

An aerial photograph of a Siemens SVC PLUS substation. The substation is a fenced-in area containing various electrical equipment, including a large transformer, busbars, and a central control building with the Siemens logo and 'SVC PLUS' text. To the left, a high-speed train is on the tracks. In the background, there are several wind turbines and a solar panel array on a grassy hillside. The Siemens logo is also visible in a white box in the top left corner.

SIEMENS

www.siemens.com/energy/svc-plus

The Efficient Way

SVC PLUS – Innovation meets experience

Answers for energy.

Enhancement of Grid Efficiency

Improved dynamic stability and power quality of power systems

Fundamental changes are affecting the power industry. Markets are being deregulated and liberalized, urbanization is continuing around the world accompanied by a constantly growing demand for energy, and renewable energy sources are playing an increasingly important role. For these reasons, new and efficient solutions for power transmission are required. In addition, the dramatic climate change is posing new challenges for power generation and transmission.

Climate protection through the reduction in carbon dioxide emissions and optimal use of energy resources is possible with innovative solutions for power transmission. Sustainability and security of the power supply are crucial issues, both today and tomorrow.

One of Siemens' solutions to cope with these new challenges is SVC PLUS® (Static Var Compensation SVC) for Reactive Power Compensation.

Siemens, as an innovation leader in FACTS (Flexible AC Transmission Systems) technology since the beginning, has more than 30 years of experience. The latest development is SVC PLUS, an innovative and universally applicable solution for grid enhancement.

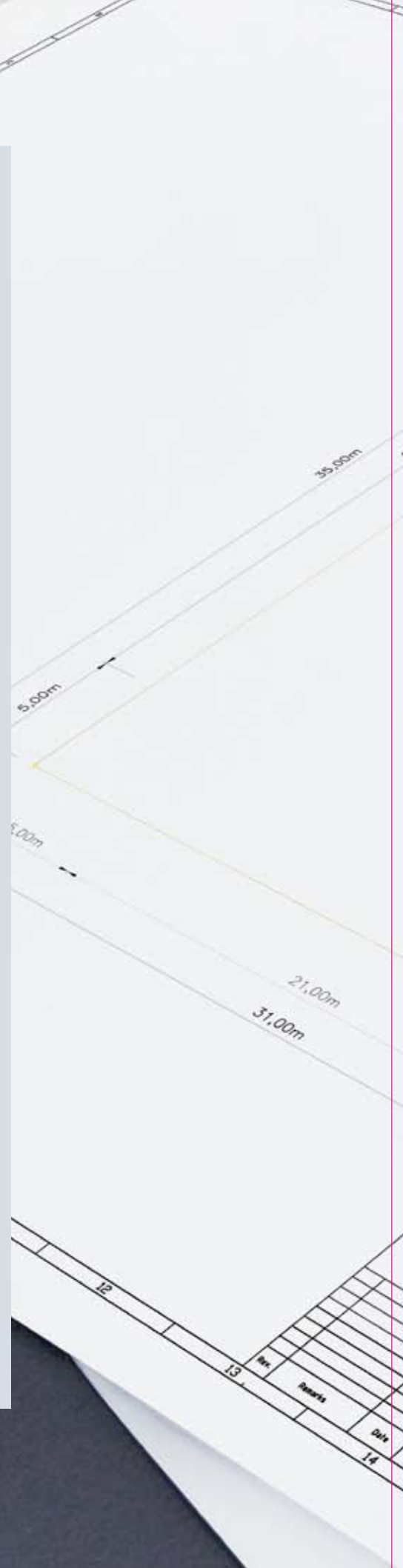
SVC PLUS is an advanced STATCOM (Static Synchronous Compensator) with Modular Multilevel Converter (MMC) technology.

Thanks to the use of state-of-the-art technology, SVC PLUS provides additional benefits compared to conventional solutions for reactive power compensation.

A solution that pays off at once

SVC PLUS offers a multitude of benefits. At a glance, these are:

- Improved dynamic stability of transmission systems
- Increased power quality; reduction in risk of voltage collapse and blackout
- Highly efficient flicker reduction in industrial applications
- Low harmonic generation and low noise emissions, thanks to the use of MMC technology
- Minimized engineering efforts due to standardized component design
- Fast, efficient, modular, and cost-effective solution



Introducing a new generation of STATCOM

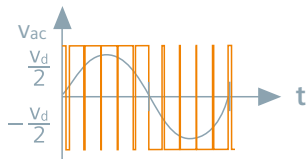
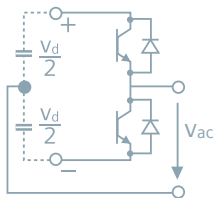
Modular Multilevel Converter design makes all the difference

SVC PLUS® uses Voltage-Sourced Converter (VSC) technology based on Modular Multilevel Converter (MMC) design.

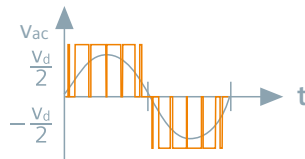
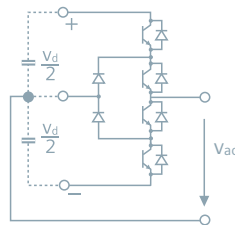
- The MMC provides a nearly ideal sinusoidal-shaped waveform on the AC side. Therefore, there is only little – if any – need for high-frequency filtering and no need for low order harmonic filtering.
- MMC allows for low switching frequencies, which reduces system losses.

- The MMC technology provides a high degree of flexibility in converter design and station layout.
- SVC PLUS uses robust, proven standard components, such as typical AC power transformers, reactors, capacitors, and industrial class IGBTs (Insulated Gate Bipolar Transistors) that are widely used for traction and industrial drives.

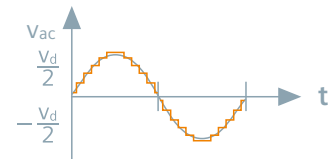
Two level



Three level



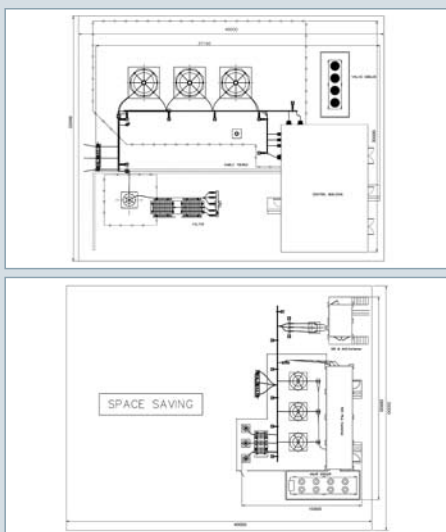
Multilevel



Convincing advantages in all respects

SVC PLUS reduces the time and resources required for project development. The relatively low number of components simplifies design, planning, and engineering tasks.

Thanks to the modular design with fewer elements than conventional SVC systems, installation and commissioning also requires considerably less time than conventional systems.



Compact and adaptable, thanks to MMC technology

- The design of SVC PLUS® is fully flexible. Both containerized and conventional building solutions are available.
- Low space requirements due to the reduced size and fewer passive components.
- A small physical footprint reduces the turnkey costs.
- SVC PLUS is the ideal solution when space is limited and costly. Examples are the extension of existing substations or new substations in congested areas such as megacities.

Modular system design

The MMC technology offers a high degree of flexibility.

- Standardized configurations are available: +/-25, +/-35, and +/-50 MVAR as containerized solutions. Up to four of these units can be configured as a fully parallel operating system.
- Easily expendable and relocatable
- Open rack modular system configuration enables transformerless grid connection up to 36 kV and +/-100 MVAR.
- Hybrid solutions with mechanically switched capacitors (MSC) or reactors (MSR) are available.

Harmonic performance

Due to the MMC technology, the degree of harmonic generation emission is quite small. High frequency noise is absorbed by small standardized high-frequency blocking filters, resulting in an SVC design which is practically independent from individual network impedances.

Operational advantages

- A very high level of system availability, thanks to the redundancy of power modules.
- Minimized maintenance and service requirements
- Standard WinCC and SIMATIC TDC control and protection hardware and software are fully proven in practice in a wide range of applications worldwide (e.g. SVC "Classic", HVDC).

Network stabilization

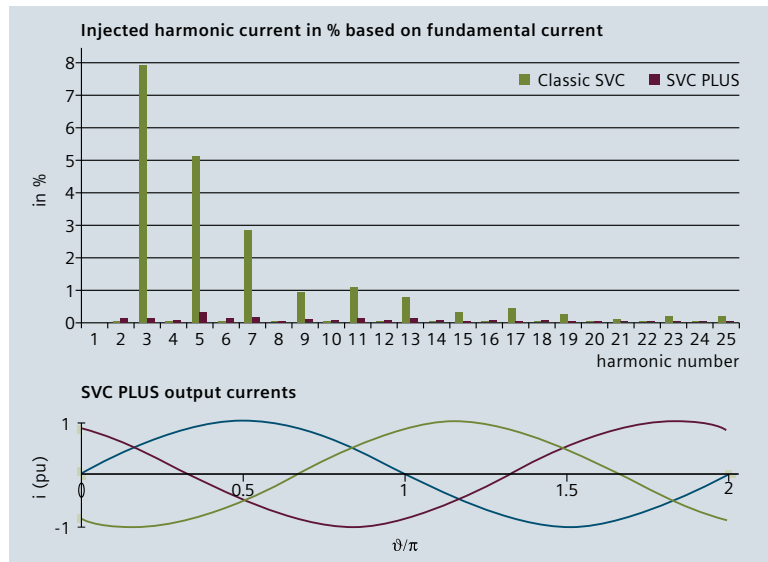
- High dynamic performance: very fast response time
- Excellent undervoltage performance: highly efficient voltage support

Economical benefits

- MMC with low switching frequencies means reduced losses.
- Fewer components translate into less time and cost demands for planning, engineering, construction, and commissioning.
- Lower space requirements help reduce property costs.



Modular system design



Harmonic performance: SVC PLUS versus SVC "Classic"



SIMATIC TDC

Tested and proven performance

Siemens has always been a leader in the reactive power compensation business, both in conventional and innovative technologies. Reactive power compensation based on thyristor-controlled technology started in the mid 1970s and has achieved a high degree of maturity in many applications, worldwide. Based on Siemens' vast experience in shunt and series compensation, active filtering, and HVDC PLUS, SVC PLUS® was developed. It helps substantially improve the quality of power

supply – within little time and at comparatively little expense. The performance and operational capabilities of standard control hardware and software have already been proven in SVC "Classic" projects. The use of well-proven standard design key components such as reactors, capacitors, converter cooling, and auxiliary equipment, safeguard the reliability of SVC PLUS and guarantee operator convenience right from the start.

Examples of applications and projects

Utility application:

- **Kikiwa SVC PLUS, New Zealand:** Installed to meet the reactive power demand of the connected load during and after system faults.
- **Mocuba SVC PLUS, Mozambique:** Provides the most flexible solution regarding system parameters and equipment design.
- **Haywards SVC PLUS, New Zealand:** Represents an integrated part of the reactive power and voltage control of Cockstrait HVDC.
- **Rio Branco SVC PLUS, Brazil:** Due to compact design there is the option to relocate the unit.
- **Blackwater SVC PLUS, Australia:** Designed to compensate for phase unbalances due to railway operations.
- **Goliath SVC PLUS, Norway:** Scored with small footprint for indoor installation.

Grid access:

- **Thanet offshore wind (UK):** Thanet wind farm has a capacity of 300 MW and is located 11 km off the Kent coast of England. Two SVC PLUS systems ensure Grid Code Compliance. The performance of the system has been proved since 2010.
- **Greater Gabbard wind farm (UK):** The 500 MW wind farm is located 23 km off the Suffolk coast of England. The three SVC PLUS systems improve the voltage stability and the necessary power factor correction. Since 2010 the SVCs have been in commercial operation.
- **London Array wind farm (UK):** London Array is the world's largest wind farm with a capacity of 630 MW. Four SVC PLUS systems will be installed for reactive power compensation and Grid Code Compliance.
- In 2010 Siemens was awarded two additional offshore wind grid access projects in the UK: **Lincs wind farm** and **Gwynt y Môr wind farm**. The compact, modular, SVC PLUS design allows the onshore connection substation to fit into limited space.



Mobility applications:

- SVC PLUS technology can be used for Static Frequency Converter purposes in traction supplies.



Industry applications:

- SVC PLUS can also be used to improve flicker performance in industrial applications.

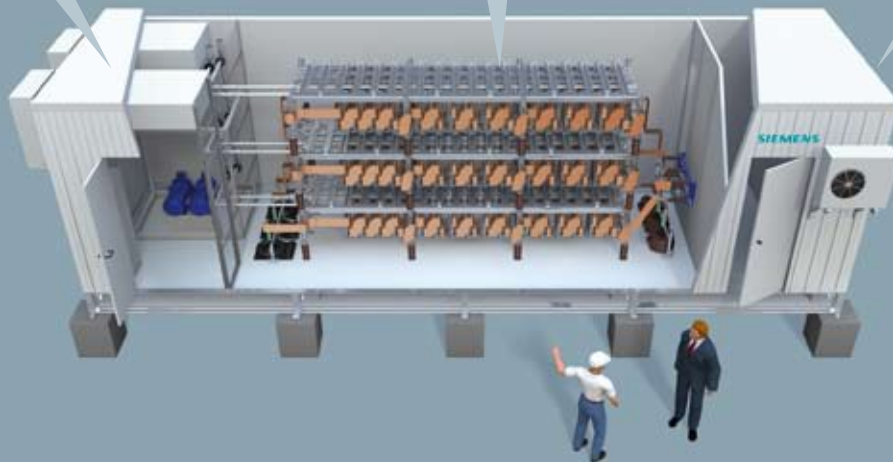
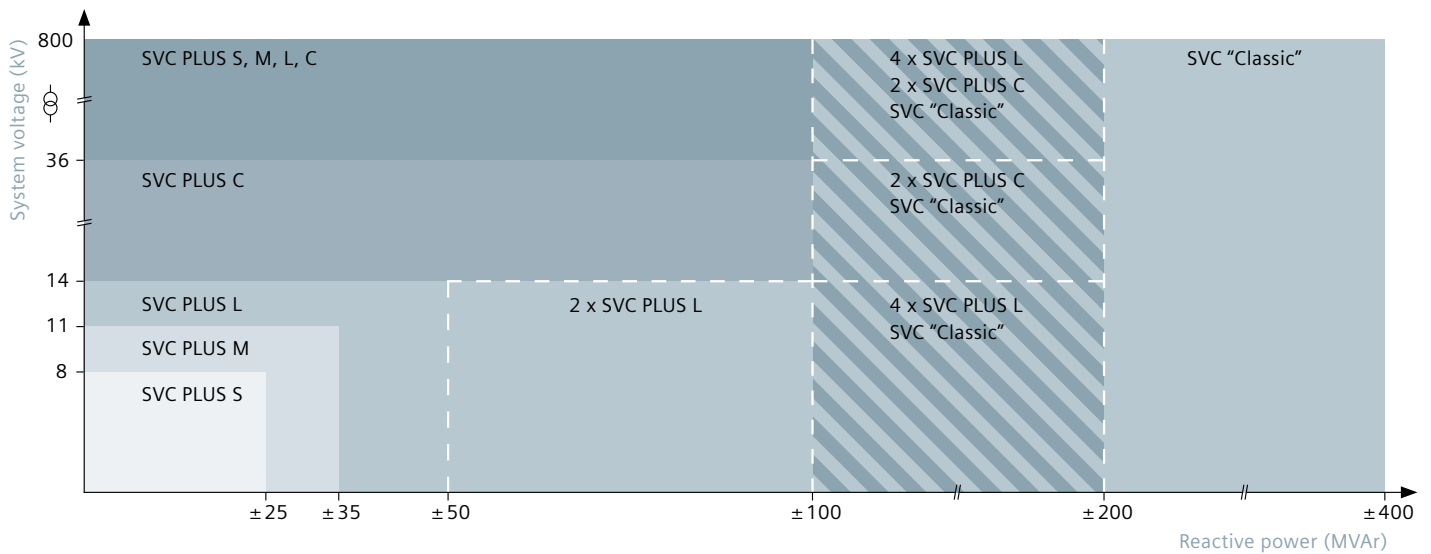
Modularity answering every challenge

SVC PLUS® helps to meet the demands of increasingly distributed generation and liberalized markets. Power producers and system operators all over the world are faced with increasing demands for bulk power transmission, low-cost power delivery, and high system security. At the same time, congestion and bottlenecks cause limitations in power transmission.

SVC PLUS provides a solution to such problems whenever they occur. SVC PLUS can be customized to individual reactive power demands:

Three standardized pre-engineered configurations covering ± 25 , ± 35 , or ± 50 MVar are available as containerized solutions, and up to four of these units can be configured as a system operating in a fully parallel manner. Transformerless solutions are available up to 36 kV. For higher system voltages, standard AC transformers are used.

This modular concept makes SVC PLUS uniquely adaptive without compromising on performance, construction time, and cost-effectiveness.



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Siemens AG
Energy Sector
Freyeslebenstrasse 1
91058 Erlangen, Germany

Siemens AG
Energy Sector
Power Transmission Division
Power Transmission Solutions
Freyeslebenstrasse 1
91058 Erlangen, Germany

For more information, please contact
our Customer Support Center.
Phone: +49 180 524 70 00
Fax: +49 180 524 24 71
(Charges depending on provider)
E-mail: support.energy@siemens.com

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