Prospects of the new SVC with modular Multilevel Voltage Source Converter

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FACTS devices: line-commutated vs. self-commutated converters

Example:

- Compactness
- Short Response Time
- Controllability
FACTS devices: line-commutated vs. self-commutated converters

\[ U_{\text{NET}} = U_{\text{VSC}} + U_{Lc} \]
\[ Q_{\text{NET}} = U_{\text{NET}} \cdot (-j \cdot I_{Lc}) \]
\[ Q_{\text{NET}} = \frac{U_{\text{VSC}} - U_{\text{NET}}}{\omega \cdot Lc} \]

Example:

Advanced STATCOM
- Compactness
- Short Response time
- Controllability
Transmission level voltage applications: two-level and multilevel converters

- Filters required for wave form construction and harmonics elimination.
- High switching frequency
- Sharp voltage steps
- Measures required for uniform voltage sharing (snubbers)
- Special gate drives required to compensate switching time tolerances
The **SVC PLUS** uses
Modular Multilevel Converter (MMC)

**MMC with cascaded H-bridges and isolated capacitors**

Very clean voltage wave form

...with modest switching frequency
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Very clean voltage wave form
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+ switches optimized for low conduction losses

= reduction in total losses

✓ High controllability, fast response
✓ Modularity, equal loading of modules
Modular Multilevel Converter (MMC) \(\rightarrow\) High performance

Step in the output order
Modular Multilevel Converter (MMC) →
High performance

HV-side single-phase short-circuit
SVC PLUS as containerized solution.
Picture: Kikiwa, New Zealand, 2 x “M” (±35 Mvar)

First two units: Thanet, UK, end 2009

2 years later: 34 units under project execution / commercial operation
SVC PLUS as containerized solution: equipment layout
SVC PLUS allows improved (combined) features and FACTS applications

- Voltage control, power system stability
- Flicker control (e.g. arc furnaces)
MMC allows new or improved (combined) features and FACTS applications

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- Voltage control, power system stability
- Flicker control (e.g. arc furnaces)
- Phase balance (e.g. railways)
- Grid access (e.g. wind farms)

![Diagram](image-url)
Converter module: H-bridge with capacitor and protective bypassing device

**MMC Topology:** Device capacitance distributed among the modules

- Very small inductance in the commutation path
  - fast commutation time, no snubbers needed
  - redution in total losses

- Smaller capacitors = limited discharge energy in case of short-circuit in the capacitor or in the module

- Redundancy of defective module through bypass covers electronics and capacitor
Alternatives and expectations – Example: DC/AC MMC converter in FACTS applications

Vision: MMC UPFC

Shunt reactive power compensation

Power flow control
Conclusions:

- SVC PLUS is a MMC STATCOM. It was initially conceived for Grid Access, specially in connection with large off-shore wind parks.

- Extended application range for network voltage and stability support, HVDC reactive power dynamic control and power quality (flicker mitigation).

- Compact design, low losses, fast response and competitive costs due to MMC technology. Containerized standard solutions from ±25 Mvar up to ±200 Mvar with 4 x 50 Mvar parallel units and open-rack units.

- First 2 units commissioned in 2009. Meanwhile, 34 units under project execution / commercial operation.

- New developments for FACTS using MMC technology are expected to come on in the next time.