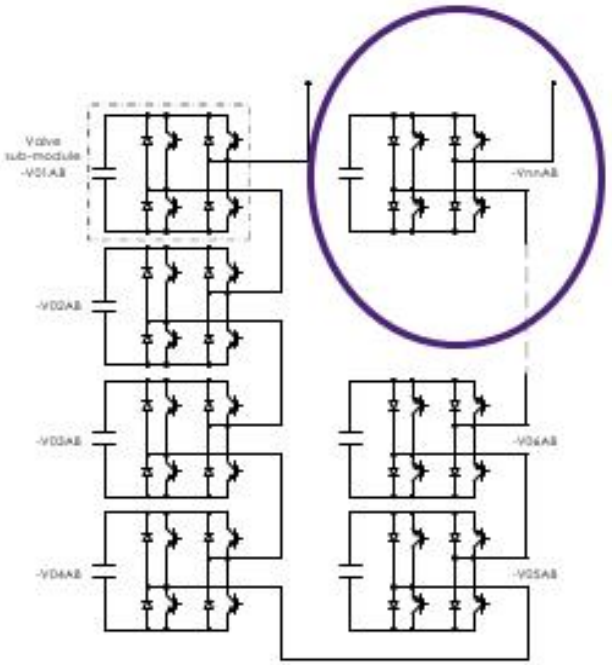
SVC PLUS – Redundancy of converter modules

Upper phase representation



Note: In case of module fail during opertion,
the system continues in operation. T
he module is bypassed automaticall.
Submodule is changed at next scheduled outage.

Number of redundant submodules can be <u>easily adapted to customer needs during design</u>

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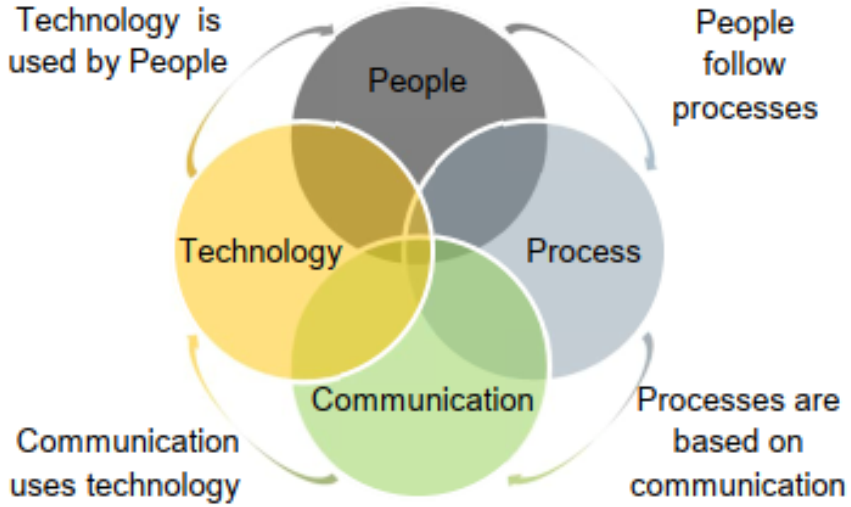
SVC PLUS – Cyber security

Cyber Security is not only about technology

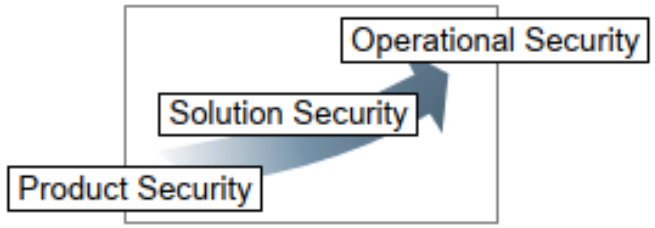


In the US the Cyber Security Framework is based on NERC CIP*

FERC

NERC

Auditable compliance (NERC) is required for bulk power systems (since 2010) in the US



Increasing awareness of cyber security for critical infrastructure

Example: In Germany certain technology is banned due to cyber security reasons

Same applies to US

Siemens Energy can provide a technical base so that the system is "NERC CIP ready"

* NERC CIP: North American Electric Reliability Corporation – Critical Infrastructure Protection

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Siemens Energy

Aleksandar Stevanovic

Mail: aleksandar.stevanovic@siemens-energy.com

Phone +52 5513532308

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